H. Zwart

The International Library of Environmental, Agricultural and Food Ethics 13

Understanding Nature

Case Studies in Comparative Epistemology

Springer

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1.1 Understanding Nature: Scientifically and Otherwise

In Ibsen's play *The Lady of the Sea*, written in 1888, the main character (Ellida) reluctantly confessed to her husband (Wangel) that she is still under the spell of a mysterious *rapport* with a sailor she once knew, at a time when she was living with her father far off on the Norwegian coast. Wangel wants to be informed in a more detailed manner about their relationship. Ellida tells him that they spent most of their time talking to each other.

> *Wangel*. Of what did you speak, then?
> *Ellida*. We spoke mostly about the sea.
> *Wangel*. About the sea?
> *Ellida*. Yes. About storms and calm. Of dark nights at sea. And of the sea in the glittering sunshiny days we spoke also. But we spoke most of the whales, and the dolphins, and the seals that lie out there on the rocks in the midday sun. And then we spoke of the gulls, and the eagles, and all the other sea birds. I think – isn't it wonderful? – when we talked of such things it seemed to me as if both the sea beasts and sea birds were one with him.[1]

Their dialogue hints at the existence of a form of knowledge about the sea and its inhabitants that is quite unlike scientific knowledge. It is different, but not necessarily deficient. Rather, it has an epistemological profile of its own. It has its own sources of information, a *style* of its own, relying on verbal, informal pathways of communication. It is a more "intimate" form of knowledge: the subject seems to be one, more or less, with its object, seems to coincide with it – Ellida's allusions hint at participation rather than objectification. It is knowledge of an experiential nature, based on careful observations and so elaborate and rich that apparently the mysterious sailor can converse about it, perhaps even "lecture" about it, endlessly. It is not the kind of knowledge one is likely to encounter in scholarly writings. Rather, it seems to evolve from more intuitive ways of knowing nature, perhaps one should even say: from more "natural" ways of gaining insight into the flux and dynamics of pristine coastal life. The subject or observant is attuned to nature. Moreover, whereas scholarly forms of discourse will

[1] Ibsen (1888/2002). Cf. Gutenberg-version: http://www.gutenberg.net/etext01/ldyse10.txt

comply with academic formats, literary texts (novels, poems, plays) seem more apt to capture and articulate this "other", more intimate type of knowledge, albeit often in a fragmentary or allusive manner.

We are accustomed, however, to identify "real" knowledge of nature with science, and for good reasons, so it seems. It is no coincidence that of the two leading international scientific journals, one is called *Nature* and the other *Science*. These titles refer to the two basic poles of the knowledge process, the object and the subject pole. They seem to cover the whole epistemological trajectory. And indeed, science and nature are intimately connected. At first glance, nature seems to have primacy. It seems to go without saying, to speak for itself, that nature is primordial, and science derivative. In the beginning there is nature, presenting itself to us, and science is a "representation". But if we look at their relationship more closely, things are not that straightforward. In a certain way we could also say that primacy belongs to science, because it is science that allows nature to reveal itself, to present itself to us in a certain manner. It creates the epistemological conditions that allow nature to become visible and measurable. Nature is not simply there, she must be made discernable. Without science, our knowledge of nature would be rather limited and superficial; our experience of nature would no doubt be impoverished and less precise. Science has provided us with highly reliable techniques and instruments (e.g. microscopes) as well as with powerful ideas (such as the idea of conducting an experiment) that allow us to discern dimensions of nature that would remain more or less inaccessible if we were to rely solely on "non-scientific" styles of observation. In short, both poles seem equally important. Without nature, science would make no sense, but the opposite is also true: no nature without science. Without science, we would see nature in a completely different and rather diffuse light. Science constitutes the clearing that allows nature to emerge.

This book starts from the conviction, however, that there are *other ways* of knowing about nature besides science. At first glance, this may not seem all that controversial. It seems obvious, for example, that there is something like practical knowledge concerning nature, such as the uncodified, experiential knowledge of gardeners, sailors, wanderers or pet-owners. Someone who travels through a particular landscape on foot on a regular basis is likely to acquire a certain amount of knowledge about such a site. Another important form of knowledge concerning nature is the knowledge articulated by artists, such as poets, novelists, landscape painters or even composers. Johann Wolfgang Goethe (1749–1832) has written many poems on flowers that bear witness to his intimate knowledge of plant forms, although not everybody will regard his knowledge as being "scientific" in a strict sense. Stories by Ivan Turgenev (1818–1883), situated in the Russian countryside, with its endless birch forests and misty ponds, rely on his "firsthand knowledge" (Troyat 1985/1988) of landscapes, birds, mammals and trees, accumulated through years of careful observation and a close "reading" of rural environments. The German landscape painter Caspar David Friedrich (1774–1840) studied the sceneries that he paid tribute to in his paintings very carefully and thoroughly. One could say of his paintings, such as *Riesengebirge* [1835], for example, that there is "truth" in them, even "knowledge". And this even applies to music, so it seems. We can

listen to *Waldesrauschen* [1862] by Franz Liszt, for example, as a fascinating and even bewildering play of notes and chords, but we may also appreciate it as a genuine effort to allow a recognisable forest experience to come to life. Or, to give yet another example, it is clear that Jean Sibelius (1865–1957), in his symphonic poem *Finlandia* as well as in various other works, succeeded in creating a truthful and convincing musical "image" of the Finish landscape. Apparently, he *knew* this landscape extremely well and this enabled him to really call it to life in his symphonic masterpieces. A poem by Goethe, a story by Turgenev, a painting by Friedrich or a musical score by Sibelius may tell us more about a particular flower or site than, for example, a botanical, geological or ecological publication in *Nature* or *Science*. Artists may allow nature to emerge, to come forward in a certain manner – and so does science. Neither the artistic nor the scientific rendering of nature can be regarded as a straightforward "representation". Rather, in all the cases mentioned, nature is experienced *under certain conditions*. Particular aspects of nature are revealed whereas others are neglected or even eclipsed. And to a certain extent we may say that the artist's nature really *is* different compared to the nature of (particular branches of) scientific research. Until recently, however, epistemology as a philosophical discipline was almost exclusively devoted to reflecting on the structure and reliability of scientific knowledge. The objective of this book is to contribute to the emergence of a more comprehensive epistemology, one that is willing and able to critically reflect on the structure and reliability of other knowledge forms as well, in the context of a *comparative* epistemology.

1.2 Towards a Comparative Epistemology of Divergent Knowledge Forms

Epistemology as a philosophical discipline is devoted to answering questions such as What is knowledge? How to assess the reliability and truthfulness of various knowledge forms? In this book, knowledge will be regarded as a *process* in the course of which nature as φύσις, i.e. as something which initially presents itself to us as incomprehensible, inaccessible, unpredictable and diffuse, becomes increasingly transparent and discrete: *objectified* and *accountable* nature. In order to capture the basic momentum of the knowledge process (the work of science), we could refer to the famous Freudian maxim *Wo Es war soll Ich werden* (Freud 1933/1940). Gradually, using concepts and technologies involved in the process of scientific knowledge production, undisclosed, primary, diffuse nature as it initially presents itself to us, will gradually be replaced by more articulate and precise renderings of nature. What tended to be bewildering and non-transparent becomes increasingly discrete. To use a phrase coined by René Descartes (1596–1650): science allows that which was vague and uncertain to become "clear and distinct".

Yet, a similar dynamic can be discerned in art. Artists (poets, novelists, painters, and composers) also have means at their disposal to produce and articulate strikingly "clear" and recognisable renderings of nature. They are also able to present

us with convincing images of natural entities and to make vague intuitions more accessible and discrete. Their rendering of nature may be astonishingly "true to life", sometimes inspiring us to refine and revise our understandings of the dynamics of natural processes. In other words, both science and art can be regarded as forms of knowledge production, as possibilities for nature disclosure. Science is no doubt an important strategy we have at our disposal for studying nature, but there are other ways to further our knowledge and to consolidate our experience of nature. All these various strategies allow nature to present itself to us in a certain way. Comparative epistemology is the discipline that tries to assess, in a critical manner, the relative validity and value of these various forms of knowledge production, these different strategies that enable us to gain important insights concerning nature or natural entities, such as landscapes, animals or plants.

In other words, a comparative epistemology refuses to accept the identification of knowledge with science as obvious or taken-for-granted. Moreover, it refuses to start from a dichotomy distinguishing "hard core" science from other forms of discourse directed towards understanding and describing our world. A famous version of the *science–literature* dichotomy was presented by C.P. Snow in his book *Two Cultures* (1959). According to Snow, intellectual life in Western society is dominated by two polar groups, namely literary authors and scientists. Between the two, there is mutual hostility and misunderstanding. Although his evidence was basically anecdotal, he articulated a widespread view. And epistemology as a philosophical discipline from the very outset has tended to accept this demarcation as well. Traditionally, the focus has unequivocally been on science. In fact, a substantial part of epistemology (from Kant up to Popper and Kuhn) has been devoted to *one particular branch* of science, a favoured discipline so to speak, namely physics. Research in physics was regarded (by generations of epistemologists) as a model for other forms of scientific discourse – it was regarded as the science par excellence. And until recently it was more or less atypical to turn attention to alternative branches of research, such as chemistry (Bachelard) or biomedicine (Canguilhem). And it was even more unusual to submit literary genres to an epistemological assessment and to compare them, from an epistemological perspective, with various forms of science – as Bachelard did.

For a comparative epistemology, however, the opposition between "science" (often identified with "physics") and literature is not a viable point of departure. Rather, a comparative epistemology will tend to distinguish and compare a relatively large number of genres, scientific and otherwise. Each discipline tends to develop an epistemological profile of its own, but the dividing line between "scientific" and other forms of discourse remains fluid and controversial. First of all, it may take some time before particular discourse forms are formally identified as either "scientific" or "literary". In fact, historically speaking, it is a rather recent distinction. Countless texts have been written, in the course of centuries, that may be regarded as belonging to the history of both literature and science. For example, Diderot's *Rêve de d'Alembert* may be read either as a "drama of manners", focusing on views on love and procreation as they existed in progressive circles in the second half of the eighteenth-century in France, but it can also be seen as a scientific

treatise, a science-based anticipation concerning the future development of the life sciences – or both. Moreover, it may take some time for scientific forms of discourse to evolve from a more or less literary towards a more "scientific" style and format. Typically, pioneers in a certain field will tend to express themselves in a rather personal and narrative manner, whereas later generations will tend to formalise and codify their language. Charles Darwin, for example, uses a much more literary and individualistic style of writing than the great majority of subsequent contributors to evolutionary theory, while the writings of Sigmund Freud, William James and other founding fathers of modern psychology are much more personal and narrative in style than most books and articles produced by later generations of academics in the field they helped to create. And the identification of certain documents as belonging to either literature or science can always be challenged. Some scholars have argued, for example, that authors such as Darwin (Bulhof 1988) or Freud (Marcus 1985) can and perhaps should be regarded as novelists rather than as academic authors. On the other hand, although books such as *Alice in Wonderland* (1965a) or *Through the Looking-Glass* (1965b) by Lewis Carroll are usually seen as literary documents, it is not impossible to regard them as reflections on mathematics or as playful introductions to a mathematical understanding of our world. In Chapter 4, I will argue that it would be a simplification to call Herman Melville's *Moby-Dick* a "novel", because what we are dealing with here is a piece of writing that explicitly questions its own official literary status. Melville's book simply does not want to be seen "merely" as a novel. Rather, it presents itself as a work of maritime scholarship.

A similar view applies to the opposite end of the knowledge process, namely "the object". From the very outset, epistemology has challenged a position that is usually referred to as "naïve realism", i.e. the belief that (natural) entities (such as roses or dogs) are simply there, waiting for us to perceive and describe them (in a scientific manner or otherwise). Truth, in this view, is basically the conformity of our descriptions, representations and understandings to the things out there. From the outset, it has been the objective of epistemology to reveal and understand the extent to which we ourselves (as subjects) are present in the things we perceive, in the entities that present themselves to us. Our sense organs, and also our biographies, theoretical frameworks and cultural embeddings will, to a considerable extent, determine the ways in which we allow the natural world to emerge. Once again, knowledge is a process, a synthesis, the product of a complex interaction between sense data and cognitive structures. There are, however, moderate and radical versions of this view. Most scientists, for example, tend to be realists, not in a naïve, but in a moderate way. They realise the extent to which their equipments and contrivances shape their objectivity, but still they tend to believe that their measurements eventually refer to an external reality. Philosophers and other scholars, involved in science studies (in a broad sense), may be moderate realists as well, but more radical epistemologies have also been adopted. In German idealism, for example, the world is primarily the product of thought. And also in our own, more "pragmatic" era, the reality of things has been questioned. According to authors like Latour, for example, scientific "facts" must be regarded as socially constructed.

Whatever position we adopt, the common ground is that roses or dogs are never simply "there". Our practices and discourses allow them to appear in a certain way. In a laboratory setting, a particular plant form will appear in a different light than in a garden. And a poem will bring other dimensions of roses to the fore than the records of experimental trials using them as model species.

This volume starts from the conviction than an abstract and general view on the way in which reality is constituted will not bring us very far. It will merely repeat the various arguments that have already been produced in a somewhat repetitious manner by countless others. Rather than addressing the traditional list of epistemological issues in an abstract manner, I will opt for a bottom-up or case-study approach. I will make use of a number of concrete examples of efforts to describe nature or natural entities that will allow us to confront and compare them as detailed and concretely as possible. In other words, this volume adheres to what may be called an "empirical turn" in epistemology.

For example, this book contains a chapter on dogs (Chapter 5). They have been used as research animals in various experiments, and functioned as favourite animal model for researcher such as Claude Bernard and Ivan Pavlov. But they also appear in countless stories and novels. Indeed, the dog novel can be regarded as a literary genre in its own right. Chapter 5 is not concerned with dogs "as such", but with various *discourses on dogs*. It is not the objective of a philosophical discourse to speak about dogs *directly*. Rather, I study the ways in which dogs appear in various discursive genres. In assessing the truthfulness of a particular form of discourse, it is not possible to step outside the world of discourse into a discursive vacuum, so to speak, in order to ascertain to what extent a dog novel (or an experiment with dogs) does justice to the dog as an "objective" entity. Neither is it my intention to become yet another author writing about dogs myself, as an animal psychologist, or a novelist, or otherwise – that is not my objective. Rather, I will look at dogs indirectly, *through* the eyes as it were of particular discourse forms. My interest is in forms of discourse, rather than in dogs as such. I do not try to understand nature, but rather the various ways is which nature is being studied and understood in various practices and fields. How do certain types of discourse allow us to disclose nature and shape our world? Implicitly or explicitly, the discourses involved will mutually challenge one another. For example, from the point of view of experimental biology, novels about dogs are often regarded as "anthropomorphic". Literary authors are blamed for projecting human thoughts and feelings on the psyche of a dog. Novelists may feel challenged by this reproach, and this may inspire them to refine their methods, or they may remain indifferent to this type of critique. And they on their part may be of the opinion that the ways in which dogs are being described by experimental biologists is impoverished and unconvincing. In other words, dogs always emerge in a particular context, in a way that is questionable from the point of view of rival discourse forms.

One of the dog novels we will discuss in Chapter 5 is *The Call of the Wild* by Jack London. From the point of view of comparative epistemology, this is a very interesting novel because its author is clearly struggling with some of the epistemological issues involved in writing about dogs. His objective is to present us with a

truthful account of the vicissitudes of a dog who suddenly finds himself exposed to extreme circumstances, namely the Yukon region in wintertime, in the days of the Gold Rush. On the one hand, he tries to describe the experiences of his main character more or less "from within", from the dog's point of view, which is of course a difficult thing to do, a real challenge for a literary genius, not only because dogs do not communicate their experiences in a linguistic form, but also because their being-in-the-world, their experience of the world is undoubtedly quite unlike ours. What does it mean to be a dog? How to imagine a world in which smell is much more important than sight, for example? London clearly feels challenged by this epistemological problem, but at the same time he tries to avoid an overtly anthropomorphic bias. But is it at all possible to write a non-anthropomorphic novel about dogs? These are the kind of the epistemological questions I will address in Chapter 5.

Moreover, his novel is not about dogs *as such*, but rather about the way they interact with and respond to their environment. The animal emerges, comes to life, so to speak, in the context of a concrete life-world. To a certain extent, this world is determined by geographical and climatologic conditions and the author tries to describe (as plausibly is possible) how a dog experiences hunger and cold. At the same time, however, it is a human world, of course, inhabited by gold diggers, Indians and adventurers of all walks of life. The author tries to imagine how a dog will manage to adjust himself to such a socio-cultural environment. Epistemological criteria for assessing the extent to which London solves his epistemological problems are not available beforehand. On the contrary, the novel is highly innovative and more or less has to provide its own epistemological criteria. Its aim is to enter and flesh out the Klondike world as seen from the eyes of a dog without turning its main character into a quasi-human being. An epistemological reading of the novel is guided by the question to what extent this ambitious goal is actually achieved. The novel itself must provide us with benchmarks for testing its credibility. We cannot compare the experiences of London's main character with the experiences of an "objective dog", because from an epistemological point of view dogs will always remain entities that emerge in the context of particular situations and particular discourses. That is, we can only determine the truthfulness of London's account in a *comparative* manner.

In short, rather than addressing epistemological issues on an abstract level, I opt for a case-study approach. This is also reflected in the way in which this book was written. It brings together a series of case studies in comparative epistemology, analysing important episodes in the history of research on nature, rather than producing a continuous narrative. Earlier versions of a number of chapters have already been published elsewhere during recent years.[2] The reason for bringing them together in a single volume is that I want to focus attention on comparative epistemology as a philosophical method or research field. In separate publications,

[2] Chapter 4 (2000a), 6 (2000b) and 8 (2004) as well as parts of Chapter 2 (2005a), 3 (1997, 2005b) and Chapter 7 (2003).

the focus will tend to be on the case study that is actually addressed. In a comprehensive volume, attention will shift from "object" to "method", from the case studies at hand to comparative epistemology as a particular way of looking at nature, literature and science.

The focus will be on the epistemology of the life sciences, on types of research devoted to ecosystems, animals and plant forms. "Nature" primarily refers to *living* nature. A comparative epistemology of the life sciences involves a whole set of questions, but the most important one can be formulated as follows: *What is the epistemological profile of science in general, and of the life sciences in particular, in comparison to other forms of knowledge concerning living nature?* I will compare the knowledge claims produced by the life sciences with insights and experiences concerning the living world as I find them expressed in novels, poems and plays. What is it that distinguishes scientific forms of knowledge from artistic ways of experiencing the natural world? Is the distinction between literature and science a meaningful one at all? And if so, is it possible to assess the reliability and truthfulness of these different forms of knowledge? Can we determine their strengths and weaknesses in a meaningful way?

1.3 Cross Sections: A Synchronic Approach

In the context of comparative research of knowledge forms it is important to distinguish between a diachronic (or "historical") and a synchronic approach. A diachronic approach studies the ways in which scientific disciplines evolve in the course of time. In the context of historical research it can be interesting, for example, to compare the discipline called natural history as it flourished during the first decades of the nineteenth century with the newly emerging research field that began to refer to itself as "biology" – but that is not what is at stake here. In this volume, the focus will be on *synchronic* similarities and dissimilarities, on comparisons between *contemporary* knowledge forms. The volume analyses a series of discrete episodes, rather than presenting history as a linear (diachronic) story line. This book starts from the conviction that contemporary forms of knowledge have something in common. They originate from a common ground; they emerge against the backdrop of the same cultural environment, they are informed by one and the same *Zeitgeist*. Therefore, differences that exist between them will be of an epistemological rather than of a historical nature. Thus, the comparison is not between different epochs or periods, but rather between different techniques of knowledge production. What I have in mind is not a history of ideas, but rather a critical comparison of the structure and reliability of scientific and artistic knowledge forms.

Most histories of the life sciences will rather opt for a more or less diachronic approach. It seems the obvious route to take: to start at the beginning (e.g. with Aristotle's *History of Animals*) and from there to work your way towards the present (e.g. the *Human Genome Project*). Histories of the life sciences tend to focus, moreover, on the "internal" history of a field. How are certain events influenced

or inspired by previous research efforts and what has been their impact on subsequent developments? Such an approach follows a longitudinal route through history, preferably focusing on the "highlights" of the field in question. From the very beginning, the life sciences are set apart to a certain extent from other realms of intellectual activity. Indeed, every realm of culture, every single scientific field seems entitled to a diachronic history of its own.

It is also possible, however, to opt for a synchronic approach. In this case, we are interested in the relationships that exist *between* contemporary intellectual trends in various realms of culture such as, for example, art, biology, mathematics or politics. This kind of research opens up cross sections through history. It starts from the basic intuition that contemporary events bear a certain family likeness to each other. To the extent that this is true, the confrontation of developments within the life sciences with simultaneous processes occurring in other domains of a culture may be enlightening. Events that coincide in time evolve from a common cultural background; they share a basic intellectual mood – although the term *Zeitgeist* tends to be avoided as a "mystification", a concept that is too reminiscent of nineteenth-century idealism. Contemporary events mirror and elucidate each other. We may study an event in the realm of politics or art in order to deepen our understanding of simultaneous events in the field of biology, and vice versa. Developments in one particular field may help us to determine the basic dynamics and structure of similar events occurring in other fields. The focus is on relationships and interactions *between* various fields of human activity, rather than on developments *within* a single field.

An example of a study that opts for a synchronic approach is *Wittgenstein's Vienna* by Allan Janik and Stephen Toulmin (1973). The authors do not restrict themselves to studying philosophy as such; the scope of their study is much broader. They try to place Wittgenstein's philosophical work within its "context of discovery". They try to capture the intellectual atmosphere, the Viennese social and cultural situation during Wittgenstein's youth by linking and comparing his ideas to those of representatives of various others fields of activity, such as literature (Musil), politics (Franz Josef, Lueger, Herzl), journalism (Kraus), music (Offenbach, Schönberg), psychoanalysis (Freud, Adler), art (Klimt, Kokoschka), physics (Mach, Planck) and so on. At a certain point they raise a question in their book that can be regarded as typical for a synchronic approach: "Was it an absolute coincidence that the beginnings of twelve tone music, 'modern' architecture, legal and logical positivism, nonrepresentational painting and psychoanalysis … were all taking place simultaneously?" (p. 18). According to Janik and Toulmin, the answer obviously should be *No*. Simultaneous events have something in common. They evolve from the same cultural setting; emerge against the backdrop of the same societal landscape. It seems admissible to start from the idea that there exists a certain affinity or *family likeness* between contemporary forms of creativity, scientific or otherwise. Indeed, similar books as the one on Wittgenstein could be written, for example, on Comte's Paris, Spengler's Munich or Habermas' Frankfurt.

From the point of view of comparative epistemology, however, the unity of site is not a prerequisite. In comparative epistemological research the focus is not on

particular cities or places, but rather on simultaneity as such. Far more important than the unity of place is the unity of *time*. Synchronicity as such suffices. Paris, Munich and Vienna are not seen as different worlds, but rather as local strongholds of a widespread cultural climate – worth studying in their own right, but as case studies so to speak. In other words, a more likely title than *Wittgenstein's Vienna* for a comparative epistemological assessment of his work would have been something like *Wittgenstein's Decade*.

As was already indicated above, this volume contains a *series* of cross sections through the history of scientific research, focusing on the history of the life sciences, but sensitive to contemporary developments and trends emerging elsewhere in their cultural environments. Although synchronicity is the starting point, in the sense that comparisons are made between simultaneous developments in different fields of intellectual activity, the diachronic dimension is not completely absent. Diachronicity is present in the sense that a *series* of case studies is presented, in a more or less chronological order.

Furthermore, whereas more radical forms of comparative epistemology will try to take as many dimensions of a given cultural epoch into account as possible, my objective is more modest in this respect. As already indicated, I will focus on two important domains, namely the life sciences and literature ("belles-lettres"), although on more than one occasion other domains of intellectual activity (such as philosophy, politics or architecture) will be involved in the analysis as well. In the case of philosophy, this is more or less inevitable of course, since philosophy as a discipline has the ambition to articulate the spirit of its time in a more or less general and comprehensive way – in a way that transcends and at the same time clarifies more specific and context-dependent manifestations of the *Zeitgeist* in other cultural domains.

Comparative epistemology is philosophy, rather than history. Although I will make ample use of the archives made available by historical research, my basic questions and interests remain philosophical. Although I use historical data, it is my objective is to address *epistemological* rather than historical issues. The basic issue to be addressed concerns the epistemological status of the life sciences. To what extent do they further our understanding of nature? To what extent are they able to produce a reliable and truthful account regarding the living world? In order to answer this type of question, a confrontation is staged between scientific forms of discourse on the one hand and literary forms of discourse on the other.

The starting point of my research is the rather obvious experience (already referred to above) that, in order to learn something about particular animals, plant forms or natural sites, we may sometimes prefer literary documents to scientific ones, in the same way as it is obvious that someone may learn more about human psychology from reading Tolstoi or Ibsen than from reading academic journals or manuals that have the term "psychology" in their title. This "obvious" fact raises a number of epistemological concerns. Apparently, the scope, the truth value of scientific research is limited. What kind of knowledge is provided by biologists (or psychologists), and where do poets or novelists "take over"? Can the insights that are communicated by literary authors really be considered as "knowledge"? For example,

can their insights be tested somehow, in terms of their truthfulness and epistemological robustness, can they be replicated? How are their insights produced? Producers of literary documents will study animals, plant forms or landscapes in ways that may be completely different from what biologists usually do, but their actual working patterns of the latter are usually more transparent. In order to discern the methods of literary authors, we have to submit their output to a process of close reading. It is not very helpful to content ourselves with saying that biologists present us with an "objective", novelists or playwrights with a more "subjective" version of reality. This is a far too easy answer. Literary documents may set out to describe the natural world in ways that are remarkably convincing and "true to life". They may sincerely try to convey the ways in which nature is experienced *under certain conditions*. They may even invite readers to follow-up and "replicate" the findings as they are presented. Up to a certain point, scientific and literary sources have the same objective: to present us with a truthful view of life. The difference is in the methods used. And although these methods are bound to be dissimilar – and sometimes *remarkably* so – we may discover striking similarities as well. Moreover, we cannot deal with these questions simply by voicing a number of armchair generalizations about "science and art". The only option available, from a philosophical point of view, is to revert to careful case studies, comparative readings of scientific and literary materials, belonging to the same historical setting, but different in terms of tools, methodology and mind-set. Both types of documents will try to convey basic "truths" regarding nature. Is it possible to define what *kind* of knowledge these sources communicate and contain? How reliable are their methods, how valid are their results?

Occasionally, we will come across literary documents that are of special importance because they are exercises in comparative epistemology *in their own right*. They deal with some of the epistemological questions mentioned above *explicitly* in the sense that they stage a confrontation between scientific forms of knowledge and rival genres. These documents, highly relevant to comparative epistemology as a project, will be further discussed in Section 1.5. First, a number of methodological issues has to be addressed.

1.4 Going Through the Archives: Preliminary Issues

A bewildering proliferation of textual materials has been produced dealing with nature and natural entities, such as ecosystems, mammals or microbes. They belong to various genres. Strategies of classification will allow us to produce some kind of order in these archives of overwhelming proportions, but will at the same time prove hazardous undertakings, as the boundaries between the genres involved will often be far from clear and, above all, historically fluid. What all these documents have in common is that, some way or another, they all try to tell us something about nature, or natural entities. Somehow they all allow nature, or natural entities, to become visible in a certain way. They try to convey certain basic insights about the

living world. A comparative analysis of these various types of discourse on living nature will not primarily focus on *what* is said, but rather on *how* it is said. All these insights regarding nature, how are they obtained, how are they elaborated, tested and refined, how are they disseminated?

Documents that try to inform us about nature can be read in various ways. As a rule, readers consulting scientific materials will focus on the data, the information, the "discoveries", the knowledge claims as such. But as soon as these materials are confronted with other types of documents, a shift is likely to occur. The focus will then no longer be on the data as such, but rather on the concepts and metaphors used, on the techniques that authors rely on in their efforts to obtain, analyse and communicate the information. In other words, in the context of a comparative epistemology, the focus will not be on the scientific discoveries as such, but rather on the vocabularies at work, the experimental technologies and conceptual frames of reference that guide the ways in which nature is perceived and understood.

A huge part of the written documents that try to shed some light on nature belongs to the realm of science, but there also exists a wealth of written materials on nature that comes from other domains, such as "belles-lettres". In many cases, it will be difficult to make out with certainty whether a particular text belongs to literature or science. Although these domains have a tendency to distance themselves from one another, and documents may sometimes emphatically endorse a particular identity (be it scientific or literary), the reader may not always share the author's views and there are always substantial boundary zones, especially if we focus on literary documents that are driven by epistemological desires similar to the ones that are discernable in more scholarly forms of writings: the desire to describe nature (or natural entities) in a truthful manner; to make living nature visible and accessible, to pass on to readers certain basic experiences concerning nature; to ask and answer a number of questions with regard to nature. Sometimes, the difference between science and literature seems obvious and the distinction easy to make. After reading merely a few words, perhaps a few lines, it will be clear what we are dealing with: literature or science. On other occasions, however, it may be rather difficult to tell whether a certain document belongs to the one category or the other, even after we have closely studied it. It may well depend, in such a case, on *our* perspective, on the way *we* look at it. If we insist, a classification in terms of either/or can always be made, of course, but in some cases it may seem a rather arbitrary decision, perhaps even a violation. Many treatises on natural history written in the nineteenth century, for example, are likely to be classified as "literary" by the great majority of scientists living today, rather than as scientific. Even Darwin's *Origin of Species*, although undoubtedly a scientific classic, has indisputable literary qualities and characteristics,[3] while the works of his grandfather Erasmus Darwin (1731–1802) are even more difficult to classify as "either" literature "or" science. His famous *The Temple of Nature* (published posthumously) is a long poem containing a theory of evolution. His

[3] This will be discussed more extensively in Chapter 3.

work is reminiscent of the fact that there have been times when poets wrote about science and scientists choose to disseminate their scientific views through poetry. In ancient Greece, the first authors who took to text-writing in order to disseminate their insights concerning nature were actually poets.

Around 475 BC Parmenides of Elea wrote a poetical treatise called Ρερι φυσεος ("On Nature"). Herakleitos ("the Obscure") of Ephesus wrote a work with a similar title in verse. Indeed, Ρερι φυσεος is not the title of a book, but rather the title of a genre. Many other Greek philosopher-scientists wrote treatises under this heading, for example, Anaximander (611–547 BC), Empedocles (495–435 BC), Anaxagoras (*c*.500–*c*.428 BC) and Epicurus (341–271 BC). These works discuss the *nature* of nature, its basic, elementary structure. They convey theoretical, rather than practical or empirical knowledge. In the early days, philosophy was more or less identical with the philosophy *of nature* and expressed itself in poetic formats. In the beginning, a clear differentiation between philosophy, science and literature had not yet established itself. Outstanding philosopher-scientists like Herakleitos and Parmenides were writers of poetry.[4]

The situation started to change, however, when a new generation of philosophers stepped forward, the Sophists who, together with Socrates, shifted the focus of attention from nature to man, from object to subject, from that which is known to the *mind* that knows. In order to understand nature, we must first of all understand ourselves. We have to put our methods, our mind-sets and our senses to the test. We have to engage in a critical enquiry concerning the possibilities and limitations of human knowledge, the reliability of human understanding. The *conditions* of knowledge, the various *forms* of knowledge, rather than nature as such, became the subject matter of philosophical research. When Protagoras claimed that man is the measure of all things, he basically meant that nature presents itself *to us*, that nature becomes accessible as an object of reflection and discourse through *human* understanding.

This shift of focus from object to subject, from "nature" to "human understanding" is something which seems to violate a natural inclination, an inherent tendency of our will to knowledge. We may compare it, I guess, to shooting pictures. Initially, we tend to focus on the objects, the things or scenes we want to retain. Gradually, however, we will start to ask ourselves how *we* may change and influence the way in which a certain object is bound to appear on a photograph. We will critically reflect on the way we use this high-tech contrivance called "camera". The same shift of attention is visible in the study of nature. It is our initial desire to understand the phenomena, the world around us. It is only after an epistemological crisis, an upsurge of deep suspicion concerning our mental faculties and senses, an experience of discontent with what human reason can achieve (such as the crisis that emerged in the days of Socrates), that the urgency is recognised of analysing *ourselves* rather than the world around us. If we want to achieve reliable knowledge

[4] Although "poetry" should not be used here in its modern sense. Hegel wisely said that the sayings of these early philosophers precede the distinction between poetry and prose (1986 III, p. 250).

of nature, a rigorous program of self-analysis is indispensable. And this is likely to incite the authors involved in scientific enquiry to "purify" their methods, their language even, to become linguistic ascetics, and eventually to do away with various stylistic and methodological "contaminations". In the works of Aristotle as they came down to us, for example, we are confronted with a corpus that presents itself as "pure" science rather than as literature. Occasional literary references are explicitly presented as such.

Yet, rigid boundaries between philosophy, poetry and science remain difficult, if not impossible to draw. This also goes for the difference between science and philosophy. Until 1800, the distinction was more or less non-existent. Isaac Newton regarded himself as a philosopher of nature. And the farther we go down the track, the more arbitrary the distinction tends to become. Aristotle, one of the most outstanding philosophers in history, was also a "biologist" in the sense that he was the author of the first important scientific treatise on animals that came to be known as *Historia Animalorum*, in which he described and classified about 520 different species.[5] His pupil Theophrastus, as a result of a "division of labour" so to speak, focused on plants and wrote a *Historia plantarum*. "Natural history" became the title of a genre at the boundary zone between philosophy and natural science, containing a mixture of both scientific observations and philosophical views. That there are insurmountable difficulties involved in trying to demarcate unequivocally philosophy from science is underscored by the fact that, historically speaking, the term "scientist" is of a remarkably recent date. The neologism was introduced by William Whewell in 1833 in order to distance experimental science from medieval scholasticism, and modernity from the Middle Ages. This distinction, however, was ideological rather than historical. Instead of doing justice to the way in which these types of discourse actually evolved, the distinction endorsed and reinforced a number of prejudices about medieval science that were prevalent in the nineteenth century.[6] Be this as it may, deliberations over the question whether Aristotle's books on animals, for example, belong to the realm of philosophy or science, are meaningless in the sense of anachronistic. It will depend on the way *we* read his work. And even today, in the post-Kantian era, countless examples of "hybrid" documents can be cited. Although differentiation has increased, the use of category headings such "philosophy" and "science" remains far from unproblematic. The impossibility of clearly demarcating science from other forms of discourse (such as philosophy and poetry) does not undermine the prospects for a comparative epistemology – far from it. One could say that it is precisely the objective of comparative epistemology to *undo* the "harm" that has been done by problematic strategies of classification, because it brings to the attention of philosophy once again several types of discourse on nature that have previously been discarded as "unscientific". Nonetheless, comparative epistemologists must be well aware of the vulnerable and often anachronistic nature of forms of classification that are likely to be used as "provisional labels" on various occasions.

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[5] "History" in these titles means so much as "factual knowledge".

[6] I will come back to this issue in Chapter 9.

In the eighteenth century, philosophy of nature (directed towards understanding nature as a kind of meta-"object") began to give way to epistemology (directed towards understanding the "subject" rather than the "object" of inquiry), not as a temporary critical detour, but as a more or less definitive "division of labour" between philosophy and science. After a series of dramatic epistemological crises, philosophers consciously began to abandon the ambition to produce a "master discourse" on nature. This is still clearly noticeable in the philosophical discourse of our own time. At present, unlike Parmenides or Aristotle, most practitioners of philosophy will no longer speak about nature *directly*. The desire to understand nature from a purely philosophical perspective is called "metaphysics", and in the course of centuries immense libraries have been devoted to this field of research, but in the eighteenth-century philosophers like David Hume (1711–1776) and Immanuel Kant (1724–1804) convincingly argued that philosophy should be a critical assessment of human understanding rather than a metaphysics of nature. According to Hume, we should examine *ourselves*, "with a narrow scrutiny" (1777/1975, p. 6), in order to find the principles that regulate our understanding, rather than the principles that regulate nature. Causality, for example, is in the eye (or mind) of the beholder. It is the way nature is disclosed and made understandable by *us*. Kant is basically in agreement with this claim. Human understanding, the framing of our mind, determines the ways in which nature presents itself to us. Philosophy is no longer a discourse on nature *as such*, but rather a discourse on our *understanding* of nature, on the extent to which authors (scientific or otherwise) may produce legitimate and reliable knowledge claims. Nature as such is de-listed from the agenda of philosophy. Scientific research should be left to the scientists as experts, while philosophers should from now on regard themselves as experts of subject-oriented forms of reflection (such as epistemology and ethics). From now on, the principal subject matter of philosophy is not nature itself, but natural science. Philosophers will study the work of astronomers, zoologists and botanists, rather than heavenly bodies, animals or plants as such. In other words, philosophy was forced to abandon its original object (nature), but received something in return, a new and fascinating topic, namely the *scientific inquiry* of nature.

Thus, Kant and other "critical" philosophers have successfully transformed philosophy into a critical, *reflective* endeavour, a discourse that is interested in science, in the interaction between science and nature, rather than in nature per se. Philosophers now analyse and write about *discourses* on nature, instead of producing discourses on nature themselves. They write about nature indirectly, so to say, by analysing, supporting or challenging the views and methods of those who write about it more or less "directly". In other words, the philosophy of *nature* became the philosophy of *natural science*. Philosophers may write about microscopes, for example, and may occasionally gaze through one, but they are not expected to use this type of apparatus to further our understanding of what is happening in a particular cell line or in a pond. Basically, philosophers are *readers*. Philosophers may use their eyes and ears, of course, but usually they will do so in order study the ways in which *others* (preferably scientists and poets) perceive or understand the natural world. Philosophy became *epistemology*, the critical analysis of our various

ways to know about, and interact with, nature. How are knowledge claims produced in laboratory environments, in experimental gardens, in libraries and in various other research sites? Comparative epistemology itself is part of this tendency toward self-reflection. The objective of this book is not to contribute to our knowledge of nature or natural entities as such, but rather to critically reflect on the various ways in which they become visible in various forms of discourse.

Another preliminary issue to be addressed in this section is the issue of normativity. Philosophers will not merely describe the knowledge production process, but rather assess it in a critical manner. They will try to determine the reliability and validity of the knowledge claims evolving from various research efforts. With normative questions and considerations in mind, they work their way through the files and archives of scientific enquiry in order to write down their – solicited or unsolicited – judgements and recommendations. As Kant explains in his *Streit der Fakultäten* (1798/1959), producing critical comments on scientific practices has become a legitimate philosophical occupation. And indeed, in the slipstream of Kant's work, epistemology, philosophy of science and science ethics have become major branches of philosophy today.

It is the conviction of *comparative* epistemology, however, that epistemologists and philosophers of science should not exclusively be interested in the *scientific* analysis of nature, but should also devote a substantial part of their attention to other forms of obtaining and transmitting valuable insights concerning the natural world. Literary sources have a special role to play in this respect. They may notably convey and capture informal and uncodified forms of knowledge concerning nature, describing nature and natural entities as they are encountered in the "life-world", that is, outside laboratories. Quite often, literary authors write and observe in a more or less systematic manner, not completely unlike the way scientists work.[7] I do not deny that, as a rule, scientific knowledge is remarkably accurate and precise in comparison to informal, experiential knowledge. Indeed, to adhere to a scientific stance basically means that we refuse to take informal and anecdotal knowledge, obtained in various practical contexts, for granted. And often, scientists will demonstrate that informal knowledge is biased or imprecise. But although we have to be aware of the limits and restrictions of informal knowledge, it is nonetheless clear that in various contexts it will remain a usable and legitimate source of insight. Experimental and experiential, formal and informal knowledge are often seen as conflicting, but from the point of view of comparative epistemology we may well see them as complementary. Even in a world enlightened by Copernican astronomy, sunrise is still a meaningful experience. Everyday knowledge must be regarded as different rather than as deficient, a body of knowledge with its own criteria of reliability and precision. Rather than disqualifying informal knowledge beforehand, because it lacks the rigorous precision of scientific knowledge claims, we may take another course and recognize that various forms of knowledge can at

[7] This is underscored by the fact that contrivances developed for scientific research at times emerge in the titles of literary works. A famous example in Dutch is the literary classic entitled *Camera obscura* by the nineteenth-century poet-theologian Nicolaas Beets (1839/1880).

least be of relative value. They have their own standards of validity. And, finally, informal experiences of nature as expressed in poems and novels may sooner or later function as a source of inspiration for scientific activities, similar to the way new scientific fields may grow out of informal knowledge practices. The field of genetics, for example, now a highly formalised and technology-driven laboratory science, grew out of practical experiences, assembled in the course of centuries in gardens, orchards and farmyards. Gregor Mendel (1823–1884) was not yet a geneticist (genetics as a research field had not yet come into existence), but rather a figure of transition diligently working in the boundary zone between traditional forms of horticulture and modern genetics, the first human being to apply the concept of an experimental trial (with which he had become acquainted during the physics courses he had taken at the University of Vienna) to growing garden peas.[8] It is one of the functions of literary sources to remind us of the value and significance of everyday experience. When it comes to elucidating the ways in which the natural world is experienced under normal, "real life" circumstances, literary documents such as novels and plays may well be consulted. Insights obtained in a laboratory setting can be used to criticise "common sense" knowledge, but it can also work the other way around: literary sources are often used to challenge the "restricted" or "impoverished" views of science. From a life-world perspective, scientific accounts may often be seen as one-sided or even flawed. In laboratories, nature is studied under highly artificial conditions and natural entities are manipulated by means of technical contrivances. Literary sources may then be used as archives containing more "authentic", less "violating" views. Somehow, literary authors have developed their own skills to write about nature and natural entities without the help of scientific equipment, relying on "softer", literary techniques, based on careful observation, but also on discernment and empathy. Yet, how valid and reliable is their output, and what we can we learn from it? Those are the kind of questions a comparative epistemology sets out to answer. They are normative questions, but the standards of judgement on which we may build our judgements are not readily available, not external to the fields involved.

As was already indicated above, there is a special category of literary documents that try to mutually expose scientific and non-scientific views of nature or natural entities to one another. These documents explicitly compare the various ways in which insights regarding nature are obtained, articulated and processed. Rather than fleshing out one particular possibility of experiencing nature, they reflect on the epistemological profiles of various strategies for viewing nature. In short, they are exercises in comparative epistemology in their own right. *Moby-Dick*, for example, exemplifies what Bakhtin (1988) has referred to "heteroglossia": a literary document in which various discourse forms are confronted with one another and played out against one another. This includes a number of scientific genres, but also religious writings, literary sources as well as the verbal and informal dialects of human beings involved in the practice of capturing whales. In short, it is an exercise in comparative epistemology. Jack London's *The Call of the Wild* on the

[8] His work will be analyzed extensively in Chapter 9.

other hand may be seen as a document in which *one particular way* of understanding dogs is fleshed out. Although rival ways of seeing dogs are present in the novel as well, they remain marginal more or less, so that the novel retains a clear epistemological identity and focus. A classical example of a *heterogeneous* novel is Mary Shelley's *Frankenstein*.

1.5 Epistemological Neurosis in *Frankenstein*

On May 4, 1818, Percy Bysshe Shelley (1872, p. 450) wrote the following poem:

Passage of the Apennines
Listen, listen, Mary mine,
To the whisper of the Apennine.
It bursts on the roof like the thunder's roar;
Or like the sea on a northern shore,
Heard in its raging ebb and flow
By the captives pent in the cave below.
The Apennine in the light of day
Is a mighty mountain dim and grey
Which between the earth and sky doth ly;
But, when night comes, a chaos dread
On the dim starlight then is spread,
And the Apennine walks abroad with the storm.

In this poem, in which Shelley addresses Mary Wollstonecraft, his travel companion and future wife, a landscape emerges under particular meteorological circumstances. What the poem tries to immortalise is perhaps not so much nature per se as a particular *experience* of nature, namely nature as *sublime*. It conveys an atmosphere of stillness and openness to nature, a sense of awe. Two years before, on June 23, 1816, Shelley had written a similar poem about the Mont Blanc (pp. 436–439). From the third stanza, the following lines are taken:

Far, far above, piercing the infinite shy,
Mont Blanc appears – still, snowy, and serene.

Once again, a landscape becomes visible and a particular experience of nature – nature as fascinating and immense – is voiced. In this serene context, however, another element is suddenly introduced:

Some say that gleams of a remoter world
Visit the soul in sleep – that death is slumber …
Has some unknown omnipotence unfurled
The veil of life and death? …

The landscape becomes an entourage for a scientific project of dramatic epistemological dimensions. Attention now shifts from the landscape as such to human beings that dwell in this sublime environment, and are apparently visited by unsettling dreams. The dream that is hinted at in this poem by Shelley was actually dreamt by Mary. And it inspired her to write the novel for which she is still famous, set in

the Mont Blanc area, about a scientist who, as her friend Shelley phrases it, "lifted the veil of life and death". This is how she herself described her famous dream:

> I saw the pale student of unhallowed arts kneeling beside the thing he had put together. I saw the hideous phantasm of a man stretched out, and then, on the working of some powerful engine, show signs of life, and stir with an uneasy, half-vital motion. (1818/1968, p. 263)

While travelling through the Mont Blanc region, both the poet and the future novelist became enthralled by a scientific dream, the possibility of transcending the boundary between life and death, and this vision was eventually transformed into the novel *Frankenstein*. It is a work of art that tries to determine the epistemological as well as the ethical profile of the new science of life that was emerging at the time, evoking a combination of enthusiasm and unease, of fascination and horror.

From the point of view of comparative epistemology, *Frankenstein* is a fascinating novel because in a challenging manner, completely different visions on nature are confronted with one another, played out against each other, namely the poetic view on the one hand and the scientific view on the other. Each view, each genre has an epistemological profile of its own.

The poetic view on nature as fleshed out in the novel is reminiscent of and akin to the poems by Percy Bysshe Shelley cited above. In her novel, Mary Wollstonecraft Shelley describes a sublime landscape, composed of a grand deep lake amidst huge snowy mountains: "palaces of nature", beautiful yet terrific. The novel speaks about the magnificent valleys, the "awful majesty" of the Mont Blanc and the "sublime, mighty Alps, whose white and shining pyramids and domes towered above all" (p. 358). It idolizes the solemn silence of imperial nature as well as the solemnizing effect everything awful and majestic in nature is bound the have on the human heart and mind. The language in these passages is poetic. Issues of life and death, origin and destiny are formulated in lofty terms.

It is not the purpose of Mary Shelley's novel, however, only to evoke this atmosphere of the sublime. Quite the contrary, this poetic vision of nature finds itself challenged and disturbed by a rival view, fascinating in its own right, namely the scientific one. Rather than voicing *aesthetic* experiences by focusing on nature's beauties, this view really wants to *unravel* her grand mysteries, her "hidden causes". But science is not a monolithic unity in the novel. On the contrary, two basic strategies, apparently incompatible with one another, the one no less ambitious than the other, present themselves to novices, to newcomers, such as Victor Frankenstein, namely alchemy and modern chemistry.

Initially, Victor Frankenstein immerses himself in the writings of the early modern alchemists, or "necromancers" as they are called in Mary Shelley's work. He reads and studies authors from the early modern era like Cornelius Agrippa, Paracelsus and Albertus Magnus with delight. Their grand, fantastic theories still seem to correspond with and to do justice to the overwhelming mysteries of nature. Alchemy constitutes an intermediate view, so to speak, between poetry (focusing on the sublime dimensions of nature) and modern science (relying instead on detachment and objectification). The poetic and the alchemistic view are not really

in conflict with one another. On the contrary, to a certain extent they seem to reinforce one another, they seem congenial to one another.

The scientific view to which Victor Frankenstein finds himself exposed at the University of Ingolstadt, however, is quite different and, above all, much less tolerant. At first glance, it is an unassuming style of research in the sense that its scope is rather limited. It only takes into consideration those questions that a scientist can reasonably be expected to be able to answer through experimental research. Yet, this unassuming aura is only an epidermal surface. Beneath it, the new science is driven by a will to knowledge so powerful that eventually it will inspire a relentless desire to manipulate and control. At heart, this new science is extremely ambitious and *Faustian*.

Initially, Frankenstein is deeply disappointed by what modern science has to offer. In some of the early chapters, Mary Shelley describes his discontent in the mind-set of modern research. He is disappointed by the achievements of the "recent enquirers" in comparison to the grand theories and dreams of the "forgotten alchemists":

> The ambition of the [modern] enquirer seemed to limit itself to the annihilation of those visions on which my interest in science was chiefly founded. I was required to exchange chimeras of boundless grandeur for realities of little worth. (p. 306)

Soon, however, Frankenstein allows himself to be "converted" to the new scientific mode of thought. Modern chemistry becomes his sole occupation. He begins to conduct physiological research using chemical instruments. After "incredible labour and fatigue" he finally experiences his *Eureka*. And at that point, the grand ambitions lingering in the unconscious realms of modern science become unmistakably apparent:

> How dangerous the acquirement of knowledge is! When I found so astonishing a power placed within my hands, I hesitated a long time concerning the manner in which I should employ it. (p. 313)

Finally, he manages to return human bodily parts back to life, using equipments that produce electricity. Terrified by the spectacular results of his experiment, he flees from his laboratory and suffers a nervous breakdown. He recovers, but it is a partial recovery only. From then on, he is completely unable to continue his scientific work:

> I had conceived a violent antipathy even to the name of natural philosophy [i.e. science]. When I was otherwise quite restored to health, the sight of a chemical instrument would renew all the agony of my nervous symptoms.… I had acquired a dislike for the room which had previously been my laboratory. (p. 328)

Frankenstein gives up his research and desperately tries to resume the poetic and romantic way of life of his more youthful days; centred around reading poetry and wandering through sublime landscapes. But he is no longer able to appreciate and enjoy the romantic aspects of nature any more. It is as if the scientific view has irreversibly infected him. The poetic atmosphere is dead to him and does not come to life again, not even in these sublime surroundings. The result is a depressing epistemological deadlock. Both views on nature, both possibilities of experiencing

nature, the poetic and the scientific one, are from now on denied to him. He can neither appreciate the one, nor endure the other. He succumbs to a chronic "epistemological neurosis" that paralyses him intellectually as well as erotically and socially.

In other words, Mary Shelley's novel is an exercise in comparative epistemology in its own right. The poems Percy Bysshe Shelley had written about their common experiences had been much more *homogeneous*. They strived to articulate and evoke *one particular* experience of nature, the poetic or romantic one that allows nature to emerge as the sublime. From the point of view of comparative epistemology, these poems are interesting precisely because they allow us to study this particular experience in a more or less pure and "uncontaminated" form. Mary Shelley's novel, however, is clearly *heterogeneous*. It stages a confrontation between different visions of nature: poetry, alchemy (a more or less "intermediary" form of discourse) and modern science. The scientific view is not depicted as a coherent whole. Rather, the scientific *ego* (young Frankenstein as a pioneer in the field of modern chemistry) is accompanied by an epistemological alter ego, an *epistemological unconscious* so to speak: the theories of the necromancers he unsuccessfully had tried to repress. Basic ideas borrowed from alchemy have a decisive, albeit more or less unconscious impact on Frankenstein's work and mindset. As he enters the University of Ingolstadt, where the new paradigm of modern chemistry flourishes, he is forced to undergo something of an epistemological conversion. Indeed: *Wo Es war soll Ich werden*, the outdated, fantastic theories of the necromancers must almost violently be replaced by the more exact, reliable and verifiable theories of modern chemistry. But Frankenstein's conversion (his epistemological "therapy" so to speak) was apparently unsuccessful. His therapists did not do a very good job. Eventually, the novel stages a dramatic return of the repressed: a resurge of alchemy, disguised as and armed with the powerful equipment of modern chemistry. Indeed, one could say that the epistemological morale of the story is that in order to become a true and reliable scientist, the struggle against obsolete modes of thought is never really completed and should therefore be continued indefinitely. In Freudian terms, the edification of a scientist calls for an interminable self-analysis – *unendliche Analyse*.[9]

What makes Mary Shelley's novel so highly interesting is that all the views involved (the poetic, the alchemistic and the scientific view) are worked out in a convincing way. They are represented as fascinating in their own right, but at the same time as problematic. The poetic view is fascinating because of its enchanting visions, but problematic because it lacks the precision and objectivity of modern science; the alchemistic view is fascinating because of its grand ambitions to uncover the primal but secret tendencies that are at work in nature itself, but it is problematic because it hinders the individual from really entering and identifying himself with the newly emerging scientific mode of thought; the scientific view certainly has its strengths (the reliability and replicability of its knowledge claims), but is problematic because it estranges the scientist from the sublimities and dignities of nature.

[9] This is precisely the conviction of Gaston Bachelard, whose ideas will be discussed in Chapter 2.

Heterogeneous novels can be seen as exercises in comparative epistemology, although they employ literary instead of philosophical techniques. A genuinely "heterogeneous" novel (or poem, or play), such as *Frankenstein*, will try to do justice to all the views that are represented in it. It will not start from an epistemological bias or prejudice on the part of the author against one particular view or genre. Although of course the basic views or genres involved will be challenged and criticised in the novel, the author herself remains more or less aloof. Instead, one particular form of discourse finds itself criticised by one of the others. The author directs or "conducts" this process, this epistemological "game", but refuses to act as a critic herself. Indeed, Mary Shelley is like the director of a play (Bakhtin 1973, 1988). All genres are given a fair chance to present and defend themselves. A final verdict is suspended. The moral message conveyed by heterogeneous documents will be that all the genres or modes of thought involved will to a certain extent reveal as well as obscure important aspects of nature, although in the end they may perhaps contribute to a more or less comprehensive view, as *complementary* perspectives – but not without dramatic episodes of epistemological struggle and conflict. In other words, the focus of such a novel is not on describing or depicting nature as such, but rather on describing and critically assessing the various strategies human subjects have at their disposal for devoting their life to the project of immortalising, analysing or manipulating nature.

1.6 Outline

This volume consists of three parts. The first part is an introduction to comparative epistemology. Whereas in the present chapter the basic idea has been outlined, Chapter 2 presents a concise overview of the theoretical backdrop or "genealogy" of a comparative epistemological approach. A number of philosophers (Kant, Hegel, Husserl, and Bachelard) are presented as the proverbial giants on whose shoulders comparative epistemologists may stand, although it is clear that more than one pathway may lead to comparative research.

Part II contains the first series of case studies. It is a comparative epistemological analysis of scientific and literary discourses on animals (notably horses, whales, frogs, dogs and ducks). Chapter 3 begins with a historical ("diachronic") overview. The fable literature on animals is confronted with the *Historia animalorum* tradition (the art and science of classifying animals). In addition, a number of other genres and perspectives on animals (comical, tragic, biblical) are taken into consideration. In some of these genres, animals are "objectified", in others they are "anthropomorphised", and in still others they emerge as epistemologically privileged beings. It is not my objective to give an exhaustive historical description, but rather to define a number of prominent positions that will allow me to ask a series of epistemological questions: to what extent do these discursive genres do justice to the "animality" of animals? To what extent do they allow animals to emerge *as animals*? Finally, the focus will shift to the nineteenth century. From now on, the

"synchronic" approach will remain dominant. From a comparative epistemological viewpoint I will discuss the work of scientists such as Georges Cuvier, Charles Darwin, Claude Bernard, Douglas Spalding, Conwy Lloyd Morgan and Ivan Pavlov. Their research efforts will be compared to and contrasted with literary documents on animals and animal research from the same period, written by authors such as Melville, Dickens, Turgenev and Ibsen. They will be regarded as literary counterparts to the scientific domain, mirroring and challenging the ideas that are emerging in scientific practices. The two types of document have something in common: they both try to move beyond the confines of traditional "natural history" and its literary counterpart, the fable literature. In science, this is done along two lines: by introducing the idea of evolution (Darwin) and by introducing the experimental method in research with animals (Claude Bernard). Both have their literary counterparts. While Melville's *Moby-Dick* will be regarded as a literary counterpart to Darwin's *The Origin of Species*, Emile Zola explicitly positions the modern "naturalistic" or "experimental" novel as a literary counterpart to Claude Bernard's in vivo animal research.

As was already explained above, however, a word of caution is in place here. The classifications used above must be regarded as provisional. To say that novels such as *The Call of the Wild* are animal novels is a simplification, of course. As will be explained in more detail later on, London's novel could also be called a novel about a particular landscape, namely the Yukon region, just as Melville's novel is about oceans as well as about whales. It is perfectly possible to read and treat London's book as a landscape novel, or as a historical novel, rather than as a dog novel. Likewise, writings by Ivan Pavlov on laboratory dogs are as much about laboratories as they are about dogs. It is *through* the animal-subject (whale, dog or otherwise) that a particular world (the Pacific Ocean or the sub-Arctic wilderness) is opened up to us. And the animals themselves always emerge as beings-in-an-environment. We could even go a step further and emphasise that novels, plays, poems, scientific textbooks and journal articles are *never* about landscapes or flowers or dogs as objective entities, but rather about the ways in which *human beings* perceive them, write about them, address and assess them.

In Part III, the second series of case studies will be presented, now focusing on the vegetative dimension of nature: plant forms and the landscapes (or ecosystems) they represent. Attention will be given to the writings of scientists such as Mendel, Pasteur and Koch and their literary counterparts. As was the case in Part I, Chapter 7 is much more "diachronically" structured than the subsequent ones. Starting point is the idea of Alexander von Humboldt, Franz Bratranek and others that particular landscapes are represented by typical plant forms that give them an identity, a "face". In Chapter 7 this idea will be used to identify a series of landscape types that have emerged in the Netherlands from the dawn of history up to the present. We will analyse how scientific and literary authors have contributed to the shaping of this landscape. It is indicated that a landscape consists of two dimensions: a dominant and a recessive (or repressed) one. As landscape history evolves, dramatic changes and reversals may be interpreted as instances of repression or as a "return of the repressed".

In Chapter 8, the focus will shift from landscape to environment and from plant forms to microbes. A play by Henrik Ibsen ("A public enemy") on microbes and the environment is analysed in a comparative epistemological manner, through a confrontation with its scientific counterpart: the rediscovery of microbial life in the 1880s by Louis Pasteur and Robert Koch.

In Chapter 9, the focus is once again on plants. Its main character is Franz Bratranek's famous colleague Gregor Mendel. The plant forms he has studied (notably the garden pea) are placed in their proper cultural environment, so to speak, on the basis of a comparative epistemology. Scientific and literary views on plants are presented as "epistemological hybrids" (combinations of dominant and recessive elements). A comparative epistemological approach will be developed to explain why Mendel's work was virtually ignored in his own lifetime, but enthusiastically rediscovered in 1900.

Finally, in Chapter 10, the focus will be on mobility and travel, rather than on place and site. The concept of a journey has always played a major structuring role in both literature and science. In scientific discourse, for example, key publications of prominent authors such as Alexander von Humboldt and Charles Darwin are basically the results of scientific journeys. Also in literary documents on nature and natural science, journeys have been crucially important, from Swift's *Voyage to Laputa* (discussed in Chapter 3) and Melville's *Moby-Dick* (discussed in Chapter 4) up to the writings of Jules Verne, to whose work this final case study is devoted. In his novels, journeys are undertaken to test scientific ideas or to perform experiments under extreme circumstances. By stressing the importance of technology-based mobility, it also emphasises the extent to which the modern world has widened in terms of *scale*. In ancient Greece, science was devoted to animals (Aristotle) and plants (Theophrastus), as entities that were visible to and analysable by the "naked", unsupported eye. They were accessible for a research practice that was not yet a *technoscience*. In Chapter 8, it is described how microscopes open up the world of micro-organisms on the micro-level. In the case of Jules Verne, many of his novels are about technologies that open up previously inaccessible macro-dimensions of the natural world for research and mobility.

This volume ends with Chapter 11, recapitulating and consolidating the analyses and pointing out directions for future research.

Chapter 2
Antecedents: Comparative Epistemology as an Outcome

2.1 Epistemology as Therapy

As was indicated in Chapter 1, "comparative epistemology" developed against the backdrop of a number of developments and reversals in the history of philosophical thinking. As Kant (1781/1975) points out in his *Introduction* to the second edition of his *Critique of Pure Reason*, at least two important turning points must be identified. Both begin with an epistemological crisis, a paralysing epistemological malaise, but eventually result in a scientific revolution, putting scientific inquiry on a completely new and promising footing. These "happy endings", however, presuppose significant "therapeutic interventions" in the form of thorough reconsiderations of the epistemological conditions for producing reliable knowledge.

The first crisis occurred around 400 BC and challenged the "naïve" epistemological basis of the philosophy of nature that had been articulated in a more or less poetic style by the "physicists". The consequences of this reversal were significant. Scholarly research began to evolve in a completely different direction. Poetry and meditation gave way to mathematics as the "royal pathway" towards reliable knowledge, building on concepts such as geometrical proof, deduction and hypothesis. The scientific mode of thinking distanced itself explicitly from other forms of discourse, as was exemplified by the famous passage in Plato's *Republic* describing the expulsion of the poets from the science-based city. And this was not a purely fictional event, but rather an extrapolation and justification of the process of curriculum-development actually taking place in the *Academy* – the educational facility Plato had established in Athens (Jaeger 1959). A new type of philosopher-scientist was produced on this suburban site, replacing the older type: the poet-thinker. Plato's approach not only produced a new type of knowledge, but also a new type of researcher, a truly "academic animal". Although in his *Dialogues* Plato demonstrates his remarkable competence in literary genres, within the walls of his Academy (the suburban sports park in which he and his colleagues and pupils met) only scientific genres were allowed. The *Dialogues* were written for a broader audience. For true academics, a thorough introduction into the rigorous mind-set of Greek mathematics was a prerequisite. The end-product, so to speak, of this process was the oeuvre of Aristotle: built upon a conceptual scheme so impressive that it

was to provide intellectual guidance as well as an intellectual *lingua franca* for many centuries to come, both in the East and in the West. As was explained in Chapter 1, the differentiation between science and philosophy had not yet occurred. The same intellectual rigor was apparent in the "philosophical" as well as (e.g.) in the "biological" writings of Aristotle and his team.

The second crisis described by Kant occurred in the eighteenth century as a result of the impressive achievements of the natural sciences (exemplified by the work of Newton) in comparison to the malaise of metaphysics. As was already indicated in Chapter 1, the impact of this crisis was enormous, notably in terms of agenda-setting for philosophy. It led to an "epistemological turn", a decisive shift from *object* to *subject*, from *nature* to *consciousness*, from metaphysics to epistemology. Philosophy became subject-oriented. Rather than describing the basic structures of nature, philosophy from now on devoted itself to reconstructing and assessing the ways in which knowledge concerning nature was produced. Initially, during the first decades of the nineteenth century, this epistemological therapy proved extremely beneficial. It gave rise to German idealism, exemplified by the works of Schelling and Hegel. Building on a critical reflection on the basic structures of the transcendental subject (*Geist*), this generation of philosophers eventually decided to reconquer the "lost terrain", so to speak, by once again elaborating a full-fledged philosophy of nature, in which consciousness or the subject (the basic structures and dynamics of thinking) played a decisive, constitutive role. Moreover, whereas Kant had developed an epistemological *statica*, Hegel can be credited for engendering an epistemological *dynamica*, analysing the dialectic self-realisation of the intellect through history. Hegel's philosophy thus gave rise to a comprehensive approach, incorporating the concrete findings of empirical and experimental research by putting them in a broader intellectual and cultural perspective. Hegel's *Naturphilosophie* can be regarded as the final outcome of this dramatic epistemological revolution, comparable in significance to Aristotle's *Physics*.

In the second half of the nineteenth century, however, the intellectual landscape changed dramatically again. The *hubris* conveyed by Schelling's and Hegel's *Naturphilosophie* met with strong countervailing forces. Notably the life sciences felt a profound desire to emancipate themselves from philosophy as "master discourse". Although several prominent biologists and chemists in the nineteenth century were educated in the philosophies of idealism and some of them (e.g. Lorenz Oken 1779–1851) were even profoundly influenced by Hegel's ideas, the rise of positivism and the growing confidence in experimental approaches were symptoms of the extent to which and the pace in which the speculative philosophy of German idealism was losing ground. Moreover, this move away from philosophy proved very beneficial to science, at least in terms of productivity. The experimental method proved to be a much more powerful instrument for natural research than philosophical dialectics.

In response to this development, philosophy once again experienced a dramatic crisis, a loss of self-confidence. The response was twofold. On the one hand, branches of philosophy emerged that restricted themselves to propagating and clarifying the logic of scientific research. Eventually, this type of philosophy (from

neo-Kantianism via logical positivism to contemporary analytical philosophy) became more or less subservient to science. Besides this development, however, there was also a more "philosophical", indeed: more self-conscious response: namely phenomenology. This philosophical movement can be seen as an effort to reflect on and overcome the situation of malaise that dominated the second half of the nineteenth century, an epoch during which (unlike before and after) influential philosophers (e.g. Nietzsche and Kierkegaard) tended to work far removed from university infrastructures. Within continental philosophy, phenomenology became the most influential philosophical approach during the first half of the twentieth century. It prepared the ground for a comparative epistemology of knowledge forms. Although the thinking of its founder Edmund Husserl (1935/1977) still maintained a high level of abstractness, comparable to Kant and the neo-Kantians, his followers became more and more interested in the concrete epistemological quandaries emerging in various scientific research fields, such as psychology. In other words, not so much Husserl himself, but rather the phenomenological "movement" he initiated prepared the ground for a comparative epistemology.

The first philosopher who explicitly fleshed out a philosophical research programme that can be regarded as comparative epistemology *strictu sensu* was Gaston Bachelard (1884–1962). Although he joined the phenomenological movement (albeit at a relatively late stage in his career),[1] his view of science, and of the relationship between science and everyday knowledge, is rather unique. He was the first philosopher to divide his attention more or less equally between literature and science.

In this chapter devoted to the "antecedents" of comparative epistemology, four philosophical positions will be assessed explicitly as developments that cleared the field for a comparative approach: Kant, Hegel, Husserl (or rather, the phenomenological movement he inaugurated) and Bachelard.

Kant's *Critique of Judgement* already amounts to a comparative epistemology of various possibilities for experiencing nature (such as physics, biology and art), although he still tends to identify knowledge exclusively with science. Hegel, however, explicitly regards art as a form of knowledge ("denkende Betrachtung"), and he believes that notably modern literature is an art form that may be seen as evolving in the direction of a more or less scholarly and intellectual discourse.

Phenomenology is the "next step". In response to nineteenth-century positivism, this movement acknowledges the possibility of other knowledge forms besides science, for example by rehabilitating the types of knowledge that structures our "life-world". Indeed, phenomenologists have indicated how science evolves from certain presuppositions that can be challenged, thus opening up avenues for alternative possibilities of perceiving and understanding our world.

Finally, special attention will be given to Gaston Bachelard. Although he did not yet use the term himself, he can be regarded as the true founder of comparative epistemology as a philosophical research field. In important respects, his works differs from Husserl's. It is part of the "empirical turn" in philosophy, exemplifying

[1] It was only in his later work that Bachelard explicitly associated himself with phenomenology (1957, p. 2).

a shift from abstract thinking to case studies, from deductive strategies ("more geometrico") to more or less "inductive" forms of epistemological inquiry. Whereas Kant and Husserl raised important questions concerning the epistemological profile of science, they preferred to do so in abstract terms. They were reluctant to apply their views to real-life cases (rather, they preferred the use of fictitious cases or thought experiments). Historical detours undertaken in their work (such as in Kant's introduction to the second edition of his first *Critique* and Husserl's reflection on Galileo's impact on the development of physics in his *Crisis of the European Sciences*, 1935/1977) are the exceptions that confirm the rule. And even these exceptions remain relatively abstract. Indeed, although Kant mentions some scientists by name in his brilliant description of the intellectual "revolution" from which the natural sciences originated (the "Umänderung der Denkart" that gave rise to modern, *experimental* research, B XVI), the analysis is still framed in fairly general terms. Bachelard was the first to address epistemological issues concretely, namely by a close reading of the documents and files that constitute the archives of science and comparing them to other areas of culture, notably the belles-lettres.

2.2 Kant: Why a Third *Critique*?

According to Immanuel Kant, human beings inhabit not one, but two worlds: the world of causality (as studied by physics) and the world of freedom (as studied by ethics). Insofar as we belong to the natural world, our behaviour is determined by physical laws, but insofar as we are moral agents, we are responsible and free. Kant's first two *Critiques* correspond to this basic demarcation. His first Critique, the *Critique of Pure Reason*, published in 1781, is devoted to our understanding of the world in terms of space, time and causality. His second Critique, the *Critique of Practical Reason*, published in 1788, is devoted to our understanding of ourselves in terms of freedom and obligation. The question now is: why did Kant venture to write a *third* Critique?

This question has been raised by various commentators and has been answered in various ways. Apparently, there is something about human beings on the one hand and nature on the other which the first two *Critiques* fail to address in a satisfying manner. But the third Critique is problematical for a number of reasons. Unlike the other two Critiques, the *Critique of Judgement* does not form a coherent whole. Rather, it is something of a hybrid. It consists of two parts, a *Critique of Aesthetical Judgement* and a *Critique of Teleological Judgement* and the connection between the two is – again – an issue that is far from clear and therefore has not failed to occupy the minds of a large number of Kant experts.

To my mind, Kant's reasons for writing his third *Critique* basically come down to the following. In his first *Critique*, he had tried to assess the philosophical significance of Newton's *physics* as a paradigm for scientific research. It outlines the basic epistemological profile of this exemplary scientific way of experiencing the world. But Newton's world is a world of inanimate objects and inanimate forces –

an *abiotic* universe so to speak. What is addressed by Newton is not nature as such, but rather nature insofar as it can be studied within the confines of this (tremendously accurate and successful, but at the same time rather limited) approach. Subsequently, the second *Critique* is rigorously subject-oriented, emphatically emphasising that the subject *as* subject is *not* a part of nature. It deals with a subjective, mental struggle between abstract and unconditional moral obligations on the one hand and natural or psychological "drives" and "inclinations" on the other. Neither *Critiques* allows us to understand human beings as concrete living entities, existing within and interacting with a dynamic natural environment. In both *Critiques*, concrete human experiences with regard to nature as such, and with *living nature* in particular, seem to have no place. Notably, experiences concerning the beauty and sublimity of nature cannot be adequately addressed, neither in the *Critique of Pure Reason*, nor in the *Critique of Practical Reason*. They cannot be meaningfully articulated, neither in terms of the deterministic worldview of Newtonian physics, nor in terms of the anthropocentric worldview of deontological ethics. A third Critique was necessary in order to come to terms with "remainders" such as these, in order to address the epistemological profile of aesthetical and biological understandings of the world.

In other words, in the third *Critique*, certain non-physical forms of experiencing nature are being addressed (where "non-physical" basically means: falling outside the scope of the deterministic worldview of classical physics). The third Critique is devoted to possibilities of experiencing nature that cannot adequately be addressed within the range of Newtonian science (as a paradigmatic example of what should count as science). The aesthetical and the teleological, as dimensions of experience, are devoid of meaning from a purely physical perspective, but emphatically present in what a phenomenologist would call a life-world view of nature. These "leftovers", these unarticulated dimensions of our experience of nature are convincingly elaborated in artistic views of the natural world.

It is in this context that Kant fleshes out a critical analysis of two rather important experiences of nature: the beautiful and the sublime. Nature in the form of the sublime – nature as "uncivilised" nature so to speak – evokes in us a rather complex experience: a mixture of anxiety ("Angst") and respect ("Achtung"). According to Kant, sublime nature emerges as something that is both fascinating and frightening (like an ocean or a mountain range). It is beyond measure, as well as beyond good and evil. Sublime nature is nature as it is represented and experienced by poets (such as Shelley, cf. Chapter 1) and painters, rather than by natural scientists. In order for this experience of nature to be possible, however, in order for nature to emerge as *sublime* nature, certain conditions have to be fulfilled. Notably, it is only possible to experience nature in this manner if we feel sufficiently safe. In a purely natural world, a wilderness, nature will rather be experienced as frightening and threatening. A certain level of technological and cultural development has to be realised in order for the experience of sublime nature to emerge – I will come back to this issue in Chapter 7.

The experience of nature as *beautiful* likewise involves a particular *relationship* with nature. It refers to a *humanised* and anthropogenic nature, to a much greater

extent than the experience of sublimity does. In order for a natural entity, such as a garden or a flower, to appear as beautiful, human intervention and cultivation seem absolutely indispensable. The beautiful is natural and artificial at the same time. It is a highly cultivated form of nature. It not only refers to a particular kind of object, but also presupposes a particular kind of subject, a cultivated and civilised one – or rather, it presupposes a particular kind of subject–object relationship.

Kant emphasises that sublimity, for example, is *not* an attribute of nature itself. It is *our* way of experiencing nature, under certain circumstances (and the same goes for the apparent goal-orientedness of nature). Confronted with the grandeur of nature, we eventually experience our own uniqueness, precisely because we realise that we (unlike other life forms) are *not* completely embedded in the natural world, determined by physical and biological laws. We have the possibility, in principle at least, to formulate and realise values and objectives of our own. A congenial view on the relationship between man and nature had already been articulated by Sophocles in his tragedy *Antigone*. In a famous chorus, nature is represented as δείνος – that is, frightening, overwhelming, grand, immense. Yet, mightier even than nature itself is man. Due to human technology and culture, nature (overwhelming as it is) will in the end be overcome by man. Thus, in the case of Sophocles, as well as in the case of Kant, the experience of sublimity eventually refers to man himself as the rational entity that is able to subdue the overwhelming magnitude and force of pristine nature, relying on the power of his intellect.

In short, the *Critique of Judgment* analyses intimate connections between objectivity and subjectivity, between experiences of nature and certain forms of human understanding. And this is precisely what the third Critique has in common with the *Critique of Pure Reason*: the awareness of the omnipresence of human understanding in our experiences of "nature". Nature is never experienced *as such*. We ourselves are present in our representations. Human understanding determines the epistemological conditions that allow nature to assume a certain appearance. The human agent *constitutes* particular forms of objectivity. *We* determine the ways in which nature is allowed to present itself to us and to enforce itself upon us. *We* determine the format, so to speak, that allows nature to emerge in a certain way. And this is as true for the artistic experience of "sublime" nature (the third Critique) as it is for the scientific experience of "objective" nature (the first Critique). According to Kant, we cannot say that art (by definition) is "subjective" and science "objective". In both cases, "nature" is a synthesis of the subjective and the objective pole.

Kant's *Third Critique* may therefore be regarded as a pivotal preliminary step towards the emergence of the philosophical horizon that allows comparative epistemology to position itself. Science and art are seen as two different possibilities for understanding nature. At times they will stimulate or reinforce one another, on other occasions they will conflict with one another, but a comparative epistemology of these two strategies for disclosing nature is bound to prove a rewarding exercise. At the same time it is clear that although Kant's critical philosophy prepared the ground for a comparative epistemology, it is not yet a comparative epistemology *in itself*, because epistemological issues tend to be dealt with on an extremely

abstract level, but also because eventually he denies that art can really engender knowledge. Yet, he acknowledges that scientific knowledge is *conditional*, that the modern sciences are the result of the introduction of experimental methods, that is, of the basic idea that we can understand something (nature) by changing and manipulating it (albeit under controlled conditions). The experimental method basically claims that, whereas in former Aristotelian times it was believed that human understanding should adapt itself to (become adequate to) its objects, the modern mind has finally understood that, in order to entice nature to reveal her secrets, we must compel the objects of research to conform to – to become adequate to – *our* formats of experience. Comparative epistemology is basically in agreement with this view, but takes this line of thinking to its inevitable conclusion by saying that, if it is true that the use of experimental methods engenders *particular forms* of knowledge, than it is at least possible to expect that other strategies for disclosing nature may exist as well and may in their own way contribute to our knowledge of nature, revealing different aspects of nature or natural entities. This conclusion becomes inevitable as soon as we leave the abstract realm of Kantian thought and study research practices in more concrete and detailed manners. Comparative epistemology will then reveal how, in the context of laboratory research for example, the adaptation of nature to the formats of human understanding can be witnessed. Laboratory researchers will indeed modify nature to such an extent that the object will comply with our research strategies, with our methodologies, our contrivances, our research apparatus. A laboratory is a basic framework that allows nature to present itself in a certain way. Human subjects (human ideas and artefacts) are emphatically present in experimental "observations". Research facilities determine the ways in which nature becomes visible to us. Thus, the scientific way of experiencing nature relies to a significant extent on our experimental mind-set, our research technologies, our technological tools for disclosing nature. Outside laboratories, a completely different experience of nature may emerge.

In conclusion, comparative epistemology agrees with the basic implication of Kant's critical writing, namely that science does not tell us something about nature *as such*. We cannot speak meaningfully about nature "in itself", beyond (and independent from) the possibilities of experiencing nature provided by human understanding (and the facilities we actually erect for making our experiences reproducible and more precise). Starting from this, however, comparative epistemology sets out to assess and clarify in much more concrete terms the epistemological profiles of the various ways we have at our disposal for disclosing nature, the various manners in which we allow nature to present itself. Kant himself calls attention to a number of scientific possibilities (notably Newtonian physics, in his first Critique) as well as certain artistic possibilities (such as the experiences of the beautiful and the sublime in his third Critique) for understanding nature, and here comparative epistemology will follow in his footsteps. But these epistemological possibilities can be fleshed out in much more detailed ways, confronting us with various possibilities (either promising or problematic) for understanding nature. In the life-world, outside our laboratories, outside the reach of "experimental reason" so to speak, nature may present itself to us in a completely different manner than

in an experimental context. But these "outdoor" experiences can be analysed in a more or less systematic manner as well. Under various conditions, nature may assume completely different aspects, and these aspects, together with the epistemological conditions that evoke them, will be described and critically assessed by a comparative epistemology.

2.3 Comparative Dialectics

Another important "antecedent" of comparative epistemology is the work of Georg Wilhelm Friedrich Hegel (1770–1831) who begins his *Lectures on Aesthetics* (1970/1986) with asking the question whether poetry and other art forms genuinely deserve to be a subject matter for philosophical reflection at all. At first glance, he argues, in comparison to science, art clearly seems deficient. It is an amusing, but trivial play, relying on fancifulness and capriciousness. Moreover, art is about appearances, rather than about the real. Yet, Hegel argues, although such verdicts may apply to certain forms of art, they do not pertain to *true* art. For there is knowledge in true art. And indeed, art is about appearances, but this should rather be taken in a positive sense: poems, novels and paintings allow the human world to *appear*. The problem is not that we are dealing with appearances. The question rather is whether the *way* in which art allows the world to appear can be regarded as truthful ("wahrhaft"). According to Hegel, art must be taken quite seriously in this respect. Her objective is to articulate our deepest insights, our highest interests and truths (1970/1986, I, p. 21). True art never merely imitates the natural world. Poets and painters (to the extent that they are *true* artists) never merely try to represent a particular landscape or object. Rather, the focus is on the way in which *they* (or *we*) perceive and experience this landscape, the thoughts and moods a landscape evokes in them (or us). In art, the world always appears as it is experienced by human subjects under certain historical and cultural conditions. Art does not imitate nature, but invites us to consider and reflect on nature.[2] True art really belongs to the realm of thought. Yet, in the case of art, a philosophical reading more or less has to actively recover this conceptual dimension, embedded in detailed descriptions of things, feelings and ideas.

The objective of art is neither merely to imitate, nor merely to articulate so-called hidden feelings. Although it is true that artists (notably poets and novelists) will often explore the less accessible dimensions of human experience, they do not do so merely to show that *nihil humani a me alienum puto* ("nothing human is strange to me"). Rather, their labour is directed towards furthering human self-understanding. We can *learn* something from art. Not only in the trivial sense that there is a moral to every story ("fabula docet"), but rather in the sense that a certain truth about human existence is revealed. Art in general, but notably dramatic literature, is devoted to trying to reconcile apparently irreconcilable conflicts (such as the conflict between the natural and the spiritual, or between individual freedom and

[2] "Die Kunst lädt uns zur denkenden Betrachtung ein" (1986, I, p. 26).

the power of the state). There is truth in literature, and in art in general, but in art (as compared to philosophy or science) this truth becomes visible in a rather concrete fashion. Literature is in many ways a special form of art. It is that art form that has begun to move away from a purely artistic perspective. It is an intermediary form that is already evolving in the direction of more scholarly and intellectual forms of writing (1970/1986, III, p. 234).

In saying this, Hegel seems to anticipate the way the modern novel will develop in the nineteenth century when, according to Zola and others, novel-writing becomes an experimental practice more or less comparable to science (cf. Chapter 5). Yet, Hegel's lecture on aesthetics is backward-looking. It is an immense retrospect that begins with the "symbolic" era (art in Egypt, India and Iran), proceeding with classic art (art in ancient Greece) and then moving on to romantic art (art in early-modern Europe), reaching its completion with a thorough assessment of the significance of the "dramatic" work of art. The novel is more or less absent from Hegel's retrospect. And this explains why the truth embedded in most of the dramatic works of art mentioned by Hegel is of an ethical and political, rather than of an epistemological nature. These dramas are devoted to the issue of how to harmonize, in concrete situations, apparently irreconcilable moral forces. For Hegel, literary dramas contain important philosophical insights. Sentences taken from dramatic authors (such as Sophocles) are treated by Hegel with the same amount of respect as the profound sayings of pre-Socratic philosophers are handled by Heidegger. They are food for thought, but notably on the ethical level.

For Hegel, the exemplification of modern dramatic art is Goethe's *Faust*, and in this play the ethical and the epistemological dimension seem to be equally important. It is a play about ethics (the will to act, the desire to experience), but at the same time it is a play about knowledge (the will to know). Faust is subject to a mid-life crisis. He masters all the disciplines of his era, only to realise that the dreary and bookish forms of knowledge in which he excels do not provide any insight whatsoever concerning the real living world outdoors. In order to explore the great inviting world beyond the confines of his scholarly cell, his *camera obscura* so to speak, the scholar has to be ready to accept the use of more dangerous forms of research, such as the "Faustian" (or "Mephistophelean") experimental method that was beginning to emerge as a generic research method exactly at that time. *Faust* is, no doubt, one of the most intellectual works of art, a scholarly exploration of the world *in rhyme*. But it is backward-looking, a grand retrospect, devoted more to ancient research practices (such as alchemy) than to modern ones, and devoted more to the humanities than to science. Its counterpart, *Frankenstein* by Mary Shelley, is forward-looking, devoted to the sciences rather than to the humanities. Moreover, and this is no coincidence, it is not a drama but a novel. One could say that the novel is the literary counterpart of experimental science, more or less as the historical drama is the literary counterpart of philosophical idealism. Indeed, comparative epistemology takes off where Hegel's idealism came to a stop. It is a sequel to his work. His epistemological reflection on science and literature ended with *Faust* [1808]. Comparative epistemological reflection begins with *Frankenstein* [1918].

2.4 Phenomenology: Science and its Discontents

Today, perhaps even more so than in the times of Kant, it is beyond doubt that experimental research is an extremely fertile, reliable, effective and productive research strategy. It basically consists of carefully determining the conditions under which nature is to be observed and studied. Moreover, experimentation entails "active" observation in the sense that, in an experimental setting, modification precedes perception. Experimenters use their "hands" (in combination with protheses of various kinds) before they use their "eyes" (again supported by various kinds of equipment). Indeed, in most cases, the words "hands" and "eyes" must be understood as a figurative way of speaking in the sense that, rather than physically using their hands and eyes, experimental researchers will preferably rely as much as possible on sophisticated contrivances for modifying and observing (or rather measuring) nature. Instead of looking at nature with the naked eye and interacting with nature with bare hands, researchers will rely on instruments that will generate quantitative data, lending themselves to mathematical analysis.

This way of experiencing nature, productive and reliable as it is, is not without certain adverse effects, however. There is a chronic complaint of long standing, articulated in literary as well as in philosophical (notably phenomenological) sources that the experimental approach basically consists of *violating* the phenomena, of *forcing* them into certain rigid and pre-structured research formats. Other, softer, more gentle, less invasive skills must sometimes be applied if we want to allow nature to emerge in a more truthful manner, producing what Goethe referred to as "soft" rather than "hard" data ("sanfte Empirie"). Examples of such less evasive skills can be found in literary documents. Like experimental researchers, literary authors use various techniques for allowing natural phenomena to become visible and recognisable to us in a plausible and convincing manner. The world as evoked by literary documents may appear as more "real", more authentic than the world of science. The art of writing novels and other literary documents entails a repertoire of techniques – techniques of "finesse". In literary documents, natural entities and their behaviours may be perceived and interpreted with precision, albeit a different kind of precision than we are likely to encounter in scientific sources.

An interesting example of such a "soft" approach to nature is provided by Jean-Jacques Rousseau in his *Reveries of a Solitary Wanderer* (1782/1965). Here he describes how, during his extended walks on the island of St. Pierre in Lac de Bienne, he set out to map the plant life flourishing on his favorite sites, collecting and identifying specimens, studying the details of vegetable life in a systematic, but non-violent way: an "innocent" occupation, a "disinterested" form of contemplation. Whereas the study of minerals or animals would involve equipment and (in the case of research animals) even violence and pain, the systematic analysis of plant life provides peace, quiet and meditation, as we encounter them in their own natural environment. It produces as well as presupposes a certain type of human being, someone who has given up societal interaction and societal ambitions for a solitary existence of self-reflection. I will come back to this example in Chapter 7.

A similar "soft" attitude, a similar reluctance to inflict harm, can be encountered in descriptions of Mendel's work who, rather than questioning nature in an aggressive manner, is said to have applied more intricate skills, painstaking brushwork, caressing rather than torturing nature, carefully moving his paintbrush among the delicate petals in order to fertilize his plants, proving that nature reveals her secrets when she is *stroked* (Mawer 1998, p. 61). His work constitutes an intermediate stage between horticulture and biotechnology – from which it is still far removed. I will come back to this example in Chapter 9.

The idea that research violates nature is notably triggered by animal research. From a phenomenological perspective, it seems that the "animality" of animals is erased and obscured by experimental analysis. Organisms are violated when being dissected, classified or experimented upon. They cease to exist as living organisms, dwelling in a world of their own. They are modified, transformed into a mechanism, an object of research and will no doubt respond by behaving accordingly. Physiologists "prove" that animals are machines by actively reducing them to a special kind of research apparatus. A similar criticism can be encountered in some literary documents on animal research. The basic objective of this volume is to recognize the epistemological significance of this dispute, over and beyond its merely ethical dimension. Phenomenologists have articulated the epistemological concerns involved in this quite pointedly.

Phenomenology is a philosophical genre that explicitly questions whether experimental research allows us to produce an authentic and truthful experience of nature. In his famous lecture on the "crisis" of science, Husserl (1935/1977) already questioned the meaning of scientific research for concrete human experiences in the life-world. The term "crisis" does not refer to the achievements of the sciences as such, but rather to their significance for human existence. In earlier writings Husserl had articulated the phenomenological desire to return to "the things themselves", to restore our original experience of them, and this ambitious project was taken up by a considerable number of followers. Phenomenology became the philosophical movement *par excellence* that developed a critical view towards the experimental sciences and their methods. But phenomenologists also tried to develop epistemological alternatives. Other forms and formats of experience were developed or rehabilitated, notably those that wanted to break away from the "impoverished" and "reduced" ways in which reality was allowed to emerge within the confines of laboratory knowledge. Criticism of the various reductionistic and deterministic tendencies within laboratory science became a favourite theme of phenomenological writings.

Thus, besides criticising (laboratory) science, phenomenology had a positive ambition as well. It wanted to develop alternative methods for analysing and clarifying authentic experiences of natural or psychic phenomena. Husserl himself engaged in this kind of research on a very abstract level, but some of his followers began to analyse more concrete possibilities of experience. And in order to elaborate and articulate concrete experiences in the life-world (i.e. the world outside laboratories) a considerable number of phenomenologists preferably relied on literary sources. Novels and poems were seen as efforts to give voice to concrete and

authentic life-world experiences in a fairly accurate manner. They were regarded as valuable starting points for phenomenological analysis. Literary writers, novelists and poets were regarded as voices that prepared the way and allowed other aspects of nature to emerge than the restricted forms of objectivity acknowledged and accepted in laboratory settings.

Like other phenomenologists, the Dutch psychologist Jan Hendrik Van den Berg (1952/1963) was suspicious of the results of laboratory research with animals. He argued, for example, that Pavlov's research strategies resulted in a rather impoverished and (therefore) unreliable view of what it means to be a dog. According to Van den Berg, Pavlov's views on dogs' behaviour were valid only insofar as the research animals were kept within the confines of a laboratory setting and submitted to the conditions of laboratory life. Pavlov was successful in establishing conditioned reflexes simply because his laboratory settings forced animals to behave in a stereotypical and predictable manner. Outside the laboratory, completely different patterns of behaviour would emerge, and extrapolation of research findings acquired in laboratory settings to the real, extramural world was extremely problematic. The dubious nature of Pavlov's knowledge claims became painfully clear when one day his laboratory premises in St. Petersburg were flooded by water from the river Neva. The research animals had to be evacuated. Human strategies of behavioural control were temporarily suspended by the overwhelming force of ("δείνος") nature. As a result of this event – that could be interpreted as a "phenomenological experiment" – the laboratory dogs spontaneously "forgot" their conditional reflexes. The outcomes of months of painstaking conditioning where literally washed away by this exposure to these unforeseen conditions. According to Van den Berg, the outside world, enforcing itself upon the laboratory in the form of a river flooding, literally refuted and disproved the external validity of laboratory knowledge.

Yet, the phenomenological movement did not restrict itself to merely criticising science. Besides pointing out some of the methodological weaknesses of mainstream experimental animal research, phenomenologists tried to work out alternative programmes for animal research and to initiate a phenomenological movement *within* biology. The intimate patterns of interaction between scientific observers and research animals that evolved in the context of these phenomenological research practices were more reminiscent of everyday interactions between humans and their pets than between mainstream experimentalists and their laboratory animals. Some of the phenomenologists used literary techniques to describe animal behaviour and their writings were often more congenial to literary documents than to mainstream laboratory reports. Their data were often anecdotal rather than experimental. The focus was on the ways in which animals experience, respond to and interact with their *Umwelt*. In terms of style these phenomenological research documents often seemed to convey a "literary" and informal atmosphere.

In the Netherlands, phenomenological biology was represented by authors like J.A. Bierens de Haan and F.J.J. Buytendijk, who were notably active in the field of ethology. Unlike biology proper, phenomenological biology amounted to the analysis of animal *subjectivity* (Bierens de Haan 1940). It tried to understand animal

behaviour "from within", so to speak. As the possibility of verbal communication with animals is denied to us, the phenomenologist had to rely on studying animal behaviour, but as an *expression* of the animal's internal subjective life. The phenomenologist tried to interpret animal behaviour (either under natural or experimental conditions) in such a way that he placed himself as much as possible in the animal's position. Empathy and imagination were important tools for gaining access to the animal's world. Animal phenomenology came to an end when Tinbergen and others "normalised" the study of animal behaviour and transformed it into a "legitimate scientific discipline", a "respectable" science (Burkhardt 1997, pp. 1, 10). According to Tinbergen, animal subjectivity was not really open to experimentation. Thus, in order to place ethology on a more scientific footing, a shift was indispensable from subjectivity to behaviour, from interpretation to "normal" experimental science (i.e. experimentation under strict conditions). Intense communication between researcher and research animal gave way to detached observation. Biologists from now on refused to think of animals in terms of *subjects* of experience. As a consequence, the effort to understand animals from within, by means of anecdotal observation and "soft" emphatic methods and skills, was more or less removed from the realm of science and pushed back into the world of belles-lettres, although more recently, scientific authors have rediscovered and rehabilitated the possibility and significance of more interactive forms of animal research, notably in the case of primates.

An interesting example of an extensive and systematic but (to a certain extent at least) *phenomenological* description of the life and intelligence of bees is the book *La vie des abeilles* [The Life of the Bees] (1901) by the Belgian playwright Maurice Maeterlinck (1862–1949), who won the Nobel Prize for Literature in 1911. In 1907 he published a book that is interesting for similar reasons, on the "intelligence" of flowers. Interestingly, these documents, usually regarded as "literature", are remarkably similar to some of the later works of Darwin – a much more "unsuspected" source. Maeterlinck's books convey an atmosphere quite similar to that of Charles Darwin's study concerning the intelligence and industry of earthworms (1881).

2.5 Gaston Bachelard: Preparing the Ground for a Comparative Epistemology

Gaston Bachelard occupies a unique position in continental philosophy. Unlike mainstream phenomenologists, he is interested in chemistry as his favourite research field rather than, for instance, human or animal psychology. Moreover, science as such fascinates him, its rigorous methodology greatly appeals to him, and he believes it is both legitimate and inevitable that scientists leave the world of everyday experience behind them in order to retire into the artificial environment of a laboratory setting. Rather than trying to rehabilitate life-world experiences as more truthful and authentic than the "reductionistic" experiences of laboratory science, he firmly contends that an epistemological *rupture* inevitably separates the scientific style of thought from

pre-scientific intuitions and the anecdotal empiricism of everyday existence. For Bachelard, the fact that science involves research under rigidly controlled conditions is not a reason for uneasiness or criticism, but rather something which he regards as positive and necessary (1938/1947). At the same time, he is intrigued by the structure of other forms of experience as well, and this induces him to gradually transform his research program from an historical epistemology of science (notably chemistry) to a comparative epistemology of incommensurable discourse forms.

In various writings, Bachelard points out that, whereas scientific knowledge results from a highly rational, methodical and disciplined way of looking at the world, more everyday and intuitive forms of knowledge are dominated by imagination. And this explains why literary documents are so important when it comes to elucidating everyday views. The images that are vaguely present in everyday settings, are elaborated and fleshed out by literary authors in more precise and articulate ways. It is his aim to analyse the basic structures of both scientific (quantitative and formal) and pre-scientific (more or less imaginary) formats of experience. In other words, Bachelard is not only interested in the world of scientists, but also in works of literature. Like many phenomenologists, Bachelard regards literary authors as representatives or spokespersons *par excellence* of the way in which we perceive and experience the world under "pre-scientific" conditions, outside laboratories. Thus, literary sources can help us to understand the epistemological profile of everyday experience in comparison to the epistemological profile of science.

Because of his twofold objective, his view on the relationship between science and literature remains ambiguous. Initially, in an impressive series of publications, he carefully analyses and assesses the epistemological profile of experimental science, notably chemistry. His aim is to reconstruct as concretely as possible the basic logic guiding experimental inquiry. Science emerges in his writings as a way of looking at and interacting with nature *sui generis*. According to Bachelard, the first and foremost challenge of scientists is to break away from pre-scientific views. This is a major task that in an exemplary manner imposed itself on scientific pioneers of the late eighteenth and early nineteenth centuries, but will continue to recur in scientific biographies. We could regard Mary Shelley's *Frankenstein*, analysed in Chapter 1, as a classical narrative of such an epistemological rupture, irrevocably changing the course of an individual's life, a description of a violent and traumatic experience. After his conversion, Frankenstein will never again be able to identify himself with artistic and pre-scientific experiences of nature.

Gradually, however, Bachelard became more and more interested in the faculty of imagination, initially as a "disturbing" factor, an epistemological nuisance, but eventually as something of interest in its own right. In a second series of studies he analyses closely the ways in which literary documents address the material world (the world of chemistry). As a kind of complementary programme, so to speak, he sets out to analyse artistic ways of looking at and interacting with the elements. He discovers that, whereas science is guided by formal styles of thinking, the non-scientific mind relies primarily on imagination and association.

According to Bachelard, the starting point for a philosophical analysis of imagination is a "Copernican revolution" similar to the one presented by Kant in his

Critique of Pure Reason. Initially, we tend to believe than imagination is a mental function that uses observations as its "raw material". Observation (the accumulation of sense data) comes first, and on the basis of these observations we "use" our imaginative faculty in order to change and modify these observations. According to Bachelard, however, we have to drastically reverse this scheme. Imagination comes first. It allows us to structure our observations, to make sense of the world around us. It is at the heart of cognitive processes that enable us to perceive and think about the world. That is why becoming a scientist involves a true mental conversion, an effort on the part of the subject to liberate himself from the sway of imagination, the *logic* of imagination, firmly embedded in our cultures and our minds. Thus, the term "imagination" does not refer to the process of modifying and combining images that are borrowed from sense data. Rather, imagination starts from a limited number of *basic* images ("archetypes") that logically *precede* our everyday perceptions. They are wired into our cognitive system as a priori images so to speak.[3]

The history of science reveals that a number of basic images tend to guide and pre-structure the way in which we perceive the world. These basic, "elementary" images are associated with the four elements (earth, water, air, and fire) out of which, according to ancient, medieval and early modern thinking, the world is composed. Examples of basic images associated with the elements of earth are the rock, the vein and the cave (Bachelard 1948a,b). Whereas the rock stands for robustness and solidity (solid grounds), the concept of the "vein" indicates that we tend to experience the earth as a huge living maternal body in which matter is slowly moving and circulating. Finally, the concept of the cave underscores the association of earth with obscurity and lack of mobility – an association on which Plato's famous simile clearly builds.

Examples of fundamental images associated with water (1942/1964) are the clear stream, the profound lake and the immense waving ocean, but also the image of discovering new grounds, new worlds, breaking away from entrenched positions. Melville's novel *Moby-Dick*, which we will discuss in Chapter 4, can be regarded as a classic elaboration of this archetypical vision of the ocean.

Basic images associated with air (1943) are blue or cloudy skies, gentle or stormy winds, as well as experiences of ascending, falling and flying, of freedom and unprecedented (but hazardous and technology-dependent) forms of mobility (cf. the Icarus myth). These archetypical experiences will be addressed in Chapter 10.

Finally, images associated with fire are purity, excitement, but also sexuality. This explains why early accounts of electricity abound with erotic associations and images. The strongest image associated with fire, however, is the image of the explosion. And this, the risk of explosion, is what lay people find both fascinating and frightening about chemistry, the science that uses fire in order to force the other elements to reveal their secrets.

These elementary images not only dominate (albeit in unconscious ways) everyday experience, but also ancient, medieval and early modern science, notably

[3] "Les images imaginées sont des sublimations des archétypes plutôt que des reproductions de la réalité" (1948a, p. 4).

alchemy. Poets and novelist, as well as alchemists, have articulated them endlessly in countless varieties. In the eighteenth century, Bachelard argues, scientists finally managed to free themselves from the pernicious influence of these elementary images. The imaginary logic of alchemy was finally repressed and a truly scientific view of the world was finally established. Yet, as Bachelard has demonstrated in his writings, in the unconscious dimensions of modern scientific practices, these hidden associations remain more or less active. The desperate struggle of scientific chemistry against alchemy still continues. Initially, Bachelard seems to put all of his epistemological and psychoanalytical equipment in its service. Gradually, however, his commitment with "objectivism" decreases, and Bachelard becomes more and more interested in imagination as a positive phenomenon. His epistemology becomes comparative rather than ascetic.

La psychanalyse du feu ("The psychoanalysis of fire") is an important highlight in his oeuvre. In this essay, Bachelard (1938/1949) emphatically emphasises that science, in order to acquire objective knowledge, should break away from the "immediate" objects of pre-scientific, everyday knowledge – notably fire. Scientists should not study nature as it presents itself to us, but rather under conditions scientists can control. Whereas poets and alchemists as well as lay people are fascinated by fire as an elementary *phenomenon*, it is not really a legitimate object for scientific research. In order to study "fire", scientists will redefine it in terms of combustion, corrosion and others chemical or physical processes and finally the "immediate" phenomenon of fire will be successfully reduced to a set of abstract chemical formulae that can no longer be associated with the time-old images connected with fire (such as the image of the rural family watching the flames in the fireside while being engaged in an endless exchange of fairy-tales and similar narratives). In order to become scientific and objective, Bachelard argues, we have to free ourselves from the seductive and intimate images that have persistently deformed the understanding of so many previous generations of researchers. Thus, science and poetry are seen as antagonistic forces. Poems and stories will continuously reinforce and rehabilitate "fireside" images, while an "iconoclastic" scientific approach will want to do away with them. Science and literature are bound to move in opposite directions.[4] The best a philosopher can hope for is to see them as complementary ways of looking at the world. That is why Bachelard does not hesitate to speak of a "psychoanalysis" of fire. The ancient images have to be left behind in the course of an epistemological intervention: "Wo Es war soll Ich werden". The scientific ego has to free itself from unconscious hindrances and unscientific attachments and beliefs. Bachelard sees it as his task to act as a kind of therapist, guiding scientific experience towards the promising road of "pure", uninhibited science.[5]

Elsewhere he describes science and imagination as two intersecting axes, but at this point in his career he still regards it as his basic objective to minimise the sway

[4] "Les axes de la poésie et de la science sont d'abord inverses. Tout ce que peut espérer la philosophie, c'est de render la poésie et la science complémentaires" (1938/1949, p. 10).

[5] "Canaliser l'expérience dans une voie scientifique" (p. 12).

of imagination, and to maximise the level of objectivity in science. For every scientific author a "diagnosis" can be formulated in terms of these two axes (p. 154). Some authors are still under the spell of the unconscious dimensions and the unresolved traumas of their field – again, we could point to Victor Frankenstein as an example of such a case. They will become hopelessly confused when it comes to working out the objective content of their research. They are perfect candidates for an epistemological psychotherapy. The scientific ego has to learn to be on its guard against alluring images and intuitions. Before long, they will develop into epistemological inhibitions blocking the road towards objective knowledge, or, as in Frankenstein's case, giving rise to grand conjectures, not sufficiently supported by evidence.[6] According to Bachelard, science is basically iconoclastic. A demarcation has to be introduced between the world of poetry and the world of science. But in order to learn how to defend ourselves against the sway of imagination, we have to study it as closely as possible – just as Freud and Jung have studied the unconscious in order to allow the ego to emancipate itself from its influences. What are the basic images and intuitions associated with fire that have managed to confuse even the most "enlightened" minds?[7] Indeed, according to Bachelard, there is an alchemist alter-ego hiding in the unconscious of every scientific *ego*, in the mind of every engineer (p. 13). Scientists and engineers are faced with the task of destroying the unscientific convictions that are still slumbering in their minds; they have to subject themselves to permanent self-criticism.

This is so to speak the "manifest" or "conscious" objective of Bachelard's work. Yet, at a certain point, when he sets out to analyse these hidden images and convictions it soon becomes clear that he finds them much more fascinating than he is willing to confess. His essay on the *Psychoanalysis of fire* gradually moves away from its objectivistic starting point, as its author becomes increasingly preoccupied – not only in a negative (i.e. critical) manner – with the basic imaged associated with the element of fire. Notably, alchemy is bound to become a lifelong fascination. In short, a philosopher of science (who initially uses the techniques and concepts of psychoanalysis in order to liberate the scientific ego from the fascinations of the past) becomes increasingly fascinated by the temptations of the *Es*. His work is like that of a moral theologian who becomes somewhat too preoccupied with describing and analysing the various forms of illicit erotic behaviour. The maxim *Wo Es war soll Ich werden* is eventually renounced. Iconoclasm and imagination are finally allowed to evolve as complementary epistemological tracks. Gradually, both axes become equally important. Eventually, Bachelard develops a profound and lifelong interest in the alchemist tradition for more than only diagnostic reasons – it becomes something of a fascination in its own right – he no longer regards it as an intellectual perversity.

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[6] "Les intuitions du feu sont des *obstacles épistémologiques*" (p. 121).

[7] Bachelard points to the epistemological difference between Marat and Lavoisier. Whereas the latter truly thinks in a scientific way, the former is still a pre-scientific mind, beset with unconscious, animistic ideas. That is why Lavoisier succeeds as a chemist, whereas Marat hopelessly fails in this profession. Out of frustration, he turns to politics and takes his revenge. Due to Marat, Lavoisier ends his life under the guillotine.

This becomes increasingly apparent in subsequent essays devoted to the "elementary" imagination, of which *Psychoanalysis of fire* was intended to be the first part. Although these subsequent books were planned as a psychoanalysis of air, water and earth, the term "psychoanalysis" is suddenly dropped from the title. On the first pages of Bachelard's second essay in this series, dealing with basic images associated with the element water and published 4 years after his essay on fire, it is clear that his attitude towards imagination has changed. Apparently, during the 4 years that separate both publications, his basic objective has become less partisan. The ultimate goal of his program becomes hesitant and unclear. Instead of "A Psychoanalysis of Water", he now opts for a more neutral title, namely *L'eau et les rêves* ("Water and Its Dreams", 1942/1964). And this, of course, is not a trivial change. How can a rationalist philosopher spend so many pages on illusions, articulated in poems and novels on streams, lakes and oceans? The answer is that he has become aware of the fact that these images of water are more than just illusions. They *structure* our perceptions, they *constitute* our experiences. Although it is still his ultimate objective to *become* a rationalist, he confesses that the progress he made with regard to water is limited compared to what he had managed to achieve with regard to fire.[8] Through the uncanny imaginings of literary authors such as Edgar Allan Poe, he has become fascinated by these elementary images as a positive phenomenon, as something indispensable, a common cognitive heritage. In other words, Bachelard inadvertently moves away from a psychotherapy of science to a comparative epistemology, where literary representations of the fluid dimensions of reality are eventually seen as different, but not necessarily as deficient, compared to scientific views. Although *The Narrative of Arthur Gordon Pym of Nantucket*, for instance, may be regarded as quite implausible from a scientific perspective, there is a different kind of truth in it. Poe is an explorer of, a "genius" of the imagination (p. 63). His monotonous work is a "poetical chemistry", a literary analysis of "heavy" water (p. 64).

L'air et les songes ("The Air and Its Dreams", 1943) simply seems to have grown out of Bachelard's fascination with images associated with air. It deals with basic experiences connected with this element such as mobility, ascension and fall. And the same goes for his two-volume essay on the elementary images connected with the earth. No longer are we told that these wonderful images, carefully collected and analysed by Bachelard, are to be regarded as epistemological hindrances. Does he still regard the workings of the imagination as an epistemological blockade? The answer is *No*. Gradually, Bachelard has come to see the experimental view on the one hand and the imaginary view on the other as *complementary* ways of perceiving and constructing a world. Although they are incommensurable and mutually challenging one another, they are both interesting, as well as indispensable, ways of coming to terms with the real.

[8] "La sincérité nous oblige à confesser que nous n'avons pas réussi le même redressement à l'égard du eau" (1942/1964, p. 10).

So far we only looked at the *elementary* images as analysed by Bachelard. No less important are the basic images associated with the sciences themselves. According to Bachelard, a limited number of basic images ("archetypes"), together with the stereotypical expectations attached to them, determine the ways in which literary writers as well as lay audiences are likely to think about and respond to science. As was already indicated, the basic image or archetype associated with chemistry is the explosion. In literary documents (or movies) where chemistry or chemists play a role, a dramatic explosion is likely to occur sooner or later. The explosion is what both fascinates and frightens the non-scientific mind, for example, in the case of the adolescent pupil who for the first time is exposed to a chemical demonstration. Gradually, scientists will train themselves into thinking that an explosion is simply one particular way for substances to interact, no more interesting than, for example, the less spectacular process of corrosion.

The archetype of biology is the monster. The monster-type is the concrete materialisation of nature as frightening and overwhelming – in one word: δεινος– and lay audiences expect that science is driven by the basic desire to come to terms with the monstrous, the spectacular, the sublime. The most obvious exemplification of the biological monster is the dinosaur (*deinos-saurus*), a term coined by Richard Owen in 1840. It illustrates what lay people tend to find particularly fascinating about palaeontology: the discovery and excavation of enormous monstrous remains and, eventually, the visual reconstruction – preferably in full colour and large as life – of the extinguished monster.[9] The same archetype can also materialize, however, into the micro-monsters of molecular biology. A more modern version of the monster is the genetically modified entity that sooner of later is expected to escape from the laboratory in order to become a serious threat to the outside world, as containment will prove impossible.

If Bachelard is right, the same seductiveness of the sublime "Leviathan" that inspired Melville to write his novel *Moby-Dick* (and made him accuse scientific authors of failing to capture the whale's alluring and stupefying grandness) must be the ultimate source of inspiration that also motivated other novelists to write monster novels, such as Jules Verne's *Voyage to the Centre of the Earth* (1864) – which will be discussed in Chapter 10 – Arthur Conan Doyle's *The Lost World* (1912/1981) – not the title of a book, but rather the title of a whole genre – and, more recently, Michael Crichton's *Jurassic Park* (1990/1991). Indeed, lay audiences *expect* biologists to produce monsters. And sometimes, of course, these expectations are "confirmed". Not, perhaps, in a way that is statistically significant, but then the lay mind tends to rely on an anecdotal rather than on a probabilistic manner of thinking. One spectacular confirmation may suffice to revivify the archetypical expectation for years to come.

According to Bachelard, the classical articulation of the monster-archetype is, of course, Mary Shelley's novel *Frankenstein* (1818/1831). For Bachelard, this novel indicates the level of estrangement that already had begun to separate the

[9] According to Stephen Jay Gould, dinosaurs are interesting because they are "big, fierce, and extinct – in other words, alluringly scary, but sufficiently safe" (1996, p. 223).

life sciences from their cultural environment at the beginning of the nineteenth century. Experimental scientists had become professionals or science-workers rather than "amateurs" or gentleman-scientists, had begun to withdraw into laboratories, where they spent long hours working with strange apparatus, thus black-boxing the procedures and technologies of science. Indeed, the information Mary Shelley provides her readers concerning what actually goes on in Victor Frankenstein's laboratory is remarkably sparse. To her, the laboratory is *terra incognita*. Her talent is not to describe and analyse the workings of laboratory life, but rather to articulate, in an extremely careful and convincing manner, the emotional responses this type of work evokes among lay audiences.

Bachelard's work is an important source of inspiration for a comparative epistemology in the sense that he fleshes out in great detail the epistemological profile of two ways of framing our experience of nature, namely experimental science and literary imagination.[10] What is remarkable and somewhat unsettling, however, is the fact that these two dimensions of Bachelard's work, namely his epistemological assessment of science on the one hand and of artistic imagination on the other, are never really brought together. They exist side by side, as it were, as independent lines of research, as independent "fascinations". Whereas his *ego* is interested in the epistemology and logic of experimental science, his alter ego explores the forgotten archives of elementary imagination. Whereas his early work is predominantly devoted to science, his later work mostly deals with artistic imagination. Some of his books emphasise the epistemological rupture that inevitably constitutes the beginning of truly scientific work, while others describe the inevitability and creativity of "elementary" imagination. None of his books endeavours to really connect them with one another. In other words, although his work prepares the ground for a comparative epistemology, he somehow hesitates to take the final step by explicitly staging a confrontation between these two modes of perceiving and interacting with the natural world.

Moreover, his world remains for the larger part an abiotic environment. Bachelard writes about the four elements (fire, earth, water, and air) as well as about the dimensions and experiences of space. That is, his epistemology preferably assesses the epistemological profile of chemistry and physics. His world is not completely lifeless, of course. In the context of the images of water, for example, he discusses the meaning of the swan (1942/1964, p. 50 ff.), while in the context of images associated with earth, attention is given to vegetation and the phenomenon of taking root (1948, p. 290 ff.). Finally, in the context of the experience of immensity, attention is given to the intimate immensity of the pristine forest (1957, p. 170). Yet, he never really becomes a comparative epistemologist of the life sciences. This rather remains uncharted domain.

Bachelard's work was not a *creatio ex nihilo*. His most important source of inspiration was psychoanalysis. In the case of Bachelard, however, this term refers

[10] Bachelard basically restricts his analysis of the imagination to literature ("l'imagination littéraire"). It is a matter of competence: philosophers are *readers*. They feel less at home when working with other art forms (1948, p. 6).

to the work of Carl Gustav Jung (1875–1961) rather than Freud. Whereas Freud was more interested in applying psychoanalysis to the humanities, his alter ego Jung preferably used psychoanalysis to analyse the scientific mind. First of all, he distinguishes between two modes of thinking: discursive thinking and imagination (1911/2001). Whereas the former evolves on the basis of logic and the causality principle, the latter relies on association. Historically speaking, discursive thinking is a fairly recent phenomenon. It was introduced by critical minds like Socrates (the founding father of logic as a philosophical discipline) and further elaborated by Plato, Aristotle and, eventually, by scholasticism. Without this intellectual achievement (the conversion of the Western mind to discursive thinking), the emergence of modern science would have been unthinkable, according to Jung. Subsequently, however, he developed a profound interest in styles of thought that were still dominated by the "logic" of imagination, notably alchemy, as a research field that to a large extent relied on association rather than on causality. Gradually, moreover, he realised the extent to which modern sciences still remain under the spell of "unconscious" and "forgotten" alchemistic ideas. Part of this research was carried out in the form of a correspondence with Wolfgang Pauli (who was awarded the Nobel Prize for physics in 1945) on the content of the latter's dreams (Pauli and Jung 1992). In other words, the case of Victor Frankenstein, a scientist who experiences a fatal "return of the repressed" in the form of alchemistic reminiscences is far from being an idiosyncrasy. Rather, his case may be regarded as "typical". Many prominent scientists (Keppler, Newton, Boyle, Kekulé, and others) have experienced instances of epistemological "relapse". Like Bachelard, Jung devoted many years of study (in fact, the greater part of his research during the second half of life) to exploring the basic logic of alchemy. In Chapter 9, his views will be outlined in greater detail.

This may suffice as a genealogy of comparative epistemology. In Chapter 3, attention will shift to comparative epistemology "proper", the first series of case studies. In four chapters of part II, we will turn attention to literary and scholarly sources dealing with animals and their worlds. Chapter 3 is an introduction to the themes, but the subsequent chapters all address particular "files" or "cases".

Part II
Animal Epistemology

Chapter 3
What is an Animal? A Comparative Epistemology of Animals

3.1 Reasoning Animals: On the Truthfulness of Literature and Science

"Now, what I want is, Facts. Teach these boys and girls nothing but Facts. Facts alone are wanted in life. Plant nothing else, and root out everything else. You can only form the minds of reasoning animals upon Facts". Those are the words of the horrible teacher Gradgrind in Dickens's novel *Hard Times* (1854/1974) who, upon being informed that Sissy's father is a horsebreaker, demands her to give him the definition of a horse. Although Sissy (due to her daily companionship with them) is intimately acquainted with horses, she is nevertheless startled by the question and unable to answer it. "Girl number twenty unable to define a horse! Girl number twenty possessed of no facts, in reference to one of the commonest of animals!", Gradgrind exclaims, and passes the question over to a boy who perhaps never so much as touched a horse, but who produces the perfect answer right away: "Quadruped. Graminivorous. Forty teeth, namely twenty-four grinders, four eye-teeth, and twelve incisive. Sheds coat in spring …" (1974, p. 5).

It goes without saying that "girl number twenty", *because* of her silence, is Dickens's heroine. She knows too much about horses, about their way of being-in-the-world, to force her knowledge of them into a factual definition. That is, she refuses to become a "reasoning animal" in Gradgrind's fashion, someone who defines the world in objective, factual terms. She seems to realize that such a language will not allow us to articulate what horses really are. The animal's way of being is obscured rather than brought to light by the restricted and impoverished language of facts, quantities and definitions. Rather than allowing us to understand them, it is bound to estrange us from them.

The *comic* nature of the scene resides in the fact that Gradgrind demands a certain speech genre (the objective, scientific language of facts and definitions) to be automatically applied to any object whatsoever (cf. Bergson 1940/1969). Eventually, however, human beings rather than horses will find themselves impoverished by this ridiculous procedure. Indeed, in Dickens's novel, the definition of the horse is preceded by a definition of man as a "reasonable animal". In order to be able to perceive the world in factual terms, this is what we have to become, depriving ourselves of

other possibilities of interaction and coexistence. While defining animals in strictly "objective" terms, we deprive ourselves of the possibility of a more intimate and, according to Dickens, more genuine companionship with them. Gradgrind's definition of a horse is as comic as the famous definition of man as a "featherless biped", attributed to Plato and mocked by Diogenes the Cynic, who plucked a fowl and brought it into the lecture room with the words, "Here is Plato's man". As a result of this joke, "having broad nails" was quickly added to the definition (Diogenes Laertius 1925/1979, 6:40).

The reason for referring to this passage in *Hard Times* is that it points to something which, from the point of view of comparative epistemology, is obviously important, namely the claim, put forward in this novel, that the apparent self-evidence of a scientific (objective, factual) understanding of the world, advocated by Gradgrind, may decrease our ability to discern what animals really are. Relying on the strategies of this type of discourse, we may have estranged ourselves from the possibility of developing a more profound acquaintance with animals, a more profound understanding of their way of being. Moreover, there is an intimate connection between knowledge and interaction, between the question what an animal *is* (the animal's way of being-in-the-world) and the question how to approach them, how to treat them (the question of animal ethics). Science apparently has obscured our proximity to animals, but it has also obscured the fundamental *difference* between their way of being-in-the-world and ours. It has obscured our understanding of the *animality* of animals.

This seems a truly philosophical concern. Yet, when it comes to rediscovering and unearthing the animality of animals, philosophy does not seem to have that much to offer. Only recently has the issue of animalhood been granted a reasonable amount of space on its agenda. It may safely be said that, during two and a half millennia of philosophical research in the West, philosophers have been by-passing this issue with remarkable stubbornness. Genuine philosophical interest in animals has been remarkably sparse, notably given the fact that we are animals ourselves. For centuries, philosophers were predominantly interested in *reasoning* animals, but mostly insofar as they were reasonable, hardly insofar as they were animals. Throughout history, philosophers have been obsessed, so to speak, with the issue of humanhood. And they tended only to speak or write about (other) animals in order to say something about humans, indeed, in order to *distance* ourselves from other animals.[1] Animalhood as such was hardly ever at stake. The animal realm was basically used as a backdrop in order to emphasize the uniqueness of the *animal rationale*. Other animal species had only "instrumental" value, so to speak, their animality did not constitute a legitimate philosophical issue in its own right. The humanity of human beings was regarded as something we "possess" over and above our mere biological existence, our animality. Non-human species found themselves beyond the scope of epistemology almost by definition. And although

[1] Even the term "animal" is affected by philosophical anthropocentrism. Whenever animals are mentioned in philosophical writings, the term usually tends to refer to animals more or less similar to ourselves, preferably mammals, rather than insects or snails.

philosophers did produce a number of highly influential claims concerning animals, such as the claim that they are basically *machines*, these claims evolved either from scientific research (cf. Chapter 5) or from reflections on what it means to be a *human* being (i.e. a rational subject who happens to occupy, and has been charged with the management of, an "animal" body). Hardly ever was animalness or animalhood addressed directly.

Would it be possible to remedy this defect, to produce a genuine philosophy of animalness? As was already indicated in the first chapter of this volume, if we want to know something about animals *as such*, a philosopher is not the most likely expert to consult. An animal is a "piece of nature", as Kant would phrase it, and philosophers are expected to critically reflect on *disciplines* dealing with animals, such as zoology and physiology, rather than on animal existence as such. It is no longer seen as the proper task and ambition of philosophy to speak directly about nature, or natural entities such as animal species. Rather, philosophy has become a critical reflection on the views and experiences brought forward by others, by other genres of discourse, notably scientific and literary ones. In these immense layers of discourse, animalhood has not at all been neglected. Indeed, for many centuries, both scientific and literary authors have been writing about animals abundantly, often in very detailed ways. In other words, if we are interested in addressing the long-neglected epistemological and ontological issues involved in animalhood, scientific and literary documents constitute our obvious point of departure. A comparative epistemology will have to follow these authors, take up the issues and questions raised by them, either intentionally or unintentionally. We will have to scrutinize and question these sources. To what extent do they allow us to determine what an animal *is*? To what extent do they shed light on the world and existence of animals? To what extent do they provide a clearing that allows animals to really become discernable?

In the course of history, humans have described and studied animals in various ways. A great variety of scientific, literary and other genres has emerged. As a rule, scientific research practices involving animals are documented quite accurately and extensively. The writings of researchers like Charles Darwin or Ivan Pavlov are not only important because of the wealth of research data they contain, but also because they include interesting details regarding the ways in which researchers and their research animals interacted, within the confines of an animal laboratory or in other research settings. Likewise, biographical and autobiographical sources may tell us something about relationships between humans and animals (wild or domesticated) in everyday life. Finally, novels, poems and plays may inform us about the lives of humans and animals, about the ways in which animals interact with their worlds or human–animal relationships evolve.

There is a chronic dispute of long standing, however, over the comparative value of these sources. Which of them represents animals in a more truthful and realistic manner? In certain respects, scientific sources seem more reliable and adequate, but in other respects literary sources can be seen as more revealing and true to life. It would be a mistake to try to answer this question once and for all in a general way. Several types of literary and scientific documents can be distinguished. They may

all in their own way shed some light on the question of "animalhood", on what it means to be an animal, but they will all have their limits and restrictions as well. In order to determine their epistemological status, their relative value, concrete scientific and literary sources on animals will have to be assessed in a comparative manner, guided by the question to what extent they are able to produce a convincing account concerning the "animality" of animals, their being-in-the-world. It seems clear that animals, notably "higher" animals such as birds or mammals, are not simply "objects", but *living* organisms, dwelling in a world of their own. They undoubtedly perceive and experience the world around them and interact with their environment. Is it possible for scientific or literary authors to somehow enter their world? Or is this something which is principally denied to us? Is it at all possible to try to imagine what the worlds of animals (e.g. whales, dogs or horses) look like "from the inside"? And what about the world of frogs and snails? In what kind of world do they dwell? Are their worlds impoverished in comparison to ours? Or is it also possible to imagine that, in certain respects, animals may have access to dimensions of reality far beyond our imagination and comprehension?

This chapter serves as an introduction to a comparative epistemology of animalhood. In the next section, scientific and literary views on animals will be placed in a broader, historical and, indeed, "diachronic" perspective. I will discuss a number of rather influential genres, articulating more or less typical views on animals. It will be indicated that both the scientific and the literary genres involved have remained remarkably stable during extended periods of time. Aristotle's *Historia Animalorum*, set the stage for centuries of animal research, finding its literary counterpart in the fable literature, that likewise originated in Greece. The various literary subgenres that have emerged in the course of centuries tend have something in common: they tend to represent animals in remarkably stereotypical and anthropomorphic ways. These discursive traditions of rather long standing, what do they tell us about animalhood?

This "diachronic" preview will serve as a backdrop for the subsequent sections, in which we will begin to develop a much more "synchronic" approach, focusing on the second half of the nineteenth century. Our motives for paying special attention to this period – in this volume, but also in this chapter – have already been addressed. During the second half of the nineteenth century, the life sciences "emancipated" from the sway of speculative philosophy (i.e. "German idealism"). Research concerning animals came to be placed on a firm scientific footing, on the one hand because biology increasingly became an experimental science, on the other hand because the concept of evolution dramatically changed our view of animals – and of ourselves in relationship to them.

Yet, from a comparative epistemological perspective it is certainly no coincidence that this same period was also the "Golden Age" of the novel as a literary genre. In their descriptions of animals, nineteenth-century novelists went far beyond the restricted stereotypes of the fable literature as it still flourished in the eighteenth century. In other words, during this period, both scientists and novelists discovered animalhood as an important and fascinating object, and both scientists and novelists developed powerful techniques for producing truthful and accurate

accounts of animal life. This also explains why in the second half of the nineteenth century a number of documents were written that explicitly endorsed or challenged the truthfulness of either the literary or the scientific views. Science and literature were more or less in competition. In this chapter, some important positions in this debate are sketched in outline, to be developed more fully in subsequent chapters.

First of all, a number of literary documents appeared in which the claim was made that the scientific way of treating and describing animals was fundamentally flawed. *Hard Times* by Charles Dickens, already cited above, belongs to this trend. Indeed, in the 1850s and 1860s the epistemological dispute between literature and science on animalhood reached a climax. I will elucidate this by referring to one of the most famous animal novels of all time: *Moby-Dick* by Herman Melville. A short introduction to (the epistemological significance) of Melville's novel in this chapter will serve as prelude to the much more detailed epistemological reading of this work in Chapter 4.

More or less during the same period, however, the opposite claim was also made. Protagonists of the scientific view (and this includes literary and philosophical authors besides scientists) stated that traditional literary forms tended to produce exaggerated or highly stylized representations of animals. These poetic representations, charming and edifying as they may be, are flawed and biased; they obstruct rather than enhance an adequate understanding of animal life. The poetic iconography of animalhood stands in the way of a more realistic and truthful rendering of the animal world.

Two literary authors are here presented as advocates of a more scientific view, namely Jules Verne and Emile Zola. Jules Verne (1828–1905) has written a series of novels (e.g. *20,000 Leagues Under the Sea*, 1870) that can be regarded as prominent efforts to flesh out the epistemological significance of the scientific understanding of nature. Moreover, Emile Zola's essay *The Experimental Novel* (Le roman expérimental, 1880) is also an important document from our perspective as it points to *structural* similarities between the ways in which literary and scientific documents are designed. His essay will also be briefly discussed in this chapter, as a prelude to a more elaborate discussion of the relationship between literature and experimental physiology in Chapter 5.

Subsequently, attention will be given to the writings of Charles Darwin. They are commonly regarded as scientific documents, and for good reasons of course, but clearly have a literary significance as well. They are situated on the borderline between science and literature, constituting a middle-position so to speak between some of the rival positions described above. To what extent does his work allow us to do justice to animals as animals? Again, this section is actually a prelude to a more extensive discussion (Chapter 6) of the type of animal practice encountered in Darwin's later writings.

Finally, as was already emphasized, animals are not merely (scientific or literary) *objects*, they emerge as *subjects* in their own right, subjects of their own world. Therefore, in the final section I will draw attention to a number of documents that suggest that animals are, epistemologically speaking, privileged beings, subjects of a completely different kind of world than ours, who are granted access to dimensions of experience that are principally denied to us.

3.2 The Comical, the Tragic and the Biblical View

In 405 BC Aristophanes' comedy *The Frogs* was performed for the first time. The first Chorus of the play begins as follows:

Brekekeke ko-ax ko-ax
Brekekeke ko-ax ko-ax

This is generally considered the first effort in history to capture animal sounds phonetically. In Aristophanes' play *The Birds* a similar effort is made, a similar chorus line can be encountered:

Tio tio tio tiotinx

These plays constitute examples of the ways in which literary texts may contribute to our knowledge of animals and animal behaviour. The plays as such, however, do not seem very interesting for readers who are explicitly interested in animals, because the frogs and bird are depicted in a remarkably anthropomorphic fashion. They are human beings in bird-like and frog-like costumes (both literally and figuratively). They speak a human language and are guided by human motives and desires. We hear their animal voices very briefly – but alas, before long they switch to a human tongue. Thus, in Aristophanes' plays, animals enter into a truly "human" dialogue with humans. The birds in his play are not nesting in the clouds, but rather involved in establishing a *polis*, a Greek colony in the air. In short, they are not at all behaving in an animal-like or bird-like fashion.

Whereas these literary documents hardly distinguish between humans and animals, some prominent philosophers, working in the same period, tended to *emphasize* the difference as much as possible. The branch of philosophical discourse initiated by Socrates, Plato and Aristotle stresses the uniqueness of man. Dialogue, reasoning and polis-building are possibilities (or lines of action) that are principally denied to animals. In his book on politics, Aristotle claims that, of all animals, only man is by nature a *political* animal in the sense that man alone of all animals possesses speech (1932/1967; 1253 a 3). Although animals are able to produce sounds, they do not have a voice. Although they are able to shriek and howl and bellow and whistle and wail, they do not produce meaningful words. Although they are able to signal pain or fear, the possibility of conveying meaning is denied to them. From an Aristotelean perspective, rather than truly describing human behaviour, the "animality" of animals is erased and obscured in Aristophanes' plays. Aristophanes voices a popular, pre-scientific view on animal behaviour and human–animal relationships.

Aristotle is not only the most important philosopher of his time, but also the most important biologist, who did much to enhance the scientific practice of classifying animals. While his teacher Plato had already introduced the dichotomous technique of classification in terms of species and genera that is still in use today (providing all species with a first name and a surname so to speak), Aristotle described and classified some five hundred and twenty species (notably marine animals) in his writings. These classifications are based on anatomical research. Rather than viewing animals from a distance, as typical *images*, the scientific

gaze really tries to enter the hidden intimacies of animal life, in search for basic structures. This gaze is not purely empirical, it is pre-structured, in the same way as Aristotelian philosophy is. Aristotle starts from, and discovers a series of, influential dichotomies that still make sense to biologists today, such as the distinction between warm-blooded and cold-blooded animals. A dichotomous logic is guiding his observations and pervades his work. Gradgrind's practice of classification is a parody, a "degeneration" so to speak of a type of discourse that was inaugurated by Aristotle and still dominated the life sciences in the eighteenth century as the core business of animal science.

The fact that Aristotle combined scientific research with philosophical contemplation was typical for the period. Philosophical and scientific views on animals tended to think along similar lines. Indeed, the distinction between both types of discourses can only be made in retrospect. Aristophanes' plays constitute a popular antipode (non-academic in an emphatic way) to this type of science-philosophy, this academic "master discourse" on animals. Indeed, in one of his plays, he explicitly derides Socrates, clearly assessing his work from a lay person's perspective. From an academic point of view, Aristophanes was clearly an outsider. His work is part of a much broader literary context and, as far as his method of depicting animals is concerned, akin to the literary genre of the fable – a genre that more or less began with the fables of Aesopus, 620–560 BC. Although some of the stereotypical character traits of fable animals may have been borrowed from the actual behavioural repertoires of the species they represent (e.g. the proverbial cunning of the fox), the animals involved tend to act and think like human beings, rather than animals. Insofar as their stereotypical features are based on observation at all, it must have been observations of an incidental and anecdotal nature, highly dependent on observer biases as well as cultural traditions and expectations. The result can hardly be expected to correspond in a recognizable manner with animal behaviour as it is studied and described by professional ethologists today. Fables contain moral lessons for humans, concerning the way we humans should behave, not with regard to animals, but among ourselves.

The "fable view" on animals continued to exist during the Christian era and far beyond. A well-known legend, that became rather popular in its Christian version, namely *Androcles and the Lion*, is written along these lines. It is set in the Roman Empire during the early Christian period. Androcles, a meek Christian, encounters a lion in the desert who is suffering from a painful thorn in his paw. Androcles removes the thorn, and thus the lion becomes his friend. Later, Androcles is captured and taken to the Colosseum with a group of Christian prisoners. He is sent into the arena to face a lion, who turns out to be the same lion he befriended. The lion joyfully licks Androcles' face in recognition. It is a charming and no doubt edifying story, but at the same time it is clear that, rather than describing real-life interactions, it conceals and prettifies extremely violent human–animal relationships. In the real Colloseum, thousands of animals (among them, lions) were slaughtered, and the real animal contemporaries of this friendly but imaginary lion suffered a much bleaker fate than his. Real animal practices did not display much *caritas* in those days.

Another highly influential genre was tragedy, the antipode of comedy and apparently much more realistic, originating in ancient Greece as well. *Antigone* by Sophocles contains a famous chorus devoted to the basic attitude of human beings to nature in general, and to animals in particular. In this chorus, nature is represented as δεινος – that is, frightening, overwhelming, grand, immense. Yet, mightier even than nature is man. According to Sophocles, our relationship with animals will always and by necessity contain an element of violence. We behave violently and aggressively towards nature and natural entities, and cannot do otherwise. We force animals to do things they would not do on their own accord and in the end our relationship usually ends with killing them. Even animals that are superior to us in terms of physical agility or strength (e.g. horses or bulls) are captured and subdued by us.[2] For thousands of years, the relationship between humans and animals has been dominated by cunning and aggression, by clubs, whips, nets, knots and ropes. This is, so to speak, the tragic view on human–animal interaction. Although domestication involves patience, observation and experience as well it is, in the end, not a very friendly process. In short, there is a profound contrast between the cordial (but anthropomorphic) attitude of Androcles towards his frightening (i.e. 'δείνος'), but eventually friendly lion, and the grim picture of human–animal relationship that is outlined by Sophocles in his chorus.

A much more friendly and congenial account of human–animal interactions can be encountered in Genesis. In the beginning of this first Bible book, man is appointed as a resort manager in Paradise, which is depicted as an ideal, tranquil zoo. An important follow-up to the Paradise narrative is the story of the Arc, in which man emerges as the great saviour of animals, safeguarding their survival in the face of an immense environmental catastrophe, due to an acute climate change (brought about by unsustainable human lifestyle patterns – unsustainable that is in the eyes of God). Notwithstanding the level of drama in the story (which after all is a story of mass extinction) the basic message is that animals depend on human beings for their well-being and, eventually, for their survival. We, as stewards, are responsible for their extinction as well as for their flourishing. According to Genesis, animals entered our Arc from the very outset, long before some of them were formally recognised and stamped as "endangered species". This status merely exemplifies a more profound and fundamental form of dependence.

The Christian idea of a peaceful coexistence and fellowship between animals and humans (as their caretakers) can be encountered in countless documents emerging in the context of Christian discourse on animalhood, not only in legends and stories, but also in works of art. In the landscapes of Paulus Potter, to mention just one example, only happy and contented animals can be encountered. They are well cared-for and simply want to be left in peace. This understanding (more or less Genesis-based) of human–animal relationships in terms of *harmony* and peaceful

[2] "Master of cunning he: the savage bull, and the hart
Who roams the mountain free, are tamed by his infinite art;
And the shaggy rough-maned steed is broken to bear the bit" (Sophocles 1962, p. 340, 341–352).

coexistence still flourishes in the nineteenth century, when biology is often practiced by theologians and generally regarded a form of applied theology, a "clerical hobby", a practical form of religious reverence – until Darwin makes his appearance. Suddenly, nature is perceived in a completely different light, in terms of violence and relentless struggle – I will come back to this later.

The fable literature described above is based on a *moral* classification of animals, highly stylised and conventional as a rule. It involves a limited number of species, displaying fixed character traits determined by literary conventions. These animals have more in common with heraldic representations of animals on shields and banners than with the animals one is likely to encounter in the real world. The classification strategies used in fables do not seem able to do justice to animals as they really are. And yet, this type of literature continued to flourish during the medieval period, that is, in a period when many people, notably in rural areas, must have been involved in intense, daily relationships with animals (notably farm animals) and must have acquired a fairly extensive knowledge repertoire of animal behaviour. This knowledge was usually tacit knowledge, however, passed on to subsequent generations in oral formats.

Yet, more realistic forms of written discourse on animals were produced as well. Often, they relied on practical experiences with animals, on human–animal interactions of long standing. An interesting example of this genre is *De arte venandi cum avibus* ("On the art of falconry") by Emperor Frederik II von Hohenstaufen (1194–1250). The falcon was a courtly animal *par excellence*, the symbol of nobility, and hunting with falcons was for centuries a favourite pastime of medieval aristocrats. It was an intricate and refined art, however, involving patience, knowledge and skill. Frederik II von Hohenstaufen, moreover, was a gifted artist and scientist. His book on falconry contains important information on the behaviour and bodily design of birds of prey and can be regarded as a highlight of medieval ornithology. It goes far beyond a heraldic or fabulous representation of the falcon.

Frederic's courtly science was the scholarly counterpart of the medieval fable literature. Yet, the fable-perspective on animals continued to flourish for many centuries to come. In the medieval era, the fable literature, with its depiction of animals as moral exemplars, or as strange monsters dwelling in far-off regions, was often reinforced rather than challenged by more scholarly forms of discourse. Medieval classifications of animals relied on written sources rather than on first-hand observation. Fabulous animals such as the unicorn were processed and described with the same amount of earnestness and scholarship as ordinary species. This applies to literary works such as *Der naturen bloeme* by the Flemish medieval poet Jacob van Marleant (*c*.1225–*c*.1300) as well as to more scholarly writings, such as *De animalibus* (1999) by Albertus Magnus (1193–1280). The fable-atmosphere remained intact, in popular as well as in courtly circles. As Morus (1953) points out, the fable-like view on animals was reinforced rather than weakened when, during the dawn of the modern era, wealthy Europeans began to explore the world on a larger scale. Reports written by these early explorers contain many fabulous accounts of gigantic whales, sharks and sea-snakes, for example. Apparently, they were based on traditional cultural stereotypes rather than on observation. And when in the seventeenth

century the French courtier La Fontaine (1621–1695) composed his charming poetic stories, he was writing about animals he hardly knew from personal experience. His "zoology", so to speak, built on literary traditions and literary sources, rather than on personal observation or anything like systematic research. For centuries moreover, popular as well as literary zoology continued to believe in the existence of fabulous animals such as monstrous sea-snakes or unicorns, long after these fictitious species had been rejected by professional naturalists as legitimate objects of reflection. Three powerful scientific movements eventually dethroned the fable perspective, dispelling it to the realm of children's books, and replacing it by a more research-based view on animal life, namely the philosophy of mechanicism, the technology of classification and the emergence of experimental physiology.

3.3 Classifying, Dissecting and Slaughtering Animals

One particular philosophical answer to the question what animals really are has been very influential, namely the idea that an animal is basically identical to a machine. According to Nietzsche, Descartes was the first who, with a remarkable audacity, dared to think of animals this way. Ever since, as Nietzsche sees it, physiologists have been working hard to verify this proposition.[3]

While dwelling in the Netherlands, Descartes (besides occasionally attending anatomical lessons involving human corpses) was very much engaged in the practice of dissecting and analyzing bodily parts of animals, such as eyes and legs. He was accustomed to pay regular visits to slaughterhouses in order to collect interesting material to be anatomized at home (Lindeboom 1979). In 1629–1630 he lived in the Kalverstraat (Calf Street) in Amsterdam, a street of butchers. "There was one winter in Amsterdam", he wrote in one of his letters, "when I went almost every day to the house of a butcher to see him kill the animals and to have carried to my lodgings the parts that I wanted to anatomize more at my leisure" (Watson 2002, p. 166). The result of his diligence was the elaboration of an ontology built on the basic contention that animals (as well as human bodies) are basically machines, *automata*.[4] They are not *like* machines in the sense that the machine merely serves as a metaphor. To Descartes, the animal really *is* a machine. The way of being of an animal is basically identical to that of a machine, an instrument manufactured by man. This implies that the phenomena of animal (as well as bodily) life can be understood in strictly mechanistic terms.

Nietzsche is mistaken, however, in presenting Descartes' basic proposition as an unprecedented and *modern* view. To a considerable extent, Descartes' ontological ideas still rely on the very mode of thought he set out to challenge and replace –

[3] "Was die Tiere betrifft, so hat zuerst Descartes, mit verehrungswürdiger Kühnheit, den Gedanken gewagt, das Tier als *machina* zu verstehn: unsre ganze Physiologie bemüht sich um den Beweis dieses Stazes" (Nietzsche 1980, 13, § 14).

[4] Despite the fact that for some time he owned a dog named *Monsieur Grat* (Watson 2002, 167).

scholasticism. In fact, the idea that animals are basically similar to human artifacts can be encountered in the *Summa Theologica* of Thomas Aquinas, one of the principal highlights of scholasticism. In *Pars 1a 2ae* of this summa, the second article of Quaestio XIII is devoted to the issue whether animals are endowed with the faculty of free choice ("*Utrum electio conveniat brutis animalibus*"), that is, whether they display resoluteness and goal-oriented behaviour. At first glance, Thomas argues, this seems to be the case, for it looks as if they intend to realize certain goals in a conscious and active manner. Moreover, they do seem to have the ability to choose. A cow, for example, will devour certain kinds of herbs, while avoiding others. At times, moreover, animals are said to display remarkable signs of sagacity. A dog tracking a deer seems to choose between different options in a syllogistic, calculating manner. Yet, Thomas maintains that eventually we must recognize that animal behaviour is completely determined. They are by nature equipped with a rather limited set of options, and in a given situation it is rather predictable what they will choose. The faculty of free choice is denied to them. Although they are sensitive, the objects of their sensitivity are predetermined by nature, rather than purposively and self-consciously chosen in view of some good. The movements of animals, Thomas argues, can be compared to those of arrows. Although one might have the impression that it is the arrow itself that tries to strike the target, it is of course the archer who is responsible for it and who makes the arrow take its course. Indeed, the movements of animals are like those of *horologia* – clockworks – or similar contrivances,[5] with the difference that whereas *horologia* are artifacts manufactured by man, natural entities are divine artefacts.[6] Although animals seem to move on their own accord, and even seem to display a certain amount of intelligence, they are in fact pre-ordained to act the way they do. The wisdom and sagacity *apparently* displayed by animals themselves, is actually the wisdom and sagacity of the divine Creator who manufactured them and brought them into existence.

By taking this line of reasoning, Thomas not only distances himself from everyday experiences with animals ("at first glance it seems as if …"), but also from the fable perspective in which animals are depicted as reasoning and choosing.

Mechanicism not only remained important for centuries, it also remained emphatically *in opposition* to what could be called a "life-world" perspective on animals. Indeed, from a life-world perspective the idea of the animal body (and this includes the *human* body) as a machine remained so uncanny that it inspired a whole series of horror stories, such as for example E.T.A. Hoffmann's *Der Sandmann* [The sandman (1817/1957)]. The gothic atmosphere of these stories indicates that the idea of the animal body as a machine was never really accepted outside scholarly (scholastic) circles. It remained an abstract image that evoked

[5] "Sic enim sagitta directe tendit ad signum ex motione sagittantis, ac si ipse rationem haberet dirigentem; et idem apparet in motibus horologiorum et onmium ingeniorum humanorum quae arte fiunt" (Summa Theologica, Prima Secundae, Quaestio XIII, Art. II, p. 82).

[6] It is no coincidence that Thomas uses the clock to elucidate his argument, since the clockwork technique was developed precisely in his own time, the thirteenth century (Cipolla 1967/2003), as a product of gothic techno-science (to be discussed in Chapter 9).

uneasiness and even – apparently – fear. The body as an apparatus remained an idea so fundamentally *strange* (ξενος) that it inspired horror, while the blurring of the distinction between body and artifact tended to be experienced as *unheimlich* (Freud 1919/1947) even in modern times.

Notably in the twentieth century, philosophers have made serious efforts to liberate themselves from this mechanistic conception of animals, prepared by scholasticism and elaborated by the philosophy of neo-classicism (from René Descartes up to Julien Offray de La Mettrie). Notably phenomenologists have tried to exorcise mechanicism in order to bring scientific and philosophical views of animals closer to forms of understanding that guide our daily interactions with the animal world.

Besides mechanicism, another scientific discourse gained tremendous importance during the era of neo-classicism, namely the neo-classical revival of the Aristotelian animal practice of classification already addressed above. In the seventeenth and eighteenth centuries, naturalists really began to study the fauna of old and new continents in a systematic manner. Linnaeus (1707–1778) and others produced a *scientific* classification of animal species, much more detailed and precise, much more "critical" and realistic so to speak than the popular fable view. According to Foucault (1966) the life sciences were suddenly inspired by a new type of curiosity, an unprecedented longing for "precision" (p. 136).[7] They wanted to restore order in a quickly proliferating, indeed: overwhelmingly proliferating animal world – a proliferation that was partly due to the influx of newly discovered species from far off continents, and partly because of the introduction of new contrivances such as the microscope. How to organize these immense domains of living beings? How to represent the animal world in an orderly, reasonable fashion? The issue was solved by introducing a rigorous epistemological framework, a rigorous taxonomy, spatially organized in the form of a table or matrix, exemplified by zoological collections and *Jardins des Plantes*. Species were described and determined in terms of a neutralized and extremely *technical* language, in accordance with prescribed formats and procedures. These procedures were rigorously iconoclastic: the visual image, the visual *impression* of animals, that had been so important for their representation in fables, was eclipsed in favour of countable, quantifiable elements. The new taxonomy relentlessly ignored and erased all the countless legends, stories, nicknames, emblems, moral lessons, epic reminiscences and coagulated anecdotes that had come to be associated with various animals. For the first time in history, more or less, scholars really began to study natural entities in a careful way, paying attention to the smallest details.[8] Indeed, these systems of classification were based on specific morphological features rather than on literary conventions.

[7] Michel Foucault (1926–1984) regards Gaston Bachelard as one of his teachers (1994, 4, p. 56). Although his archeology of knowledge (notably his publications in the 1960s) can be regarded as a comparative epistemology, it does not entail a comparison between different knowledge forms (such as literature and science), but rather between discursive formations separated from one another in time (comparisons, for example, between the Renaissance and the neo-classical period).

[8] "L'âge classique donne à l'histoire [naturelle] un toute autre sens: celui de poser pour la première fois un regard minutieux sur les choses elles-mêmes, et de transcrire ensuite ce qu'il recueille dans des mots lisses, neutralisés et fidèles" (Foucault 1966, p. 143).

Their point of departure was a dramatic, *iconoclastic* gesture of exclusion.[9] Therefore, they seemed more objective compared to previous research strategies as well as more able to deal with the prolific richness of animal life.

In fact, the technology of classification quickly gained a certain amount of popularity. It began to disseminate throughout the life-world. Lay naturalists began to explore and classify animals (as well as plants) along the lines Linnaeus and his colleagues had set out. As we have seen in Chapter 2, even Rousseau became addicted to the practice of "herborisation", although in his case the practice was confined to the vegetable realm – until the "epidemic" finally reached individuals such as Gradgrind, the stereotypical teacher. It was precisely because of these technical and detached methods for classification and description that this type of scholarship became the object of literary discontent in the nineteenth century. The technical language of classification seemed to entail an impoverishment of the real-life animal world, a kind of epistemological violence. Animal nature as such, brimming with creativity, with life, seemed subdued and eclipsed by a life-less system of formal distinctions.

In 1851, Herman Melville published his novel *Moby-Dick* in which the classificatory view on animals is rigorously criticized as being untrue to life. The concepts and classifications of scholarly biological discourse (on animals in general and on whales in particular) are explicitly challenge by Ishmael, who claims to represent the whale-man's point of view, based on experiential knowledge, indeed: on "the real living experience of living men", on a life spent at sea rather than in a scholarly study. For it is "only on the profound unbounded sea", Ishmael assures us, that the whale can be "truly and livingly" found out (Melville 1851/1931, p. 1032). According to Ishmael, only whale-men really and truly know what a whale is. Many are the men who have written of whales, but only a few of them ever really saw one (apart from the stranded whales they – or others – dissected). Indeed, the only way to do justice to a whale, to acquire reliable knowledge about whales, is to sign up as a sailor on a whale-ship in order to hunt them. A whale-ship, he tells us, was "his Yale College and his Harvard" (p. 826). These huge living organisms are violated as soon as they are taken out of their immense maritime environment to be dissected and classified. They cease to exist as truly living organisms, dwelling in their own world. They are ontologically injured and transformed into objects of research. Experiential knowledge is preferable to knowledge that is derived from reading books or dissecting cadavers. The most excessive symptom of what scientific strategies lead to is the fact that scholars refer to the whale as a mammal rather than a fish.

On the other hand, it is highly questionable whether Ishmael's alternative "cetology" (whale science) can be regarded, from an epistemological point of view, as a progression. For in order to produce his own, competitive view, Ishmael often resorts to the old stereotypical (or even archetypical) fabulous image of the giant whale, a species he addresses with names borrowed from traditional (notably Biblical) sources, such as *Leviathan*. Although at first glance Melville's novel seems to convey a rather outspoken bias in favour of practical and experiential knowledge, at the expense of scientific expertise, a

[9] "Observer, c'est donc ce contenter de voir. De voir systématiquement peu de choses" (p. 146).

closer analysis reveals that Ishmael's presentation of the whale-man's point of view is often ironical rather than wholeheartedly partisan. Indeed, his quasi-scholarly discourse on practical cetology is critical (of established science), but self-critical as well. He is clearly aware of the fact that, in certain respects, the information on whales accumulated and disseminated by whalers is highly unreliable. Whereas most whale-men display an astonishing disinterest in whales *as animals* (apart from their commodity value), others are quite willing to join the notorious inclination of sailors towards mystification and exaggeration, displaying a predilection for the marvellous, the legendary and the grotesque. Still, Ishmael assures us, although a professional hunter's account "may suffer from exaggerations", the apparently fabulous is sometimes fully equaled by the overwhelming realities of the great whales (p. 869).

Moreover, the human–animal relationship that provides us with these lively, concrete and (according to Ishmael) highly valuable insights concerning whalehood is an extremely violent animal practice, namely whaling, which entails a rather barbarous and merciless slaughtering of the sublime animals Ishmael claims to admire so much. In this respect, *Moby-Dick* rather seems to subscribe to the tragic view articulated by Sophocles. Experience tells us that basically, man and nature are at war with one another. The whale, this huge and fascinating animal, δεινος par excellence, is classified and dissected by scholars, transformed into literary stereotypes by poets, and eventually butchered by practical men. An overwhelming animal is finally overwhelmed by human cunning and intelligence. And this raises several moral issues, such as the possibility of extinction, extensively discussed in Melville's lively novel. Thus, Melville's masterpiece is a document that contains ample material for comparative epistemology. In Chapter 4 we will subject this literary document to a closer reading.

It would be rather one-sided, however, to suggest that in the nineteenth-century science and literature were continuously at war with one another, as two completely estranged and incompatible "cultures". Other literary authors of this same period were much more "science-friendly". They take a much more sympathetic stance toward science. In Jules Verne's novel *Vingt miles lieues sous les mers* (*20,000 Leagues Under the Sea*), for example, published in 1870, the scientific way of understanding whales is treated with much more respect than is the case in *Moby-Dick*. The first chapters of Verne's novel are remarkably similar to Melville's: they follow the same course so to speak. They tell us about an expedition that is destined to hunt down a particularly δεινος whale, a huge monster, an "enormous thing", that bewilders the scientific world. Indeed, for the scientific view described by Verne, to only way to come to know and pacify this creature is by dissecting it.[10] The mysterious whale seems to trigger a return of the repressed. It seems a verifica-

[10] In Verne's novel, the world of science is dominated by the same authorities, the same modes of thought that are challenged in *Moby-Dick*: "Si c'était une cétacé, il surpassait en volume tout ceux que la science avait classés jusqu'alors. Ni Cuvier, ni Lacépède, ni M. Dumeril, ni M. de Quatrefages n'eussent admis l'existence d'un tel monstre (1870/1977, p. 10). Indeed, it is stated that the only way to gain reliable knowledge concerning the mysterious whale, the only way to reclaim the *Es* so to speak, is through dissection: "il fallait disséquer ce monstre inconnu" (p. 36).

tion, after all, of the fabulous view on marine animals, an *ichtyologie fantastique* (p. 17). Yet, whereas whales as animals and the ocean as a natural environment play a tremendously important role in the novel, they are eventually described from an outspokenly scientific perspective. The Melville-like atmosphere of the first chapters quickly gives way to a modern scientific approach. Biological, ichtyological, mechanical and oceanographic terms and concepts are used to frame literary descriptions and observations. Verne based the writing of the novel on a tremendous amount of scholarly research. He prepared himself by rigorously studying the standard scientific discourses on oceans and their animal inhabitants as they flourished in his epoch. This type of scholarly knowledge is represented in the novel by Professor Aronnax from Paris, a palaeontologist and oceanographer, an expert on the monstrous in nature, consulted whenever something excessively huge and strange (either alive or fossilised) is encountered.

More δεινος than any natural whale, however, is the artificial one, the giant and marvellous submarine built by the scientific genius Captain Nemo. Its strength, intelligence and rapidity greatly surpasses anything displayed by real living whales. In Verne's novel, literary tales and mystifying stories about whales, although they dominate the first chapters, fall silent as soon as it becomes clear that the giant whale is actually a machine. They are discarded as primitive and untrue, whereas in the course of the novel the scientific way of understanding the world, apparently impotent at first, gains tremendously in prestige. Still, Verne's novel constitutes an exercise in comparative epistemology. Various language games and knowledge forms (literary stereotypes, practical knowledge of whalers, insights and hypotheses of scientific experts) are mutually exposed to one another.

Finally, an unequivocal advocate of the scientific view deserves to be mentioned here as well, namely Emile Zola, who in his essay *The experimental novel* ["Le roman expérimental", 1880] underscores the basic epistemological *congeniality* of science and literature, of experimental physiology and novel-writing. Indeed, in this document, another scientific animal practice is described that gained tremendous importance in the nineteenth century (besides anatomy and classification), namely the art of conducting an animal experiment. In the context of experimental physiology, or "vivisection", animals are neither classified, nor dissected, but experimented upon. The animal's organism is damaged on purpose in order to observe the consequences of the damage. According to Zola, the structure of a novel should reflect the design and logic of a physiological experiment. Like an experimental physiologist working with research animals, a novelist will determine and vary the conditions to which human personalities are exposed, in order to observe what kinds of human behaviours are triggered or reinforced by these conditions. They are subjected to certain traumatic experiences in order to observe what kind of behavioural responses are likely to develop. Zola explicitly bases his views on the work of Claude Bernard (1813–1878), the most prominent of all the vivisectionists, who in his youth had considered a literary career. Notably, Zola relies on Bernard's famous *Introduction to the Study of Experimental Medicine* (1865/1966). We will return to Zola and Bernard in Chapter 5, devoted to physiological experiments with animals as described in scientific and literary sources in the nineteenth and early twentieth century.

3.4 Darwin: Prelude, Climax and Aftermath

The epistemological polemic of Melville's novel, challenging the lifeless, schoolish and technical procedures of academic classifications, constitutes an important part of the back-drop for what was perhaps the most dramatic scientific event of the nineteenth century, the publication of Charles Darwin's *The Origin of Species* in 1859. What is interesting about Darwin's book (from a comparative epistemological perspective) is, first of all, that to a considerable extent it relies on *experiential* knowledge, on practical experiences with nature (e.g. in the context of pigeon breeding); secondly, that it is a tale of adventure, a narrative of a journey around the natural world (similar in many ways to Jules Verne's *Vingt milles lieus sous les mers* or Meville's *Moby-Dick*) and, finally, that it reads like a novel – a fascinating, carefully composed story, with a compelling story line, a hero and a plot – according to Ilse Bulhof (1988) who emphasises the exceptional literary qualities of Darwin's book. It is full of fresh air and the author takes his readers with him on a fascinating expedition through overwhelming landscapes, described in an inspiring way. It does not present the results of anatomic dissections or experimental research. Rather it is an exercise in scientific *imagination*. It starts from a wealth of observations, but eventually the reader is invited (or rather: compelled) to see the world in a new light. It recommends and fleshes out a new way of looking at natural entities. "*The Origin* gives a sense of nature in the open air rather than in the museum or on the dissecting table. It has a sensitivity to animals and their environment which was lost as biology became more professional and retreated into the laboratory" (Burrow 1985, p. 14). In this section I will put the literary qualities of Darwin's best-seller in a broader perspective, positioning his oeuvre in the boundary zone between scientific and literary discourse forms.

According to De Beer (1964/1976, p. 138) three stages can be distinguished in Darwin's scientific biography, each with its own style, its own methodological profile. During the first stage, Darwin was an amateur naturalist who took a special interest in collecting beetles and a number of other hobbies typical of the clergyman he was supposed to become. He was invited to join the *Beagle* expedition because, besides being an experienced naturalist, he was a well-educated *gentleman*, that is, someone who would not only examine interesting sites (while Captain Robert FitzRoy and his crew would be carrying out their hydrographical surveys), but who would also be able to mess and converse with the captain in a civilised manner.

The second stage involved his travel around the world as a naturalist on board of H.M.S. Beagle. Darwin was overwhelmed by the sheer luxuriance of tropical vegetations, the bleak but sublime coastlines of Tierra del Fuego and the pristine conditions of the Gallapagos Islands. But first and foremost, the *Beagle*-experience entailed an epistemological leap in terms of *scale*. Before going on his journey, Darwin tells his readers, he had not realised how *large* the world is, in terms of space, but even more so in terms of time. Indeed, this is what he stresses in *The Origin of Species* time and again: human time pales into insignificance in comparison with the overwhelming amount of time nature has at her disposal. "Wide intervals of time …", "Vast intervals

of time …", "Vast lapses of time …" are phrases often used by Darwin in this context: "[The] lapses of time involved in the process of evolution are so great as to be utterly inappreciable by the human intellect" (p. 439). This is what Darwin means when at the end of his books he emphasises that there is grandeur in the new view of life he took home with him" (p. 459). In other words, Darwin's book does not merely contain a large number of data or "facts". Rather, it is an invitation to appreciate the full *scale* of nature and to view the natural world, not in terms of harmony and equilibrium any more, but rather in terms of millions of years of relentless struggle and competition. Even evolution itself is not a "fact", but rather a perspective, a (highly revealing and challenging) way of looking at nature and its species. Nature is not a stable harmonious ecosystem, but an immense world, forever changing, where animals (individuals and species) are continuously struggling for survival. The view of nature as harmonious is only possible within the confines of a rather restricted timescale: the scale of human time, measured in days, years and centuries, millennia at best. As soon as we look upon nature in terms of its own proper temporal dimensions, the ontological profile of the natural world changes dramatically. In short, Darwin's book does not simply convey a large number of observations but rather invites us to look at the world in which we live *in a certain manner*. And for this reason, we can read it like a work of art. It opens up new and astonishing possibilities for experience. Reading Darwin's book amounts to being trained in a new style of perception. It is an epistemological event that makes certain forms of experience, a certain style of research possible. Darwin's best-seller does not contain a theory *strictu sensu*, but rather a research programme, a way of viewing the natural world. And this is an important epistemological condition for accepting the idea of evolution. The timescale of human action is too limited (compared to the temporal dimensions of nature) for the idea of evolution to be credible. Although it is possible in the life-world to produce new varieties, it is beyond our power to produce novel species. Species as such remain what they are – they appear as immutable, and a pigeon will always remain a pigeon, whatever its colours. It is only on a much more expanded scale, on the timescale of *nature*, that the idea of evolution becomes feasible.

Finally, there is a third stage in Darwin's work, completely different from the previous one, again: notably in terms of scale. The large world of his *Beagle* adventure gives way, once again, to a micro-cosmos, a house and garden: his Down estate, where he came to spend decades of research on species like barnacles and earthworms, while taking part in practices such as keeping pigeons and cultivating flowers that were popular in his social environment, the English leisure class.

These different practices and settings are reflected in *The Origin of Species*, as well as in his subsequent publications. In the first chapter of his book ("Variation under domestication") Darwin stresses the practical and experiential nature of the type of knowledge on which he relies. The data presented in this chapter are assembled during the "third" stage of his career: "I have kept every breed [of pigeons] which I could purchase or obtain.… I have associated with several eminent fanciers, and have been permitted to join two of the London Pigeon Clubs …" (p. 82). The experience gained from these and similar animal practices would not have sufficed to undermine the long-standing faith in the immutability of species.

Chapter 4, however, is devoted to "Variation in nature". And it is here, as well as in subsequent chapters, that the difference in scale becomes important. Nature has millions of years at her disposal and this explains how even minute changes, accumulated in the course of countless generations, may eventually lead to astonishing results. Thus, whereas humans working in their pens and gardens are only able to produce new varieties, nature is able to produce new species. Nature grants "vast periods of time for the work of natural selection" (p. 147). Indeed: "incomprehensibly vast have been the periods of time that produced new species" (p. 293).

When his book was about to be published, there was a difficulty over the title. Darwin wanted it to be called *An Abstract of an Essay on the Origin of Species and Varieties Through Natural Selection* (De Beer p. 155), but the publisher objected. Nonetheless, it was Darwin's firm intention to devote the remainder of his life to the elaboration of this mere "abstract" into a series of extended studies.[11] Because of his worsening health, however, only the first part of this huge and ambitious project was finished. In 1868 he published *Variation of Animals and Plants Under Domestication*, basically a follow-up of the first chapter of *The Origin of Species*. From a comparative epistemological point of view, however, a much more plausible explanation for his failure to complete his ambitious project (i.e. more plausible than ill health) was the fact that the setting of his research had so drastically changed: English countryside again instead of the vast uncultivated horizons of immense untamed nature. Darwin is now interested in animal behaviour evolving in a homely context. He now lives in a very small world again and his object of study is no longer evolution on a grand scale, but rather the behaviour of modest, unspectacular organisms, such as earthworms in his own garden.

"The subject may appear an insignificant one", Darwin (1881) acknowledges in the *Introduction* to his monograph on earthworms, but eventually he concludes that these unassuming animals have played "a more important part in the history of the world than most people would at first suppose". The vegetable mould has past many times through, and will continue to pass many times through the intestinal canals of worms. Indeed, without this labour of the worms the earth would become sterile. In this treatise, Darwin's world has once again become an extremely calm, serene, small-scale and peaceful place. It lacks the stylistic grandeur and drama of *The Origin of Species*, but still has the power to invite us to view and explore the world in a certain manner. Interestingly, in the course of his work on anthrax, Pasteur also highlights the role of earthworms, but in his case struggle remains the perspective and the earthworms are depicted as the "vector of death" (Debré 1994/1998, p. 317).

Darwin's somewhat naive enthusiasm when it comes to praising the intelligence, dedication and zeal of earthworms is likely to raise an occasional smile in contemporary readers. Yet, this type of discourse has literary qualities in its own right. It breathes the atmosphere of common, practical, everyday experiences with animals, at times systematic, at times anecdotal. Whereas *The Origin of Species* is the scientific counterpart of huge and impressive books of travel written in the

[11] Cf. Chapter 9.

nineteenth century (by literary as well as by scientific authors) such as *Moby-Dick*, his book on the life and significance of earthworms is the scientific counterpart of similar studies written by men of letters, such as the famous monograph on the life of bees by Maurice Maeterlinck (1901), already mentioned in Chapter 2. Like Darwin, Maeterlinck is intrigued by phenomena that bear witness to the zeal and *intelligence* of bees. Indeed, the intelligence of his favorite species is emphasized throughout the book as a source of enthusiasm. Why? Whenever we discover the existence of intelligent organisms anywhere in nature, Maeterlinck tells us (1901, p. 133), we seem to experience an emotion similar to the one that befell Robinson Crusoe when he discovered a human footprint on the beach. It means that we, as intelligent human beings, are not as exceptional (and therefore not as lonely) as we had expected.

Thus, both Darwin and Maeterlinck, the scientist and the poet, set out to transcend the time-old understanding of animals in terms of deficiency: animals as bodily mechanisms, *lacking* intelligence, *deprived* of consciousness. From here, two lines of further research evolve. The first line of research is ethology, the systematic study of animal behaviour. This line will be further explored in Chapter 6. Although it can be regarded as a refinement of some of the techniques and methods introduced by Darwin and Maeterlinck, it increasingly opts for an "external" and "objectivistic" view on animals. The other line of research moves in the opposite direction. It opts for an "internal" view on animals, regarding animals as subjects of their world and preparing the ground for an inquiry into the question in what kind of world animals dwell. Rather than portraying animals in terms of deprivation and deficiency, the possibility is considered that their modes of experience are *different*, rather than impoverished. It may well be that animals are dwelling in worlds we ourselves may never enter. In other words, the deficiency might be on the part of the beholder. It is *our* deficiency that we cannot truly understand them. This idea, that animals are *different* rather than deficient, and perhaps even epistemologically *privileged* in the sense that they are open to worlds of experience denied to humans, is brought forward in a number of literary documents that will be briefly discussed in Section 3.5.

3.5 Animals as Epistemologically Privileged Beings

Tacitus (1958) tells us that ancient Germanic tribes kept bands of horses in sacred forests. Priests on special occasions visited these mysterious sites, these sacred natural living quarters in order to observe their neighing and snorting. These horses were regarded as confidants of the gods and on no other revelation more reliance was placed. On holy days, priests, kings and chiefs of state came there to study them (1958, p. 279). Apparently, the archaic mind believed that horses were dwelling in an openness denied to humans, a clearing which somehow surpassed their own way of standing out towards the world. They carefully observed these privileged beings, who apparently were granted an intimacy with the grander forces of

being and nature, one that transcended the restricted boundaries of the human realm. By observing them and accompanying them on holidays, they allowed themselves to go beyond the restricted horizons of human experience and to cast a glance into possibilities of being and experience with which these animals seemed to be intimately acquainted. Although in a way these ancient priests can be regarded as proto-ethologists, as ethologists *avant la lettre* so to speak, their way of studying animal behaviour greatly differed from the ways in which animal behaviour is studied by modern biologists. Horses are nowadays no longer seen as intermediaries. Their behaviour no longer conveys a "higher" meaning, is no longer regarded as containing important pieces of information for humans, such as weather-forecasting. It is studied for its own sake.

In order to clarify what actually took place – from an epistemological point of view – in these ancient Nordic forests of Tacitus' days, the work of Martin Heidegger (1889–1976) may be of some assistance. To a certain extent at least, his work really *is* a philosophy of the forest, notably of forest clearings. And in various ways he has made efforts to bring to life again archaic ways of experiencing the world, articulated by philosopher-poets, from Herakleitos to Hölderlin. Moreover, Heidegger is a philosopher who claims that scientific fields like biology will never really be able to lay out an animal's way of being. In the context of biological research, an animal is bound to become an object of physiology, anatomy or ethology. But, according to Heidegger, these disciplines do not really succeed in opening up for us the world of living beings. To live, Heidegger stresses, is not a *characteristic* of animals, but rather their basic *way of being*. The question regarding an animal's way of being cannot be posed (let alone be answered) by biology. Notably, according to Heidegger, biology fails to discern the fundamental difference between humans and animals. This difference does not reside in empirical characteristics, such as the "superior intelligence" of humans or the absence of fur on their skin. Man is not an extremely intelligent animal, or something like that, he is not an animal at all. The basic difference between man and animal is something beyond biology. The difference resides in the human way of being in the world.

What does Heidegger himself tell us about an animal's way of being? He does not address this issue directly. Rather, his philosophy is post-Kantian in the sense that it entails a critical reflection on the ways in which animals emerge in scientific and literary forms of discourse, in biological treatises and in poems (notably a number of poems by Rainer Maria Rilke). Building on these sources, he sketches (rudimentary as it may be) a provisional ontology of animalhood. Whereas an anorganic entity – a stone, for example – does not have a world at all, Heidegger (1983) argues, animals do have a world. Yet, they seem to dwell in a rather poor and restricted world compared to ours. Animals, so it seems, do not really *ex-ist*, do not really stand out towards other things, towards being as such. A cow, for example, will notice the grass, but the beauty of the meadow escapes her. The animal hears the sound and tone of a voice, but does not understand the meaning of the words. Heidegger agrees with Aristotle that, although an animal is able to bellow, neigh or bray, it will never master a language, will never really understand or convey meaning (cf. Aristotle 1967, 1253 a 3). Whereas humans are basically *responsive* (reacting out of an understanding of

what is perceived by them), animals are basically *impulsive*. Moreover, the possibility of truly becoming involved with things is denied to them – the grass will always remain grass to them and a prey a prey, it will never become something funny or lovely, charming or beautiful, disgusting or pitiful. Objects which cannot be somehow connected with the animal's vital interests and needs are not perceived at all and remain insignificant to them. Moreover, an animal's world will never change. Human beings *build* their own world, uncovering aspects of being which to animals remain forever hidden. Animals however inhabit a world, forever incomparable with ours. An impoverished world – at least from a human point of view.

Elsewhere, however, Heidegger acknowledges that the animal produces a particular interpretation of the world, albeit a rather limited one (p. 243). The environment is interpreted from a certain perspective, namely in terms of possibilities for absorbing things, for life-enhancement. The animal only perceives what can be absorbed or used in order to enhance life. All things which cannot be interpreted in such terms, or which do not allow the animal to further its own existence or the continuation of its species, will simply not be perceived at all.

In his book on Nietzsche, Heidegger (1961) brings forward a similar point of view. The animal does not *know* what it wants, one cannot even say that it really *wants* something (p. 66). An animal is merely urged or driven by impulse. To will something involves an understanding of what is desired. Hunger, for example, urges the animal to feed himself, but according to Heidegger we cannot say that the animal has a representation of food *as such*. His appetites are deprived of understanding. In short, Heidegger's ontology of animalhood seems to remain safely within the beaten tracks of traditional ontology. The animal emerges as deprived of the possibility of really understanding the world.

Certainly, this view on animality is something of a disappointment. For an author driven by the ambition to completely revise and revitalize traditional ontological discourse, to go beyond the traditional conception of man as an *animal rationale*, something more innovative should have been expected. His analysis does not take us very far, in comparison to traditional ontological discourse on animals as epistemologically "maimed". Rather than really reflecting on what scientific or literary sources tell us about animals, Heidegger builds on and reaffirms (albeit in his own Heideggerian dialect) the established dichotomies of traditional ontology. Indeed, from the perspective of comparative epistemology, Heidegger's reflections are disappointing. They are interesting in the sense that they consider the possibility that animals dwell in a world of their own, and that their way of being is quite beyond the scope of biological research. Although biology is highly informative and reliable, not all dimensions of animality are accessible to science. On the other hand, however, Heidegger's views remain firmly in line with the Western metaphysical tradition. He continues to define the animal's world (as well as the animal's possibilities of interacting with this world) in terms of deficiency.

This seems a rather premature judgment. Apparently, he already answered the question of animalhood before really raising it. In order to be really able to compare our being-in-the-world with an animal's way of being, we will really have to ask ourselves what it *means* to be an animal (a horse, a whale, a bat or a frog).

By immediately framing the issue in terms of poverty and deficiency, Heidegger seems to opt for a rather traditional and predictable line of reasoning. He joins the chorus so to speak, instead of really allowing the question of animality to emerge. Only humans are granted the possibility of being susceptible in a genuine sense to what surrounds them. They build a world, rather than interacting impulsively with an environment composed of a rather limited set of relevant objects. Compared to ours, the animal's world seems profoundly obscure. They will never experience the enlightenment for example that may occasionally befall us when we read poetry or are involved in scientific research. Although Heidegger seems to agree that it cannot be excluded that animals dwell in an openness of their own, we cannot know or say anything meaningful about it.

Heidegger's views are critical insofar as he criticized biology for being "biologistic", that is, blurring the ontological difference between humans and animals. In order to reaffirm this difference, Heidegger develops a line of thinking that is more or less similar to traditional ontology. Should we really intend to explore the world of animal experience from "within", from the perspective of an animal's way of being, should we really want to explore the possibility that animals develop an openness towards the world of their own, that their way of standing out towards the world is *different* rather than *deficient*, an obvious point of departure for a comparative epistemology would be to reflect on the ways in which the animality of animals is described in *literary* sources. Although elsewhere Heidegger often makes use of the possibilities of poetry for surpassing and leaping beyond seemingly inescapable but unsatisfactory trajectories of discourse, Blans (1996) emphasizes that this is not the case where animals are concerned. Heidegger even refuses to enter the overtures that emerge in some of the poems of Rainer Maria Rilke (1875–1926). In one of his elegies, Rilke assigns an openness to animals which surpasses our objectivistic way of perceiving things, and he adds that, by reflecting on the mysterious gaze of animals, we ourselves might regain a susceptibility now lost to us. This possibility for interpreting the animal's gaze is bluntly rejected by Heidegger. He criticizes it as the expression of a "biologistic" kind of metaphysics which prefers animal impulse to human understanding. Let us have a closer look.

Rilke has written at least two important poems on animalhood. The first one is his famous poem entitled *Der Panther* [The Panther, 1903]. It describes a caged animal in the *Jardin des Plantes* in Paris. It is an animal that is more or less the victim of a scientific practice, an inhabitant of a scholarly zoo. For our purposes, the first stanza is the most important one:

Sein Blick ist vom Vorübergehn der Stäbe	His gaze has, from the passing of these bars,
so müd geworden, daβ er nichts mehr hält.	Grown so weary that it can hold no more.
Ihm ist, als ob es tausend Stäbe gäbe	To him it is as if there are thousand bars,
und hinter tausend Stäben keine Welt.	beyond these thousand bars, there is no world.

The animal inhabits an impoverished, obscured and empty world. This is not his authentic way of being, it is a *consequence* of ontological violence, depriving him of the possibility to really interact with his environment. It is something which is enforced upon him, it is not a defect which stems from the animal's own way of being. Obviously, the poet suggests that, if the animal was allowed to dwell in his

own world, he would experience his surroundings in a completely different light. His world would surely open-up to him. The poverty of the animal's world is an effect of a particular human–animal relationship, of a particular disposition. He is reduced to being a living element in a project of classification. His boredom is a symptom of the ontological violence to which this animal is subjected. The opening lines of Rilke's *Eighth Duino Elegy*, a second important poem on animalhood, takes a completely different perspective. In this poem he addresses the animal's way of being-in-the-world in much more general terms:

Mit allen Augen sieht die Kreatur	The creature discerns openness with all
Das Offene. Nur unsre Augen sind	Its eyes. Our human eyes, however, are
Wie umgekehrt und ganz um sie gestellt	as if reversed. And all-surrounding it
Als Fallen, rings um ihren freien Ausgang.	As barriers, preventing its free passage.
Was draussen *ist*, wir wissens aus des	What *is* outside, we know it from the animal's
Anlitz allein…	Face only….

Rilke's poem (1991, p. 470), of which only the opening lines are cited here, is an effort to enter and reflect upon the animal's world "from within". The numbness, the poverty of the panther's world really was an artifact. In principle, animals tend to dwell in an openness denied to us. We may only enter it indirectly, namely by studying the animal's face and gaze. Heidegger's comment on this poem, his decision to denounce Rilke's effort as "biologistic", seems remarkably defensive and traditional, almost like a metaphysical "reflex". From someone like Heidegger, something else would have been expected. Although a certain amount of vitalism is certainly present in Rilke's lines, there is more to it than that. Heidegger reproduces and reinforces the time-old distinction between animals on the one hand and the "animal rationale" on the other. The fact that it is phrased in a Heideggerian ontological dialect does not conceal the prejudiced nature of his view, the continuity between traditional metaphysics and Heidegger's position. He could (and no doubt should) have taken another route. He could have based his views of animalhood on a more phenomenological understanding of animals, informed for example by literary sources. In his efforts to uncover what has happened to the Rhine River, he was quite willing to rely to a significant extent on the poetry of Hölderlin. Why is Hölderlin's work acceptable (even indispensable) as a valuable source of philosophical input, whereas Rilke's poetry is rejected?

Agamben (2002/2004) has tried to open up the controversy by confronting the poetic description of "the open" in Rilke's elegy with the concept of the open as it is elaborated in Heidegger's work, notably in terms of αληθεια – the uncovering force of art. Whereas according to Rilke the animal sees the open "with all its eyes", our human eyes have been "turned backward". They are placed like traps or barriers around us. Whereas humans never enter the "pure space" outside, the animal genuinely moves into the open. This "reversal of the hierarchical relationship between man and animal" (p. 57) is precisely what Heidegger calls into question. As a consequence of nineteenth-century biologism, he argues, Rilke succumbs to an anthropomorphization of the animal and a corresponding animalization of man. Heidegger maintains that the animal is unaware of the open, in the sense of the unconcealed. An animal remains shut out from the very experience of openness. Both Rilke and Heidegger preserve the

distinction between humans and animals, but while Rilke does this by describing animals as epistemologically privileged beings, Heidegger firmly rejects it as a "hominization" of the animal. The animal is only open towards an unconcealed, undisclosed world. Therefore, animal existence can be regarded as a fundamental form of boredom. According to Heidegger, human freedom, our ability to break away from the concealing closures in which all creatures are firmly embedded, is achieved through language. Following in the footsteps of Plato and Aristotle, Heidegger traces the gap separating humans from animals back to language. But once again, this analysis only seems to reaffirm the traditional nature of Heidegger's view.

According to Oudemans (1996), however, a further reflection on Heidegger's understanding of animals may lead to other, less disappointing possibilities. To begin with, he argues, it is not Heidegger's intention to draw a comparison between humans and animals. Rather, it is when speaking about "world" that the animal's way of being is addressed. Primarily, Heidegger is interested in human existence. To stand out towards the world means to experience it as something completely astonishing to us. And it is here that the animal presents itself to us and reveals its mysterious gaze, which calls for wonderment rather than disdain. For apparently, they have their own way of standing out towards the world, one we cannot enter. We cannot really image what their world looks like. We are deprived of the possibility to really understand them. If we want to describe an animal, we are likely to revert either to anthropomorphism, or to a mere biologistic understanding. And this is *our* poverty, Oudemans argues. The possibility of existence open to animals such as horses or whales is forever denied to us. It may well be that these animals have their own way of standing out to things, of becoming involved with things, and perhaps their world merely *seems* poor because it is obscure *to us*, because it is a world into which we will never really be able to follow them. Due to their mysterious gaze, Oudemans claims, animals allow us in an unfathomable way to turn away from our own susceptibility to the world and become, to a limited extent, involved in theirs. Heidegger's contention regarding the poverty of animals should therefore not be interpreted in terms of deprivation, with the implication that our way of standing out towards the world should be regarded as a standard compared to which all other forms of life stand out as deficient. We cannot really know what the animal's world looks like. The possibility of really following them into their world is denied to us. The enigmatic aspect of animal existence, their unfathomable way of standing out to things calls for wonderment and awe, and Oudemans refers to a poetic passage in Heidegger's writings where it is suggested that the floating, singing and calling of a bird in the summer sky calls us and brings us into the open (Heidegger 1979, p. 95). Both man and animal stand out to the world as openness, but each in a way that is inaccessible to the other.

I guess this is also what Wittgenstein was pointing at when, in his *Philosophical Investigations*, he claims that, should a lion be able to speak to us, we would not be able to understand him – we would not really be able to follow him into his world (1984).[12] In short, although Heidegger initially seems to adhere to a rather traditional understanding of animals in terms of deprivation and lack (lack of discernment and

[12] "Wenn eine Löwe sprechen könnte, wir könnten ihn nicht verstehen" (p. 568).

understanding, lack of true involvement), his reflection on the animal's way of being eventually, on closer reading, seem to point to more promising possibilities. Unfortunately, even if Oudemans is right, we must conclude that Heidegger himself never really followed his own lead.

It is not my objective, however, to determine whether Heidegger was "right" or "wrong". The question rather is: what kind of sources did Heidegger use to articulate his views? From the point of view of comparative epistemology, the disappointment is not caused by Heidegger's conclusions as such (his reflections on the "poverty" of animals), but rather by the fact that he refrains from really using literary sources as pathways that may allow us to increase our proximity to the animals' world. According to Heidegger, this epistemological possibility is principally denied to us, regardless of whether we rely on biological or on literary sources. Science and literature suffer from a fundamental "poverty" in the sense that, according to Heidegger, they both obscure rather than clarify the ontological difference between humans and animals, the former because of the "animalization" of humans, the latter because of the "hominisation" of animals. From a comparative epistemological perspective it would be unsatisfactory to view this deadlock as given. The basic conviction guiding comparative epistemology is that we can further our understanding of these philosophical issues by considering *concrete examples* of literary and scientific efforts that set out to analyse the extent to which animals can really be said to be open towards the world.

A comparative epistemological approach to this issue of animalhood urges us to start from a scientific or literary document in which animals are presented as epistemologically privileged beings. In 1726 Jonathan Swift published his famous book *Gulliver's Travels*. One of these travels, to the land of the horses, seems a promising point of departure.

The first two voyages, to the land of the dwarfs and the land of the giants, are by far the best known. Yet, from the point of view of comparative epistemology the third and the fourth voyage are much more important. The third voyage (to Laputa) takes Gulliver to the Academy of Lagado. It is a literary analysis of the epistemological status of experimental research as it was emerging in the seventeenth and eighteenth centuries (the "scientific revolution"). Actually, it is a parody on the Royal Society of London. Researchers are involved in hilarious research projects – although for those readers who are prepared to see *through* the exaggerated descriptions, the projects involved are not all that ridiculous, at least not in retrospect. For example, the efforts of research "fellows" who are involved in producing artificial cobwebs, or in distracting energy from biomass, are less ridiculous if seen from the perspective of current research on biomaterials and biofuels. The ridicule is, to a certain extent at least, in the eye of the (uncomprehending) beholder.

Far more important for our present purposes, however, is the fourth voyage, to the land of the *Houyhnhnms* – a population of noble horses. When Lemuel Gulliver is left behind by pirates on the shore of an unknown land, he meets with an intelligent and generous race of quadrupeds, surpassing human beings in their way of standing out to the world in all respects. In fact, the island is inhabited by two prominent species: the *Houyhnhnms* and the *Yahoos*. The latter are described as

disgusting brutes, but actually they are remarkably similar to humans. In short, we are faced with something of a reversal. The horses are considerate and wise, the humans filthy and dumb. Never did Gulliver behold such disagreeable animals, such ugly monsters, such deformed creatures. The worst thing about them is their aggressive behaviour and their offensive smell. The horses, however, are decent and competent animals, wise governors, patient interlocutors and teachers. Gulliver's first encounter with this remarkable species is described as follows: "The horse started a little when he came near me, but soon recovering himself, looked full in my face with manifest tokens of wonder.… I would have pursued my journey, but he placed himself directly in the way, yet looking with a very mild aspect, never offering the least violence. We stood gazing at each other for some time …" (Swift 1967, pp. 270/271). Subsequently, after another horse has joined them, the two Houyhnhnms start neighing to one another, using various gestures: "like persons deliberating upon some affair", indeed: "not unlike those of a philosopher, when he would attempt to solve some new and difficult phenomenon" (p. 272).

Swift's story is a satirical articulation of the basic sense that there is something to animals such as horses that prevents us from describing their way of being merely in terms of deficiency and lack. Yet, when we ask ourselves to what extent this novel really allows us to open-up the world of these noble animals, to *understand* their life, we must confess that, from the point of view of comparative epistemology, Swift's analysis is rather disappointing. Although at first glance the *Houyhnhnms*' gaze of wonder seems to convey the possibility that they are epistemological subjects in their own right, *subjects of experience*, dwelling in a world of their own, they actually emerge as "governing, rational animals" (285), that is, as idealised humans. Swift uses the time-old strategy of homonisation, along the lines of the fable genre. The author wants to tell us something about humans and is not really interested in animals at all. Rather than addressing the question what horses *are*, Swift is describing "noble savages" *disguised* as horses. They represent a rationalistic, enlightened ideal for *humanity*, but they are completely unconvincing as *animals*. Instead of with real animals we are confronted with imaginary beings, displaying features that are recognizably *human*. Although some traits and features of real horses are retained (the Houyhnhnms do have tails), Swift basically confronts us with a rather anthropomorphic version of this species. His story is the English counterpart – in prose – of Fontaine's poetry. The inclination to describe animals in a human-like fashion, displaying human characteristics, has infected literary discourse as a kind of chronic epistemological epidemic. It has not really encouraged literary authors to really focus their attention in the animality of animals.

Therefore, we apparently have to move further down the track. We have to enter the nineteenth century, notably the era of realism. The literary counterpart of Darwin's realism, of Darwin's desire to describe the world not as an idealised harmonious arcadia, but rather as a violent, proliferating wilderness, a world of relentless struggle, is the realistic novel. It is in this context that we may be expected to find literary sources on animals that are epistemologically more convincing. We will begin with one of the most famous and impressive animal novels of all time, Herman Melville's *Moby-Dick*.

Chapter 4
What is a Whale? *Moby-Dick*, Marine Science and the Sublime

4.1 *Why Moby-Dick*? An Introduction

Moby-Dick (1851/1931) is a magnificent novel, an American epic, a literary encyclopaedia, a monument of language. Jean-Paul Sartre (1941/1977) called it a *Summa*, a gigantic, monstrous, antediluvian book. One may read *Moby-Dick* for several reasons, and from several perspectives: as a novel of adventure, a psychological case history casting an obsessed sea captain, an anthropological study of nineteenth-century maritime life, or a fascinating example of Bakhtinean "heteroglossia".[1] Whenever reference to *Moby-Dick* is made, the first thing that will come to mind, no doubt, is the novel's fantastic plot, more spectacular than tragic, when the great White Whale at last destroys the destroyer of its species. Indeed, *Moby-Dick* can be read as an affidavit, a persistent effort of Ishmael – its narrator – to convince us of the fact that things like that can really happen – although in the end hardly anyone will believe him.

In this chapter, however, *Moby-Dick* will be read as a literary document that sets out to tell us something about maritime nature, about the wide, unshored, oceanic expanses and its most eminent inhabitant, the whale – the great *Sperm Whale* to be exact. Melville's novel constitutes an important file, a chapter in animal history, written in the middle of the nineteenth century, when Darwin was about to publish his *Origin of Species*. *Moby-Dick* is a document that pretends to answer the question *What is a whale?* Or rather, it stages a struggle between several incompatible answers, yielded by incompatible perspectives on marine life, mutually challenging and criticizing one another. Moreover, these answers entail different *ethical* judgements on the moral status of the whale and on the moral propriety of whaling.

Three perspectives, three ways of answering the question of the whale, as fleshed out in the novel, will be taken into consideration in this chapter: that of the whaler (or "whaleman" as Melville calls him), the scientist, and the philosopher. In this introduction I will sketch them in broad outline, before submitting them to a more careful examination in subsequent sections.

[1] According to Bakhtin (1988), a true novel is a polyphonic, multi-voiced interplay of languages, accents and dialects. This is exemplified by the following quote taken from *Moby-Dick*: "Something of the salt sea yet lingered in old Bildad's language, heterogeneously mixed with Scriptural and domestic phrases …" (p. 813).

To the nineteenth-century *whaler*, whales and their environment offered ample opportunity for a life of adventure and hazardous encounters. But first of all, they provided him with a source of income. The sordid, time-consuming business of whaling basically came down to transforming incredible amounts of organic blubber into merchantable oil. In his magnificent head, the Sperm Whale kept the precious substance from which he derived his name, *spermaceti*, that used to be manufactured into medicinal products.[2] Finally, whale bones and teeth were used as raw materials for contrivances of various kinds.

To the nineteenth-century *scientist*, the sea and the whale basically constituted an enigma. In the 1850s, marine scientists were still struggling with obscure phenomena such as tides and currents,[3] the existence of deep sea life and the chemical composition of sea water (Deacon 1971). As for whales, naturalists from Aristotle onwards had clearly been puzzled by them. Aristotle noticed that whales and dolphins were viviparous and that they had breasts and lungs (489b4, 521b24) and therefore, he set them aside from other sea-animals. Yet, although he recognized several similarities with terrestrial quadrupeds, it was Linnaeus himself who finally decided to associate these life forms with one another – an important decision, because it resulted in a change of name: *mammals* instead of *quadrupeds* (Nordenskiöld 1928/1946, p. 213). But precisely how such a gigantic mammal was able to survive and find its way in the depths and immensities of the oceanic world, remained utterly incomprehensible.

Finally, from a *philosopher's* perspective, the ocean functioned as a powerful image, as in the case of Kant, who incorporated the image of the wide, maritime expanses into his theory of the sublime. In the case of Nietzsche, who regarded himself a spiritual descendant of Columbus (Janz 1978, p. 247) and compared his philosophical project with a sea journey,[4] the ocean functioned as a metaphor for widening one's perspective and expanding one's horizons, as exemplified by his aphorism "Embark" in *Die fröhliche Wissenschaft* ["The Gay Science"]:

> [W]hat is needful is a new *justice*! And a new watchword. And new philosophers. The moral earth, too, is round. The moral earth, too, has its antipodes. The antipodes, too, have the right to exist. There is yet another world to be discovered – and more than one. Embark, philosophers![5]

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[2] *Spermaceti* literally means "whale sperm", which was what "landlubbers" (incorrectly) believed the white, greasy, odorous substance to be.

[3] "The secrets of the currents in the seas have never yet been divulged, even to the most erudite research …" (p. 869).

[4] See for example his Letter to Erwin Rohde of February 22, 1884: "In the meantime, I pursue my course. It is really a journey, a sea journey …" ("Inzwischen gehe ich meinen Gang weiter, eigentlich ist's eine Fahrt, eine Meerfahrt …").

[5] "[E]ine neue Gerechtigkeit tut not! Und eine neue Lösung! Und neue Philosophen! Auch die moralische Erde ist rund! Auch die moralische Erde hat ihre Antipoden! … Es gibt noch eine andere Welt zu entdecken – und mehr als eine! Auf die Schiffe, ihr Philosophen!" [Die fröhliche Wissenschaft, § 289]. The same basic image is present in § 124 ("We have left the land and have embarked …"), § 283 ("Live dangerously.… Send your ships into uncharted seas …") and Appendix ("Toward new seas.… Without plan, into the vast open sea I head my Genoese ship" – note that Columbus came from Genoa).

This summons clearly resonates with the "archetypical image" associated with water as a basic element, discussed in Chapter 2, water as the element of freedom, of mobility, of widening one's horizon. Although Nietzsche himself refrained from doing what he summoned others to do, scientists like Darwin and novelists like Melville actually went to sea. Darwin, although regarded by Nietzsche as an arid and mediocre mind,[6] exposed himself to the experience of a long-term trans-oceanic voyage in the course of which he did discover new worlds, new justifications, new moral watchwords even ("struggle for life") that were to have a tremendous impact on science, philosophy and even culture at large.

Other perspectives are present in *Moby-Dick* as well, such as the theologian's one, depicting the whale as the biblical Leviathan and the ocean as that part of the world where the great flood never abated. Indeed, the interpretation of marine phenomena in Biblical terms is more or less omnipresent in the novel and also resounds in the views and language of the philosophical sailor and story-teller Ishmael.

But what about the novelist's whale? Actually, there is not *one* novelist's whale. Ishmael-the-narrator unmistakably sides with the whaler's point of view, but Melville-the-author is interested in, and tries to do justice to, a plurality of voices. Various idiolects are allowed entrance into his multi-lingual novel. On some occasions, for example, the whale is viewed from a purely *economic* aspect, and the novel informs us about the incredible quantities of oil that may be extracted from one whale, while the whale's head is called the *Heidelbergh Tun*, a great "tierce" replenished with five hundred gallons of spermaceti (p. 963/964). At other times, however, the whale emerges as an *aesthetical* phenomenon, and we find the spectators allured by the "gentle joyousness", the "mighty mildness of repose in swiftness" with which the gliding great whale is invested (p. 1086). Even within a particular perspective, such as the scientific one, the novel's language tends to oscillate between, for example, a *mechanistic* account (telling us that the aorta of a whale is larger in the bore than the main pipe of the water-works at London Bridge[7]) and a more or less *vitalistic* one, explaining how by breathing, the whale withdraws from the air a certain element imparting to the blood its *vivifying* principle; and how, during his sojourn in the depths, he carries "a surplus stock of vitality in him" (p. 982).

As for the novel's *dramatis personae*, Ishmael is initially a light-hearted adventurer who wants to see the world and find out by experience what whaling is. He is enlisted on the *Pequod*, with Ahab for a captain: an introvert, demonic maniac, who lost a leg while trying to capture *Moby-Dick* on a previous voyage and is now obsessed with this one desire: to "dismember his dismemberer" (p. 860). Queequeq, one of the Pequod's harpooners, is casted as a noble savage. We are told, for instance, that his head is reminiscent of George Washington's head: "Queequeg was George Washington cannibalistically developed" (p. 789). The *Pequod* takes

[6] "For scientific discoveries of the type of Darwin's a certain narrowness, aridity and industrious diligence … may not be a bad disposition" (Nietzsche 1980, § 253).

[7] The water roaring in its passage through that pipe is "inferior in impetus and velocity to the blood gushing from the whale's heart" (p. 754).

sail from the famous East-Coast whaling port of Nantucket. Its inhabitants, we are informed, are outstanding whaling experts who for centuries cruised the oceans to give chase to the great Leviathan. In the case of the Pequod, however, the whaling-voyage is transformed into a disquieting crusade against *Moby-Dick*, a white Sperm Whale of astonishing magnitude, the most appalling of all brutes, notorious for his intelligent malignity. In the meantime a considerable number of whales are captured, but *Moby-Dick* remains the Pequod's "final and romantic object" (p. 887). When, in the tropical Pacific, the fatal encounter finally takes place, it all ends with a fantastic, incredible catastrophe. After killing Ahab, *Moby-Dick* manages to sink the vessel. Ishmael is the sole survivor, the last human being in a flooded world.

But Ishmael's account is not simply another fantastic whaling-story. From the very outset it purports to be a quasi-scientific manual on whaling and on whales, a monograph on *cetology – Cetus* being the Latin name for whale.[8] Similar cetological works had been published in previous years, such as Thomas Beale's *Natural history of the Sperm Whale* and (above all) William Scoresby's *Account of the Arctic Regions with a History and Description of the Northern Whale Fishery*. Melville knew most of these books and extensively borrowed from them (Vincent 1992; Parker 1992). *Moby-Dick* is in fact a literary parody on this genre that was quite popular at the time.[9] From an epistemological point of view, these documents constitute an intermediary genre between official science and the "folk biology" of practical men. In the writings of Beale, Scoresby and others, two contemporary ways of acquiring knowledge on whales – namely practical experience and systematic research – tend to converge into documents that can be regarded as epistemological hybrids. In *Moby-Dick*, however, the basic tension between scientific and practical knowledge is amplified, *intensified*. For its narrator it is clear that a whaler's understanding of the whale is of a completely different nature than the scientific one. Whereas whalers draw from their personal acquaintance with the phenomena of maritime life, the scientist relies on careful, systematic observation (notably dissection of stranded whales). Ishmael unmistakably acts as the whaler's advocate. His practical cetology is emphatically *anti*-scientific.

This chapter aims to be an analysis in depth of the epistemological aspects of Melville's novel. In Section 4.2, the whaler's epistemology of *self-exposure* will be confronted with the scientist's epistemology of *self-restraint*. To what extent can science truthfully disclose the wondrous phenomena of maritime life in general and of a whale's life in particular? Most notably, I will focus on Ishmael's criticism of the scientific practice of classification, building on our discussions in Chapter 3.

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[8] The order of the cetaceans includes whales, dolphins and porpoises and is taxonomically subdivided into *odontocetes* (toothed whales, dolphins, porpoises) and *mysticetes* (baleen whales). The sperm whale is a toothed whale, notorious for hunting giant squid in the deep, dark, inaccessible ocean regions.

[9] At times, he uses lofty scientific formula – "It will have been seen that …", "as has been elsewhere set forth …", etc. – but the general mood is one of parody and laughter. Indeed, "Moby-Dick reads like a formal essay, except that Melville's tone is mocking and his procedure high-spirited" (Vincent 1992). *Moby-Dick* provides ample material in support of Bakhtin's theory that the novel parodies official speech genres, including that of science.

Subsequently, I will turn to philosophy and its epistemology of *meditation*. Most notably, I will focus on the way the experience of the sublime is represented in the novel. Gradually, however, this comparison will reveal the extent to which epistemological choices and differences also determine our *moral* experiences and assessments concerning whales. Indeed, *Moby-Dick* reveals the close affinity between epistemology and ethics. Melville's novel allows us to understand how the whaler's appreciation of the whale differs from that of the scientist, not only in terms of epistemology, but also in terms of ethics. The conditions created by the practical, the scientific and the philosophical way of perceiving and experiencing whales are bound to generate diverging moral affinities. This is quite apparent, for example, when the issue of the possible extinction of the whale is raised. What we may learn from *Moby-Dick* is that our position regarding such issues is determined to a large extent by our *epistemological convictions*, as well as by the sources and practices we tend to rely on when answering the question "What is a whale?" In other words, Melville's novel can be read in various ways, but it is first of all an exercise in comparative epistemology.

4.2 What is a Whale? The Epistemology of Self-exposure Versus the Epistemology of Self-restraint

As already indicated in Chapter 3, the whaler's knowledge of whales and their environment is characterized in *Moby-Dick* as "the real living experience of living men" (p. 869). Only whalers really and truly know what a whale is, and only a whaler's picture of a whale conveys a truthful idea of the living animal as seen by his living hunters. Scientists are basically regarded as inexperienced. Most of them have seldom seen, let alone hunted whales. The basic epistemological stance of practical cetology is *self-exposure*. The only way to get to know the whale is to expose oneself to the experience of a whaling voyage:

> How vain and foolish, then, thought I, for timid untravelled man to try to comprehend aright this wondrous whale, by merely poring over his dead attenuated skeleton.… No. Only in the heart of quickest perils; only when within the eddyings of his angry flukes; only on the profound unbounded sea, can the fully invested whale be truly and livingly found out. (p. 1032)

A whale-ship, Ishmael assures us, was his Yale College and his Harvard (p. 826). And although he agrees that a professional hunter's account may suffer from exaggerations, he nonetheless emphasizes that on certain occasions, the apparently fabulous will be "fully equalled by the realities of whaling" (p. 869).

Ishmael claims to have read a substantial amount of official zoological publications on whales, but he seldom finds them very helpful when it comes to understanding whales. Utter confusion exists among the natural historians of this animal, he argues, and they themselves quite readily admit it – an "impenetrable veil" is said to cover all knowledge of the *cetacea* (p. 838). For Ishmael, the cause of this confusion is not difficult to point out. Many are the men who have written of the whale, he tells

us, but only a few ever saw living whales, and only one of them (William Scoresby) was a professional harpooner and whaler. Most landsman (and this includes most naturalists) are completely ignorant of some of the plainest and most palpable wonders of the oceanic world. Of a particular species of whales (namely the Killer Whale) Ishmael tells us that "little is known to the Nantucketer, and nothing at all to the professed naturalist" (p. 844). As to the great Sperm Whale, he assures us that his is still an "unwritten life" (p. 839). It even seems impossible to visualize the whale. The great Leviathan defies any representation. He is that one creature in the world which remains unpainted. There is no *earthly* way of finding out precisely what the whale looks like. Again, the only mode in which even a tolerable idea of his living contour can be derived, is "by going a-whaling yourself" (p. 921). And the only genre that may be able to convey this type of knowledge truthfully is the novel. Like Ibsen in *The Lady of the Sea*, Melville seems to subscribe to the idea that there are forms of knowledge about the sea and its inhabitants that are more intimate and natural somehow than formal knowledge and cannot be articulated in scientific terms. Only literary genres can document them in a sensitive and convincing way.

Thus, according to Ishmael, cetology can only achieve its aims by abandoning the epistemology that entails careful, protracted scholarly work in favour of self-exposure. After having ascertained that a picture of a whale contained in a book by the naturalist Frederick Cuvier is seriously flawed, Ishmael pardons the author by pointing out that he never had the benefit of a whaling voyage. All pictures in "a scientific systemized whale book" by Lacépède are judged as incorrect (p. 920). And when in another volume a surprisingly correct engraving is encountered, Ishmael concludes that the person responsible for it "was either practically conversant with his subject or else marvellously tutored by some experienced whaler" (p. 922). Still, some serious fault might be found with the anatomical details of this whale, Ishmael admits, "but let that pass" (idem.). Official science, taking its drawings mostly from stranded specimen, is a deficient practice. For Ishmael, even the carefree pictures of whales painted by retired sailors on boards, boxes and whale-teeth are usually more adequate than the most careful drawings in scientific publications.

Thus, self-exposure is the royal path to knowledge. To Captain Peleg, who enlists him on the Pequod, Ishmael explains that he wants to find out by experience what whaling is, that he wants to see the ocean with his own eyes (p. 802). Peleg suggests that he might step forward and take a peep over board, where the open ocean can readily be seen: an unlimited prospect, exceedingly monotonous. "Well, what's the report?" Peleg asks him, "what did ye see?". Not much, is Ishmael's answer, nothing but water and the horizon. But in order to really *see* the ocean, one has to dwell on it for months, for years preferably.

The lives of whales are obscured by the methods of "professed naturalists" and scientific "cetologists". As soon as a scientific stance is taken, the real living whale seems to disappear. As soon as we are informed about the number of vertebrae in the whale's vertebral column, or about the exact latitudes and longitudes of the whale's migratory routes, the real living whale seems lost. The epistemology of science is one of self-restraint, rather than self-exposure. From a scientific point of view, sailors (particularly whalers) are to be regarded as a notoriously *unreliable*

source of information on whales.[10] Their basic flaws are capriciousness and (above all) a tendency towards exaggeration. They all too readily allow themselves to be fascinated by the marvellous. "In maritime life", Ishmael assures us, "far more than in that of *terra firma*, wild rumours abound, wherever there is any adequate reality for them to cling to. And as the sea surpasses the land in this matter, so the whale fishery surpasses every sort of maritime life, in the wonderfulness and fearfulness of the rumours which sometimes circulate there" (p. 867). As whalers are "by all odds the most directly brought into contact with whatever is appallingly astonishing in the sea" (idem), Ishmael acknowledges that their reliability should be counted even less than that of the other sailing professions. Face to face, they eye the sea's greatest marvels. Therefore, it is only by exaggerating the factually known that one can approximate something like the real living experience of whalers. Thus, conjectures are readily turned into possibilities, and possibilities into established facts.

In Chapter 45 Ishmael presents us with a formal *Affidavit* regarding the question whether a sperm whale can really destroy a whaling vessel. He begins by saying that he cares not to perform his task methodically, like a "professed naturalist" would, but contents himself with producing the desired impression by citing a limited number of citations, practically or reliable known to him as a whaler. From these citations, he takes it, the conclusion aimed at will naturally follow of itself (p. 881). His subsequent argument is indeed worked out in accordance with this procedure. One of the problems facing the whaler is that his experiences may often seem incredible to landlubbers. People ashore only vaguely surmise what an enormous creature a Sperm Whale really is. In order to establish that a member of this species may be sufficiently powerful, knowing and malicious to destroy and sink a large ship, several items of evidence are cited. In the year 1820 the ship Essex of Nantucket was attacked by a huge Sperm Whale. "I read [the captain's] plain and faithful narrative", Ishmael assures us, "and conversed with his son, and all this within a few miles of the scene of the catastrophe" (p. 883). An extract from the captain's own account runs thus:

> At all events, the whole circumstances taken together, all happening before my eyes, and producing, at that time, impressions in my mind of decided, calculated mischief, on the part of the whale (many of which impressions I cannot now recall), induce me to be satisfied that I am correct in my opinion. (idem)

Mention is made of other evidence "one way or another known to me" and finally Ishmael points out that the marvellous event is not only corrobated by present facts, but that similar marvels occurred in previous ages. Procopius, sixth century AD, by the best authorities considered a most trustworthy and unexaggerating historian, testified how a great sea monster destroyed vessels in the sea of Marmora. According to Ishmael, this certainly must have been a whale, and he is even "strongly inclined" to think a Sperm Whale. For although Sperm Whales are never seen in the Mediterranean, further investigation brought out that not so long ago a Commodore Davis found a skeleton of a sperm whale on the Barbary coast. Ergo,

[10] "All sailors of all sorts are more or less capricious and unreliable" (p. 887).

Procopius' sea-monster must in all probability have been a sperm whale. In this manner, Ishmael gives us an impression of a whaler's method of argumentation.[11]

From a Bachelard-like point of view, it is not too difficult to subject Ishmael's account to a "psychoanalytical" assessment. As was pointed out in Chapter 2, Bachelard follows Jung in his distinction between the two modes of thinking: formal (or discursive) and imaginative thinking. Whereas the former evolves on the basis of formal logic and the causality principle, the latter relies on association and anecdotal information. It is obvious that Ishmael's cetology belongs to the second format. This means that his epistemological differences with the various forms of scientific academic discourse are of a very fundamental nature indeed. Starting point of his cetology is a *typical image* (τυπος, ειδος, ιδέα), namely the monster archetype, the icon of an incredibly huge and even veracious whale. It is an obstinate idea: the biblical Leviathan, that is also emphatically present in various pre-modern scientific sources, such as Procopius, and in the stories of sailors of all times. Ishmael's treatment of empirical data is clearly in accordance with this imaginative mode of thought. He eagerly cites sources that support his basic idea, while ignoring others. Contradictory evidence simply cannot be true. It is at odds with the very basic, ineradicable idea that inspires him, that imprinted itself in his psyche – his basic truth. Scientific discourse can never live up to, never do justice to this basic, inviting, indeed: alluring image. From the point of view of imagination, as a mode of thought, science is bound to disappoint us. Indeed, as an iconoclastic practice, it remains suspicious towards the images of the marvellous, aiming to replace them with quantitative data, numbers, biological terminology, chemical nomenclature and so on. Ishmael is disappointed by nineteenth-century zoology much as Victor Frankenstein was disappointed by nineteenth-century chemistry. Take for example Victor's lamentation already cited in Chapter 1: "The ambition of the [modern] enquirer seemed to limit itself to the annihilation of those visions on which my interest in science was chiefly founded. I was required to exchange chimeras of boundless grandeur for realities of little worth" (p. 306). Ishmael's experience is remarkably similar. Yet, unlike Victor, he stubbornly refuses to subject himself to an epistemological conversion. Or perhaps we should say that, given his working-class background, he simply was not granted the privilege to really expose himself, other than in a toilsome and autodidactic manner, to the ideas of modern science. He was exposed to conditions (the world of manual, industrial labour) that differed significantly from those of Frankenstein (the bourgeois world of books, poetry, cultural travel and refined experience) and this may have resulted in their diverging epistemological trajectories.

In her impressive and superbly documented history of the marine sciences, Margaret Deacon (1971) elaborately reflects on the epistemological tension between

[11] Jules Verne wrote a novel that shares some similarities with Melville's (Les histoires de Jean-Marie Cabidoulin, published in 1901) – although in Verne's case the narrator sides with the scientific view, rather than with the stories and anecdotes of whalers. Nonetheless, the same types of discussion on sea-animals of monstrous proportions are addressed, against the backdrop of the same epistemological conflict between formal and factual lines of thinking versus imaginative and narrative ones, between practices of classification versus story-telling.

scientific and practical knowledge, tracing it carefully through history, although (quite unlike Ishmael) Deacon rather sides with the scientist's point of view. From Pliny and his contemporaries onwards, Deacon argues, throughout the roman and medieval period, and even during the Renaissance, marine scholars used to taken what she calls a "literary" approach to maritime phenomena, reading, citing and assembling extracts from various sources, producing encyclopaedic compilations of views borrowed from various documents, with the result that knowledge of natural phenomena such as currents and tides was usually much more accurate among (illiterate) seamen than among scholars. The people who practically *used* the sea, however, often did not transfer their accumulated knowledge to paper. While medieval sailors were often well informed about those features of the sea which were relevant to their profession, medieval and early modern writers seldom had any practical knowledge of the phenomena they discussed. The limited number of "solid facts" that were introduced from time to time, were invariably derived from the practical experience of sailors.

It was not until the seventeenth century that marine scientists began to appreciate the importance of first-hand examination and observation. A collaboration between scholars and sailors ensued. Sailors were now asked to collect and record information concerning marine phenomena in the journals of their voyages. At several occasions, the Royal Society published *Directions for Seamen*, counting on the scientifically oriented sailor to collect and record oceanographic information. Such measurements would gradually allow the mapping of so amorphous an element as the ocean (p. 84).

Initially, Beacon tells us, scientists tended to distrust the ability of sailors to make objective observations, almost as much as sailors scorned the complacency of landlubbers. But half-way the nineteenth century – the era of *Moby-Dick* – the prospects for overcoming this tension became more favourable. Gradually, the collaboration between scientists and sailors improved.

Already in 1769 (or 1770) the importance of a dialogue between scientists and sailors became evident. In that year, Benjamin Franklin noticed that mail packets sailing from Plymouth to New York were taking 2 weeks longer than the American merchantmen sailing from London to Rhode Island. He mentioned this to Captain Folger, of Nantucket, and was told that this was because the packet boats were unaware that they were sailing against the Gulf Stream. American whalers who hunted the whales on both sides of the current had done their best to enlighten them, but their advice had been disregarded. At Franklin's request, Folger marked the course of the current on a chart, and with the publication of it, people at last became familiar with the concept of the Gulf Stream.

Several concrete examples of collaborations between sailors (including whalers) and scientists are pointed out in Deacon's book. Captain William Scoresby, who also figures in *Moby-Dick*, was a whaler who published extensively on meteorology – his *Account of the Arctic regions* has already been mentioned. This book was a whaling manual written by "a genuine whaler gifted with scientific caution and restraint" (Vincent 1992).[12] Other sailors who greatly contributed to the development of marine science were, for example, Robert Fitzroy of H.M.S. Beagle, who

[12] In *Moby-Dick*, Scoresby's scientific exactitude is ridiculed.

systematically recorded observations in a geographical journal, and John Murray, who joined a whaler as a surgeon and later became an expert on deep sea biology. Sailors were allowed to contribute to science insofar as they adhered to its basic epistemological premises and educated themselves in viewing the ocean in accordance with scientific methods. It took some time before they had familiarized themselves with the protocols and procedures recommended by modern science. By and by, the logbooks and journals were emptied of their narrative content and filled instead with columns, tables, measurements, coordinates – in short: with symbolical data, with *numbers*.

Ishmael's cetology can perhaps be regarded as a protest against this recruitment of whalemen for the scientific cause, and as a rehabilitation of precisely those forms of knowledge that are bound to be erased by these new types of registration, new techniques for keeping records. *Moby-Dick* is, one might say, an epistemological mutiny.

From an epistemological point of view, at least one claim made by Ishmael seems highly questionable, namely the claim that his cetology is based on "the visible whale", on on-site experience. Rather his methodology seems to fit into Deacon's description of the "literary" approach, building huge collections of extracts and anecdotes, complemented with a limited amount of direct observation. I will follow up on this in Section 4.3.

4.3 On Classifying Whales

One particular scientific issue receiving ample attention in *Moby-Dick* is that of classifying the whale. Ishmael distances himself from the uninspiring output of official science, containing so little "original matter", in order to work out a "popular comprehensive classification" of his own (p. 839). A ponderous endeavour indeed, amounting to "the classification of the constituents of a chaos" (p. 838). But, he assures us, "I have swam through libraries and sailed through oceans; I had to do with whales with my visible hands, and I will give it a try" (p. 839).

The basic question is whether a whale is a mammal or a fish. Two official cetological definitions of a whale are cited: Cuvier ("The whale is a mammiferous animal without hind feet", p. 754), and Linnaeus ("I hereby separate the whales from the fish; on account of their warm bilocular heart, their lungs, their moveable eyelids, their hollow ears, and *penem intrantem feminam mammis lactantem*", p. 839). To a whale-wise practical cetologist, this – the identification of the Sperm Whale as a mammal – is unacceptable. How can the most eminent of all sea animals be something other than a fish? In fact, Ishmael consulted Simeon Macey and Charley Coffin, both of Nantucket, for their judgement, and they united in the opinion that the reasons set forth by official science were altogether insufficient, or even humbug (p. 839). Ishmael himself takes "the good old fashioned ground" that the whale is a fish, and calls upon "holy Jonah" to back him. This is how he defines a whale and labels him "for all time to come": "A whale is a spouting fish with a horizontal tail. There you have him …" (p. 840). And he adds: "By the above definition of what a

whale is, I do by no means exclude from the leviathanic brotherhood any sea creature hitherto identified with the whale by the best informed Nantucketers; nor, on the other hand, link it with any fish hitherto authoritatively regarded as alien" (idem).

Ishmael admits that his "contracted" definition, said to result from "expanded meditation", lacks "minute anatomical descriptions" (p. 839). It relies on the immediate, visual aspect of the whale *as such*, in his entire bodily volume, on *Anschauung*, so to speak. It constitutes what could be called a phenomenological alternative to the dissecting practices of official science. Yet, on closer examination, Ishmael's definition cannot be said to result from "uncontaminated" experience alone. On the contrary, more than on first-hand experience, on "the living experience of living men" as he calls it, it relies on written documents, on theories, on the opinions of authorities, such as the Book of Jonah and the witty "experts" from Nantucket – and, eventually, it relies on a basic idea, a basic image. Confirmed more or less by a number of dramatic experiences, but not based on systematic research. In order to find support for his idea, Ishmael's cetology borrows from literary sources, such as Procopius and the Bible – a way of practicing natural science that had been rendered obsolete by Linnaeus, Cuvier and others. His cetology may be called pre-Linnaean. It adheres to the epistemological premises, the "historical a priori" as Foucault (1966) called it, of a previous epoch, namely the Renaissance. Indeed, the similarities with pre-Linnaean documents, as analyzed by Foucault, are remarkable. The typical set of items listed in natural histories before Linnaeus and Cuvier, can be found in Ishmael's account as well: the names of whales in different languages (Hebrew, Greek, Latin, etc.), references to the whale in the Bible (Jonah, Job, Isaiah, Ezekiel) as well as in outstanding works of art (Hamlet, King Henry, Rabelais, Paradise Lost, etc.), stories about famous, fabulous whales (Rinaldo Rinaldini, Timor To, New Zealand Jack, Morquan, Don Miguel)[13] and other *litteraria*, emblematic representations of whales,[14] information about medical properties of certain whale products (such as spermaceti), anthropomorphic descriptions ("the Hump Back Whale is gamesome and lighthearted", "the Black Fish carries an everlasting Mephistophelean grin", etc.). As Foucault points out, this method for defining natural entities relies to a significant extent on imagination and association, i.e. on the logic of similarities and resemblance.[15]

As a typical pre-Linnaean document, Ishmael's account fails to make a clear distinction between the various sources he uses, such as first-hand observation, hearsay and literary documents. All these materials are simply piled together. From the point of view of science, Ishmael's cetology constitutes a regression, so it seems. It eagerly borrows from literary sources, quite in accordance with the "literary method" that had been in vogue until the middle of the eighteenth century. From Linnaeus onwards scientists had been working hard to strip their object of its

[13] These are whales "as well known to the students of Cetacean history as Marius or Sylla to the classic scholar" (p. 882).

[14] Cf. "les blasons où ils figure" (Foucault 1966, p. 141).

[15] "[L]a ressemblance se situe du côté de l'imagination ou, plus exactement, elle n'apparaît que par vertu de l'imagination" (1966, p. 83).

textual layers, allowing it to appear naked as it were, collecting factual data rather than texts.[16] Ishmael, however, persists in unsystematically combining personal observations with extracts of all sorts. In the libraries of whaling he recovers the sediments and residues of centuries of *Historia animalorum*, in combination with input from the fable literature. With his exegetic readings of Jonah and other canonical (or less canonical) works, Ishmael's cetology comes much closer to the biblical zoology (zoology as a special branch of theology and biblical studies) as it still flourished far into modernity – even up to "Paley's theology", quoted by Ishmael – than to the marine biology of his day.

Modern science is basically iconoclastic. It destroys the image of the object as a whole, as a *Gestalt*, in order to replace it by series of numbers and measurements (Foucault 1966, p. 150; Lacan 1981, 1994). But Ishmael clings to his fascinating *image* of the whale, which in many respects remains a very traditional icon, the biblical Leviathan of old. One cannot say that the whaler's whale in *Moby-Dick* is the *real* whale. Rather, like the snow-white quadruped in the royal standard of Siam and the Hanoverian flag (p. 873), Ismael's heroic whale is a more or less *imaginary* animal, a fabulous heraldic iconization, rather than a biological species.

4.4 Whaling and Philosophy: The Meditating Sailor

While Ishmael's attitude towards natural science is outspokenly hostile, his attitude towards philosophy is much more sympathetic. The philosophy he has in mind, however, is of a (pseudo)-platonic, mystifying, meditative type: "Meditation and water are wedded for ever", he tells us (p. 760). Going to sea is Ishmael's way of becoming a philosopher.[17] All deep thinking is but "the intrepid effort of the soul to keep the open independence of her sea; while the winds of heaven and earth conspire to cast her on the treacherous, slavish shore" (p. 823) – the shore of official science and of the "cosmopolite philosopher" (p. 824). In the howling infinite landlessness resides "the highest truth, shoreless, indefinite" (p. 823). Again, Ishmael's view of philosophy reflects the *elementary* images associated with water, such as freedom of movement and openness of thought.

Of special interest in this respect are his reports of his experiences in the mast-head. The mast-head is described as a "contrivance" (p. 852) for meditation. It is to a philosophical sailor what the laboratory is to a scientific landsman. To a meditative man, the mast-head is simply delightful. There you stand, lost in the infinity of the sea, amidst a sublime uneventfulness. Standing in the mast-head, a place deprived of all comfort, is an ascetical technique for temporarily isolating oneself. Indeed, the basic epistemological maxim of Ishmael's philosophical practice is

[16] "Toute le language déposé par le temps sur les choses est repoussé … C'est la chose elle-même qui apparaît" (Foucault 1966, p. 142).

[17] His pagan friend Queequeg does not need such an experience, for he is always content and equal to himself, a (Stoic) philosopher from birth (p. 789).

isolation, as a basic condition for meditation. Thus, the sailor becomes a "Platonist" (p. 853), an absent-minded philosopher. He even runs the risk of losing his identity, taking the mystic ocean at his feet for the visible image of that deep, blue, bottomless soul, pervading mankind and nature (p. 854) – a description in which again an elementary, archetypal image can be recognised. The mast-head is the place where the *via practica* of whaling imperceptibly passes over into the *via contemplativa* of philosophy.[18] But alas, the truth as it is discerned by a meditative sailor hardly allows systematic articulation. The wisdom of the mast-head is bound to cloak itself in silence. "Wonderfullest things are ever the unmentionable" (p. 823).

Moby-Dick is, if anything, a philosophical novel. A considerable number of philosophers are mentioned: Pythagoras, Plato, the Stoics, Seneca, Melanchthon, Hobbes, Montaigne, Bacon, Descartes, Spinoza, Pascal, Locke, Rousseau, Bentham, Kant. The whale's magnificent head is compared to the heads of Plato, Locke and Kant, its skeleton to that of Bentham. Sailing with a Sperm Whale's head hoisted on the starboard, and a Right Whale's on the larboard side, it seems as if the Pequod had hoisted in Locke's head on one side, and Kant's head on the other (p. 957). But like all true philosophers, the captured and hoisted whales remain deeply silent. Their front displays utter indifference towards the world. "Speak, thou vast and venerable head", Captain Ahab mutters one night, "speak, mighty head, and tell us the secret thing that is in thee. Thou hast dived the deepest. There, in that afwul water-land, there was thy most familiar home. In deep midnight, O head, thou hast seen, and not one syllable is thine" (p. 947). But even if a whale's head could speak, this type of experience cannot be articulated in a discursive manner. It is the experience of the real (Lacan), "das Es" (Freud), of diffuse, unstructured nothingness. The whale really seems to belong there. He remains self-possessed, in tropical as easily as in polar waters, thus constituting something of a philosophical ideal: "Oh, man! admire and model thyself after the whale!", Ishmael exclaims, "Do thou, too, live in this world without being of it. Like the great dome of St. Peter's, and like the great whale, retain, O man! in all seasons a temperature of thine own" (p. 945). The whale is both an exemplification and a symbol of the sublime.

A considerable number of philosophical issues are being addressed. A prominent one, discussed on more than one occasion, is the question whether the whale (most notably *Moby-Dick* himself) is simply to be regarded a "dumb brute" (pp. 857, 876, 972), or rather an "intelligent agent". On the one hand we find it stated that *Moby-Dick* is an active, knowing whale, an animal acting with aforethought, out of intelligent malignity, a judiciously malicious agent, inflicting decided, calculated mischief on his foes, with deliberate designs of destruction. On the other hand we are told that the whale is a dumb brute who acts out of blind instinct and rage. Apparently, the latter view is corrobated by anatomy, that is: by the "wonderful comparative smallness" (p. 970) of his cortex. For under the long floor of the crater of his skull reposes "the mere handful of this monster's brain" (p. 969). Some

[18] A certain Captain Sleet used the mast-head as a contrivance for systematic scientific experiments (p. 853), notably for examining compass deviations. But to Ishmael, much more a philosopher than a scientist, it is a place for meditativeness.

experts from Nantucket even deny that Sperm Whales have a brain. Besides having so small a brain, the whale seems to have no nose, no olfactories, and no voice.[19] He does not seem to have the power of smelling (p. 982). And as for his ears, they are so astonishingly minuscule that they are hardly detectable. Add to this the fact that he has such disproportionally small eyes and it becomes questionable whether he has any sensitive awareness at all. This huge, black, massive front simply has no face.[20] The front of the Sperm Whale's head is a dead, blind wall. His tiny eyes are located at either side of his prodigious head. He cannot see the world in front of him. How does he manage to integrate his (extremely restricted) sensitive impressions, or to concentrate on any particular visible item? But then, he spends most of his lifetime in the bottomless deep where utter darkness reigns.

How does the whale experience his world? In what kind of world does he dwell? What is it like to be a whale?[21] Such are the questions that puzzle Ishmael the philosophical sailor. The whale's world simply seem inaccessible, his experiences unimaginable. We must not forget, of course, that at the time *Moby-Dick* was written, nothing at all was known about the sonar system or echolocation by means of which whales find their way about, quite unlike anything we humans can experience or imagine.[22] The nineteenth-century sailor was faced with a fundamentally alien form of life. But even with the knowledge of today, it seems utterly impossible for man to experience what a whale experiences – and he might therefore just as well keep his silence, for no vocabulary whatsoever can make this type of world-experience accessible to us. To a certain extent, the whale can be regarded an "epistemologically privileged being", as it was phrased in Chapter 3, having access to dimensions of the world far beyond our imagination and reach, and developing forms of experience in inaccessible regions that are totally unknown to us. Man simply lacks the a priori conditions for entering or experiencing a whale's world. *From a human perspective*, the whale's gloomy, silent world seemed an extremely impoverished one. A surviving glimpse of "that shuddering period, ere time itself began, when Saturn's grey chaos swayed through Polar eternities" (p. 1033). On the other hand, the nineteenth-century whaler was utterly amazed by the methodical, regular way, the remarkably reliable uniformity with which whales followed their migratory

[19] Cetologists nowadays will disagree with this of course. The sperm whale's brains are now considered to be large and complex, even comparable (in terms of size and complexity) to those of primates (Scarff 1980; McIntyre 1974). They are social, communicative animals that produce extremely loud, explosion-like sounds (Kooyman et al. 1975).

[20] "How comprehend his face, when he has none? Thou shalt see my back part, my tail he seems to say, but my face shall not been seen" (p. 987). This in contrast to seals, who display an almost human look in their round, peering heads and seemingly intelligent faces (p. 1071). The other extreme is the giant octopus encountered by the Pequod one day: "No perceptible face or front did it have" (p. 927).

[21] A similar question is addressed by Thomas Nagel (1974).

[22] Ishmael has it that the whale's communicativeness is concentrated in his tail. The peaking of the whale's dignified flukes is perhaps "the grandest sight to be seen in all animated nature" (p. 986). "There are gestures in it, wholly inexplicable, mystic gestures" (p. 987), and there are hunters who declare that through these flukes the whale "intelligently converses with the world" (p. 987).

routes amidst the widest expanses of water.[23] While whaling vessels were sprinkled in a disorderly way over the entire watery circumference, Sperm Whales continued their way along a given ocean-line "with such undeviating exactitude, that no ship ever sailed her course, by any chart, with one tithe of such marvellous precision" (p. 879).[24] The whale lives "systematically" (p. 982), ascending to the surface at regular intervals, always taking the same number of breaths. The Sperm Whale blows as a clock ticks, with the same undeviating and reliable uniformity (p. 889), as predictable as "the mighty iron Leviathan of the modern railway" (p. 1090).

4.5 *And God Created Great Whales*: The Philosophy of the Sublime

Ishmael's philosophical practices converge into one basic experience, that of the sublime. The very sight of open water already turns him to admire "the magnanimity of the sea which will permit no record" (p. 795) and his prolonged exposure to the unshored, harborless immensities and oceanic expanses only intensifies this experience. The sea, Ishmael tells us, is the anonymous element per se, encompassing everything, but impossible to demarcate. When standing in the mast-head, with a view on the limitless expanses of water around him and his thoughts dwelling on philosophical themes, he experiences the sublime, the astonishing immensity of the world in terms of time and place: Columbus sailed over numberless unknown worlds to discover his one superficial western one (p. 925); Noah's flood is not yet subsided: two thirds of the fair world it yet covers (p. 926).

And yet, apparently, Ishmael has spent enough time in the mast-head, and became enough of a philosopher to understand that the experience of the sublime is not a pure, immediate event, but rather a conditional one. Certain conditions have to be met in order for this experience to occur. If we were to be exposed to the ocean unshielded, we would simply be struck with terror. It is only gradually that man loses his sense of "the full awfulness of the sea which aboriginally belongs to it" (p. 926). The sea is perceived as sublime by *us*, but our perception is already marked and shaped by certain concepts and ideas. For one thing, it is prerequisite that, up there in the mast head for instance, we feel reasonably safe, that we somehow stand *above*

[23] "The hidden ways of the Sperm Whale when beneath the surface remain, in great part, unaccountable to his pursuers; and from time to time have originated the most curious and contradictory speculations regarding them, especially concerning the mystic codes whereby, after sounding to a great depth, he transports himself with such vast swiftness to the most widely distant points.… The Nor'West Passage, so long a problem to man, was never a problem to the whale" (p. 869).

[24] "So assured, indeed, is the fact concerning the periodicity of the sperm whale's resorting to given waters", Ishmael tells us, "that many hunters believe that, could he be closely observed and studied throughout the world; were the logs of one voyage of the entire whale fleet carefully collated, then the migrations of the sperm whale would be found to correspond in invariability to those of the herring-shoals or the flight of swallows. On this hint, attempts have been made to construct elaborate migratory charts of the sperm whale" (p. 878).

it. Under such conditions, a sailing philosopher may not "feel one whit more of terror than though seated before your evening fire" (p. 930). The basic element (water, fire) has been subdued by human technology: still fascinating, but no longer terrifying. Yet, the *real* sea, experienced immediately so to speak, is simply terrible – a masterless commotion. Man is alien to it. "No mercy, no power but its own controls it. Panting and snorting like a mad battle steed that has lost its rider, the masterless ocean overruns the globe. Her creatures carrying on an eternal war since the world began. Consider all this …" (p. 926). When seen from the mast-head, the ocean appears sublime, but when Ishmael, at the time of the final catastrophe, suddenly finds himself floating in the middle of the ocean, with no sign of humanity in sight, then the ocean is still enormous and immense, but utterly terrifying. Under such conditions, the experience of the sublime has completely vanished and is replaced by sheer terror and despair. The ocean now seems nothing but emptiness, and the one time philosopher becomes a perishable living being, about to disappear in the frightful abyss without a trace. "The wild, the watery and the unshored" (p. 1050) is δεινος beyond comparison, it is pure indifference, referred to by Levinas as the *il y a*, a world disappearing in darkness, utterly insensitive to human suffering. It is the dreadful sea as it emerges in the dream reported by Clarence in Shakespeare's *King Richard III*, about stumbling, or being pushed, overboard, "into the tumbling billows of the main:/Lord, Lord! methought what pain it was to drown". The same indifference is signified by the Sperm Whale – the animal without a face. The sublime is an experience that will occur under the condition that we somehow remain part of the human world.

To what extent can Ishmael's meditations on the sublime be considered Kantian? At first glance, both authors seem to refer to, and to be fascinated by, one and the same basic image. Indeed, one could say that, while Kant's Critiques (notably the first two) are so utterly dominated by the formal, discursive mode of thought, his phenomenology of the sublime is remarkably imaginative, "un-Kantian" perhaps, guided by and responsive to an elementary image.[25] The ocean, Kant tells us, is called sublime – *erhaben* – because the idea of infinity is conveyed by it, but certain conditions have to be met in order for such an experience to occur at the sight of something which, if experienced *as such*, could only produce in us fear and abhorrence.[26] So far, Kant and Ishmael seem to agree.

Moreover, not only to the sea itself, but also its most eminent inhabitant, the whale, seems to evoke this experience of the sublime. According to Kant, the mathematically

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[25] "So kann der weite, durch Stürme emporte Ozean nicht erhaben genannt werden. Sein Anblick ist grässlich; und man muss dat Gemüt schon mit mancherlei Ideen angefüllt haben, wenn es durch eine solche Anschauung zu einem Gefühl gestimmt werden soll, welches selbst erhaben ist.… Wer wollte auch … die düstere tobende See erhaben nennen? … Der grenzenlose Ozean, in Empörung gesetzt … [I]hr Anblick wird nur um desto anziehender, je furchtbarer er ist, wenn wir uns nur in Sicherheit befinden …"

[26] Cf. Nietzsche: "Now, little ship, look out! Beside you is the ocean: to be sure, it does not always roar, and at times it lies spread out like silk and gold and reveries of graciousness. But hours will come when you will realize that it is infinite and that there is nothing more awesome than infinity" (1974, § 124).

sublime refers to that which is immeasurable and great "beyond comparison",[27] and these are precisely the terms in which the experience of spotting living whales is articulated by Ishmael. In a quotation he extracted from a book on natural history it is said that "if we compare land animals in respect to magnitude, with those that take up their abode in the deep, we shall find they will appear contemptible in the comparison. The whale is doubtless the largest animal in creation" (p. 753). Indeed, chief among Ishmael's motives for going to sea was "the overwhelming idea of the great whale himself" (p. 762). On entering a whaler's inn, he discerns on a primitive, soot-coloured painting of a black mass of "unimaginable sublimity" – a whale. The Sperm Whale is referred to as "the mightiest animated mass that has survived the flood; most monstrous and most mountainous! That Himmalehan, salt-sea Mastodon, clothed with such portentiousness of unconscious power.… Living in the bottomless deep …" (p. 797). He is, without doubt, "the largest inhabitant of the globe; the most formidable of all whales to encounter; the most majestic in aspect …" (p. 840). Leviathan is of a mighty magnitude. The most imposing view to be had is that of the full front of his head: this aspect is "sublime" (p. 967). When hunting the whale, the whaler competes with what seems grand beyond comparison, a mighty monster, absorbed in incommunicable contemplations, an animal of "great inherent dignity and sublimity", both ponderous and profound (p. 984). His head is comparable to "Melanchthon's forehead" (p. 968), but in the great Sperm Whale, the "high and mighty godlike dignity inherent in the brow is so immensely amplified, that gazing on it, in that full front view, you feel the Deity and the dread powers more forcibly than in beholding any other object in living nature" (idem.). The grandeur of his head incites the idea of genius. "But how? Genius in the Sperm Whale? Has the Sperm Whale ever written a book, spoken a speech? No, his great genius is declared in his doing nothing particular to prove it. It is moreover declared in his pyramidical silence" (968).[28] In *Moby-Dick*, the Sperm Whale is described by the very images Kant himself uses to allude to the sublime: pyramids, St. Peter's Dome.

Yet, according to Kant, eventually we must recognise that neither the ocean itself, nor the whale as such should be regarded as sublime. Rather, he follows Sophocles: more overwhelming even than nature is man. The experience of the sublime eventually refers to our own ability to conquer and subdue maritime nature. For Ishmael, this cannot be true. The sea itself, and the whale itself remain what is truly sublime and we become insignificant in comparison with it. Although we slaughter whales, Ishmael seems to believe that we cannot really destroy these animal as such, not their basic image or idea. The pre-Adamite whale survived the great Deluge without the help of man, and dwells ever since in an antediluvian world unknown to us. He steered clear

[27] Ishmael, visiting a whale's skeleton worshipped by the inhabitants of an island, marvels, but also seized the opportunity for doing some anatomical research. How now!, the priest shouted, "Dar'st thou measure this our god!" (p. 1030). Here, apparently, Ishmael is doing what on other occasions he blames scientists to do, namely reducing the sublimity of the whale to quantitative data. It also shows Ishmael's flexibility in terms of methodology. He may occasionally resort to more or less scientific methods.

[28] More sublime than any other whale is of course *Moby-Dick* himself: "Not the white bull Jupiter … not Jove, not that great majesty Supreme! did surpass the glorified White Whale as he so divinely swam" (p. 1086).

of the Ark, went his own way, survived the Flood by becoming a sea animal. In that wondrous period, the gloomy epoch of Saturn, all the world was the whale's (p. 1033), when in shuddering polar eternities he lived his undocumented life. He is the gliding great demon in the seas of life, defying the unimaginable cold and blackness of the deep. As an apparition, in his full terribleness, when breaching from the farthest depths, the Sperm Whale is of all cetacean the most sublime, inspiring both awe and wonder, and the list of names for the whale in thirteen languages with which Ishmael begins his cetological account reads like a series of incantations, pronounced in order to adjure something terrible. He is marvellously adapted to the most extreme of circumstances, but at the same time out of place, both as a sea-dwelling mammal and as the sole survivor of the prehistoric monsters that roamed the earth in distant times. In the end, all efforts to *represent* the whale's sublimity are bound to fall short. Not only will his life remain un*written*, he is also, as we have seen, that one creature in the world that must remain un*painted* to the last. No portrait can hit the mark with any considerable degree of exactness (p. 921). A painting will be most like a whale when it is difficult to imagine that this really is what his living contours look like.[29]

But *Moby-Dick* is not an unequivocal monologue on sublimity. Ishmael both mocks and venerates the whale, for example when he points out that the absence of a nose is a deficiency that only adds to the animal's grandeur. Moreover, in spite of all veneration, whales are still being captured, hoisted and butchered, and their bodies are ruthlessly desecrated in the course of a demolishing procedure during which every trace of dignity is completely erased. One whale, about to be captured, is said to produce "an enormous wallowing sound as of fifty elephants stirring in their litter" (p. 895). A red tide pored from all sides of another gigantic whale, whose tormented body wallowed in a crimson pond, abating in his flurry, while spasmodically dilating and contracting his spout-hole, until finally "gush after gush of clotted red gore shot into the frighted air" (p. 932/933). Like Dionysos himself, the great whale – "that big god aloft there somewhere in yon darkness" (p. 866) – is cut to pieces in the end. "Every whaler is a butcher" (p. 942), involved in a bloody, greasy business, using whales as raw material for his trade, spilling tonnes of Leviathanic matter. They constitute the rank and file in an appalling and uneven battle between the technologically equipped bipeds of industrial society and the giant but defenceless mammals of ante-deluvian nature. One of the Pequod's crew members is said to be so utterly lost to all sense of reverence for the whale's majestic bulk and mystic ways, that in his poor opinion, "the wondrous whale was but a species of magnified mouse" (p. 830). The experience of sublimity can easily give way when man finds his inferiority in terms of bulk and physical strength more than compensated by his superiority in terms of technical equipment and cunning.

This struggle between veneration and disregard also applies to the ocean as such. Yet, in the case of *Moby-Dick*, maritime nature ultimately gets the best of it. Eventually,

[29] Cf. Wolf, 1986. One illustration, although calculated to excite the scepticism of landsmen, is judged by Ishmael as "admirably correct and lifelike in its general effect" (p. 921). But Captain Scoresby, in his eagerness no doubt to comply with the epistemological principles of science, drew his pictures on too small a scale to convey the desirable impression.

the human world is shown to be only a transitory phenomenon. Barometers, quadrants, charts and other equipment cannot subdue the helplessness and fragility of humanity before the shrieks of the ocean and the madness and gladness of her demonic waves. It is certainly no coincidence that, shortly before his fatal encounter with *Moby-Dick*, Ahab destroys his quadrant, shouting: "Science! thou vain toy!" (p. 1058). In the end, all collapses, "and the great shroud of the sea rolled on as it rolled five thousand years ago" (p. 1102). Melville's masterpiece not only addresses the issue of the disappearance of whales. His novel is also about the inevitable disappearance, sooner or later, of man himself. Melville seems to take a "grim pleasure" in showing our insignificance before the magnitude of nature (Kazin 1960, p. 59). *Moby-Dick* constitutes an attempt to present us with nature as it might be conceived with man entirely left out. In the end, all that is left is the trackless, fathomless "nothing" that has been there from the beginning, a beginning that just *was*, with no one present either to deplore the extinction, or to rejoice at the survival, of magnificent species such as the whale, or humankind. And no doubt, as we disappear, it will seem as if all these events have never happened, as human beings are no longer available to record their traces.[30]

4.6 Will the Whale Perish? The Ethics of *Moby-Dick*

In *Moby-Dick* whaling is perceived as a highly dubious animal practice. To the whaler, the whale is either an object of exploitation (the whaler as a butcher) or an opponent in a contest (the whaler as a hunter). To Ishmael's mind, however, the scientist's objective is no less disturbing. For science aims at reducing the unknown to the known. Thus, the living animal becomes a lifeless object. By dissecting the whale, by harming his vitality, his dignity and integrity, science hopes to put him in his zoological place. Apparently, it is only the philosopher, or rather the philosophical sailor, who appreciates the inherent dignity and sublimity of the whale. But there is a prize to be paid: this philosophical upgrading of the whale seems to rest on mystification and idealization.[31]

That there are certain drawbacks to Ishmael's idealistic overestimation of the whale, becomes clear when the question whether the whale will eventually perish is explicitly addressed (Chapter 105). Can Leviathan long endure so wide a chase? Will he not at last be exterminated from the waters? Can he escape speedy extinction? Ishmael agrees that the prospects seem disquieting, especially if we look at the vicissitudes of other large species: "Though so short a period ago – not a good lifetime – the census of buffalo in Illinois exceeded the census of men now in London, at the present day not one horn or hoof of them remains in all that region …" (p. 1035). Will not the whale befall a similar fate? Here, however, the sailing Platonist assures us that this will not be the case. The waning whale can

[30] Cf. Nietzsche: "Es gab Ewigkeiten, in denen der Mensch nicht war; wenn es wieder mit ihm vorbei ist, wird sich nichts begeben haben" (Über Wahrheit und Lüge im aussermoralischen Sinne, 1873, Nachlass).

[31] See for example Ishmael's denial of the fact that the breath of a whale is attended with an "insupportable smell" (p. 752).

always resort to its eternal December in some polar citadel, impenetrable to man. "We account the whale immortal in his species, however perishable in his individuality" (p. 1037). He despised Noah's ark, and if ever the world is to be again flooded, the eternal whale will still survive.

But present-day readers may not that easily be reassured. Rather, we tend to rely upon scientific research to provide us with statistics and facts. After carefully counting whales and diligently monitoring populations, scientists will tell us that the prospects are rather bleak. In the middle of the nineteenth century, a sensitive whaler could perhaps still afford to calm his presentiments with the help of platonic reflections on the imperishability of such an amazing species – of the indestructibility of whales as a basic image or idea – but nowadays the whale has finally entered the Ark, that is: the sphere of human responsibility, and it is only by an active policy of protection that the shrinking "herds" of ante-diluvian monsters may be preserved.

Yet, as a novel, *Moby-Dick* basically deals with epistemological problems of representation rather than with ethical issues of extinction. *Moby-Dick* analyzes a number of epistemological strategies for perceiving and describing whales. In the case of the sailor-philosopher, the strategy used is idealization. Notwithstanding the poetic beauty of the panegyrics that at times descend from Ishmael's idyllic masthead, they serve an ideological function insofar as they do not interfere with the brutal butchering that is going on at sea-level and on deck. While calmly reflecting on the platonic, idealized whale, the real whale is allowed to extinguish. A similar ideological function can be discerned in some of the poetic, Biblical metaphors employed by the Pequod's whaling crew, while in their very hands, the mysterious whale is speedily transformed into the raw material of their grubby trade. Nineteenth-century scientists may well fall short in doing justice to the living experience of the living whale, and may well have failed to keep their objects alive and intact, but their dissecting practices (usually of stranded whales) constituted a much more refined form of demolition than those of whaling proper.

What we may learn from *Moby-Dick*, insofar as ethics is concerned, is that our position on moral issues depends on our epistemological stance and on the epistemological nature of the sources we rely on in answering the question "What is a whale?" As for the issue of extinction, the Pequod's crew, much like their modern colleagues, seem utterly unaffected by such a prospect, while the philosopher's stance in *Moby-Dick* is one of disavowal and denial. In Melville's time the scientific knowledge concerning whales was too limited to be of much help in this matter, while modern scientists may take various positions. While some of them provide us with disquieting statistics, others argue that extinction is a natural phenomenon and whales are apparently an evolutionary dead end (cf. Slijper 1962).

4.7 Concluding Remarks

This chapter was devoted to a case study: the epistemological significance of one of the most important animal novels ever written. In Chapter 2 it was indicated that, for centuries, the literature on animals has been dominated by two very influential

genres: the "history of animals" tradition, initiated by Aristotle and based on dissection and binary classifications, and the fable literature, relying on remarkably stable and typical images of animals. In the nineteenth century, in Darwin's era, a much more realistic approach emerged in literature, philosophy and science. Animals suddenly became *alive* so to speak.

Interestingly, in *Moby-Dick* all these lines of development seem to converge. First of all, as a fabulous animal, a kind of sea monster, the great white whale seems to adhere to and revivify the fable literature. On the other hand, practices of classification are emphatically present and fiercely discussed. Sometimes, Ishmael himself reverts to techniques of classification and dissection, investigating the remains of stranded whales for instance, or describing their brains and sense organs with some precision, while on other occasions he firmly rejects these techniques as inadequate. That is: the time-old tension between "science" and "literature", between classification and imagination, as two basic epistemological orientations when it comes to knowing animals is fleshed out in a polemical manner in this novel. Which of the two will prove a dead end? Which of the two will show itself to be the fittest approach in this epistemological "struggle for survival"? Ishmael's decision to align himself with the whaler's whale, so overtly loaded with the logic of the fabulous, does not seem a very promising option, from an epistemological point of view that is. Melville's book contains a very *realistic* version of both traditions, however. The whale as an animal is no longer a type or caricature, it is no longer an anatomical oddity, but really seems to come alive.

Chapter 5 will likewise be devoted to practices of dissecting and demolishing living animals, but in a rather different context. In *Moby-Dick*, science was predominantly represented by practices of classification and taxonomy. In the course of the nineteenth century, however, the experimental approach became increasingly important. Evolution theory and experimentation are the two manifestations of realism in biology, counterparts of the realistic novel. That is why, in Chapter 5, the focus will shift from classification as a scientific "animal practice" to experimentation. In terms of species, the focus will be on experiments with dogs. In the case of *Moby-Dick* we started with the literary document and looked at scientific discourses from that perspective. In Chapter 5 a different approach will be taken. First of all, we will describe the emergence (notably during the second half of the nineteenth century) of realism in both science and literature. Subsequently, we will focus on scientific discourse (animal experiments, notably *dog physiology*), while the final sections are devoted to its literary counterparts (notably the *dog novel*).

Chapter 5
What is a Dog? Animal Experiments and Animal Novels

> "What do you want frogs for, mister?" one of the boys asked him.
>
> "I'll tell you", answered Bazarov.… "I shall cut the frog open to see what goes on inside him, and then, since you and I are much the same as frogs except that we walk about on our hind legs, I shall know what is going on inside us too."
>
> "And what do you want to know that for?"
>
> "So as not to make a mistake if you're taken ill and I have to treat you."
>
> "Vasska, d'you hear that? The gentleman says you and me are the same as frogs."
>
> "Go on, into the water with you, my young philosophers!" said Bazarov [Ivan Turgenev].
>
> In everyday life, men do nothing but experiment on one another [Claude Bernard]

5.1 Prelude: The Year 1859 and the Triumph of Realism

The lines quoted above come from Ivan Turgenev's famous novel *Fathers and Sons*, published in 1861, but describing a series of events set in the year 1859, when Charles Darwin published his scientific best-seller. As was indicated in Chapter 3, Darwin's *Origin of Species* entails a triumph of a realistic view on nature over the (then dominant) romantic view. The same tendency towards realism was omnipresent in Melville's whaling novel – notably in the relentless descriptions of the violence of whaling as an "animal practice" – and it is precisely this shift from romanticism to realism that is at the heart of Turgenev's novel as well.

The book sets out to analyze a generation conflict. The "fathers", notably Nikolai Kirsanov and his brother Pavel, are the *romanticists*: Russian landlords who value art, culture, French and English novels, good manners, in short: an aesthetic and educated, but rather idle and melancholy lifestyle. In their youth, they visited the university, not in order to become physicians or scientists, but in order to be educated as "gentlemen". The new generation of the *realists*, however, is represented by Nikolai Kirsanov's son Arcady (a science student at the university of St. Petersburg), but especially by his friend Bazarov, a young and ambitious physician who is interested in natural science, notably physiology and chemistry.

Bazarov spends most of his time dissecting frogs. He despises everything that has to do with sentimentalism, romanticism and aestheticism. He visits the Kirsanov estate during the summer holidays, not because he wants to expose himself to the mysterious charms of provincial sunsets, but in order to look for, and experiment on, frogs – his favourite animal model. The struggle between romanticism and realism is reflected on the ethical level as well, namely as the conflict between (romantic) "idealism" and (realistic) "nihilism". Indeed, in order to characterize Bazarov's position, it was Turgenev who coined the term "nihilist". Bazarov is the prototypical nihilist: not in the sense of being someone who sees everything in a negative light, but in the sense of being a man who "looks at everything critically", who does not take anything for granted, not even moral ideals. All men are similar, from a scientific point of view, he claims, and slight individual variations (i.e. "character") are of no great importance. Bazarov is someone who has no faith in (moral) principles, only in frogs (i.e. in systematic experimental research). While Nikolai and Pavel Kirsanov read the lofty works of Goethe and Schiller, Bazarov prefers Liebig, Büchner[1] and the German physiologists, claiming that even a mediocre chemist is twenty times more useful than the greatest poet. Bazarov emphatically relies on the methods of science and views the aesthetical lifestyle of the older generation as a waste of time. He even denies the possibility of romantic love, although tragically enough he eventually cannot resist the appeal of a mysterious lady and falls madly in love with her, thereby counteracting his own maxims. If we read Turgenev's novel as an experiment, one could conclude that as far the erotic content is concerned, Bazarov's "realistic" (i.e. physiological) theory of love is refuted by his personal experiences. From the point of view of comparative epistemology, however, it is important that Turgenev, like Melville in the previous chapter, refuses to take sides in this epistemological generation conflict (Troyat 1985/1988). Both perspectives are treated with fairness, both are allowed to present themselves, both are fleshed out in a credible and convincing way – both are challenged by untoward events.

Turgenev's novel reflects a conflict of generations, or rather: of worldviews, that was really taking place on a rather broad scale throughout Europe. In England, as was already described in Chapter 3, Darwin's *The Origin of Species* conveyed a new way of looking at the world. Nature was viewed in a realistic, post-romantic way, not in terms of balance and harmony, but in terms of a relentless, continuous struggle – between species and variations in Darwin's case, but it was not difficult to extrapolate this scheme to a conception of life as a struggle between human individuals (liberalism), classes (Marxism), nations (nationalism) or races (racism). In the same year as Darwin, Samuel Smiles had published another best-seller, called *Self-Help*, preaching the gospel of self-discipline and labour. Smiles encouraged individuals, notably from the lower social classes, to prepare themselves for a life of competition, a social struggle for survival. His heroes were *self-made men*,

[1] Ludwig Büchner (1824–1899) was the author of *Kraft und Stoff*, a gospel of the emerging scientific worldview, quite popular at that time. Justus von Liebig (1803–1873) was the father of organic, applied and agricultural chemistry.

engineers and scientists, usually of humble descent, who adhered to a realistic and practical view on life. Through hard work and temperance, Smiles tells his readers, upward social mobility can be achieved, as the world is highly in need of a new type of human being: realistic, hard-working and – above all – eager to learn. The book conveyed a strong aversion towards the idealization of idleness and aestheticism, in vogue among the higher social strata. Indeed, the heroes of the realistic age are no longer the painters and poets of romanticism, but rather inventors and other representatives of science-based practices. This is the human variety that will be able to maintain itself in the struggle for survival under the conditions of modernity.

In France, writers such as Balzac, Flaubert and Zola represent a similar trend, but now in the domain of literature – as was already mentioned in Chapter 1 – by giving rise to a new literary style called "naturalism". They propagate the realistic or naturalistic novel. Novel-writing is regarded by them as basically congenial to physiology or other forms of scientific research. In 1829, Balzac had already published his *Physiology of Marriage* (1829/1997). Love should no longer be treated in a romantic fashion, he assures us. In this century, in which the exact sciences play such a prominent role, there is a need for "keen observation and for facts" (p. 20). Indeed, the book abounds in observations and statistics. Marriage is seen as a relentless struggle, a continuous battle of the sexes, even as a "disease", and his book reads like an epidemiological survey devoted to this widespread affliction (p. 21). In his many novels, Balzac likewise tends to take a more or less realistic and even scientific outlook. He sets out to produce a classification of human types, similar (to some extent) to the way in which naturalists had been classifying animals and plants.

In naturalistic novels, authors begin to study the responses of their characters to various circumstances (usually adversities) – more or less as if they were research subjects in an experiment. An important example of a "naturalist" is Flaubert, who based his novels on extensive research and site-visits. Instead of depicting highly exceptional individuals (preferably "heroes"), as was usually the case during the Romantic era, the work of the new novelists was devoted to the careful analysis of the daily lives of ordinary people, notably their love life and their working life. Emile Zola, in order to define the basic profile of his work, used terms like "natural history" and "physiology". In Section 5.3, I will consider more thoroughly his claim, already mentioned in Chapter 3, that novel-writing is basically similar to conducting an experiment. Finally, in 1890, Ernest Renan more or less summed it all up in his book *L'avenir de la science* (*The Future of Science*) in which it is argued that the basic intellectual tendency of the nineteenth century is the replacement of philosophy by the natural sciences, notably physiology.

As far as the life sciences themselves were concerned, the most important event during this period in France was no doubt the publication of *Introduction à l'étude de la médecine expérimentale* (Introduction to the study of experimental medicine) by Claude Bernard in 1865 (1865/1966). Bernard is generally known as one of the "champions" of vivisection who, in the context of both research and education, subjected large numbers of animals, notably dogs, to painful and often fatal experiments.

Although as a youth he had tried his hand at playwriting (Romantic style), at a certain point he decided to abstain from writing belles-lettres completely and to devote himself to science instead. He called his method "experimentation by destruction" ("expérience par destruction", p. 37). According to Bernard, the logic of experimentation basically consists of two steps: *destroy* or remove a particular part of the animal's body (e.g. an organ, a tube, and a nerve), and *observe* the effects of this destruction in the living organism.[2] In this manner he was able, for example, to discover the function of the liver in the context of metabolism. Whereas for centuries anatomists had been unable to understand the role of this large mysterious organ, Bernard showed that an experimental approach could solve the riddle. "Passive" observation (i.e. describing nature without interfering with it) gave way to a much more active and even aggressive stance. According to Bernard, experimental scientists deliberately act upon nature, *damage* nature, in order to observe the effects of their own doing. They artificially produce the phenomenon they want to study. In his *Introduction*, Bernard explains how the hand of the experimenter must actively intervene in order to allow the phenomenon under study to emerge (p. 27). Indeed, the success of experimental work greatly depends on technical dexterity and the devices scientists have at their disposal to manipulate the organism. Eventually, the experimenter wants to acquire full mastery over his object ("modifier pour maîtriser", p. 104). Sentiments concerning research animals, sympathy or compassion with warm-blooded animals, with his numberless rabbits or dogs, are completely absent from his text. Indeed, he refuses to say anything about his rabbits and dogs at all. His book conveys an extremely professional, detached and down-to-earth attitude. Written after his retirement (actually a systematic recapitulation of the scientific method he had elaborated and refined in the course of a lifetime), his textbook became quite popular, not in the least among novelists, as is evident from Zola's euphoric review – to be discussed in Section 5.3.

Turgenev's novel already indicated that the same shift from romanticism to realism was noticeable in Russia. One of the voices heralding the dawn of the new realistic era in the 1860s in Russia was Dmitrii Pisarev (1840–1868), editor of the journal *The Russian Word*. Several statements made by Bazarov in Turgenev's book are actually quotes taken from this work (sometimes literally, but usually slightly altered), such as the phrase that nature is not a temple but a workshop.[3] Another important representative of the new era, one of the rising scientific intellects of the 1860s, was I.M. Sechenov, the author of *Reflexes of the Brain* [1863].[4] In fact, according to Frolov (1938/1970), Bazarov as a character was modelled after him, although Troyat

[2] "On supprime un organe sur le vivant par la section ou par l'ablation, et l'on juge … de l'usage de l'organe enlevé. Ce procédé expérimental … est mis tous les jours en pratique en physiologie" (p. 16/17).

[3] Pisarev actually used the word "cathedral" instead of "temple" (Todes 2000, p. 19). Turgenev's variation is perhaps a blending of Pisarev's quote with the title of the book *The Temple of Nature*, a romantic view on nature published by Erasmus Darwin in 1803. Another famous quote by Pisarev, paraphrased by Bazarov, is that a bootmaker is of more use than Shakespeare.

[4] Sechenov had wanted to publish his report in a widely read monthly review, but the censor would only permit publication in a medical journal. This medical journal, however, suddenly became very popular (Todes 2000, p. 20).

(1985/1988) claims that Bazarov was modelled after an English physician. The issue is of some relevance, as Sechenov, in his role as professor of physiology at the University of St. Petersburg, was actually Ivan Pavlov's teacher. He had studied abroad with prominent physiologists such as Müller and DuBois-Reymond in Berlin, Funke in Leipzig, Ludwig in Vienna and Helmholtz in Heidelberg, while much of his early work was done in Claude Bernard's laboratory. Pavlov later called him the father of Russian physiology. After experimenting with frogs he became convinced that all psychological activities of human beings (including love) can be explained in physiological terms, that is, as complicated reflex arcs.

The most famous proponent of Russian physiology, however, was Ivan Pavlov (1849–1936) of course. He studied at the University of St. Petersburg (as did Bazarov) where Sechenov was one of his teachers. Subsequently, he carried out research in Breslau and Leipzig, where he worked with Heidenhain and Ludwig and learned how the best laboratories of the time were organized. After returning to St. Petersburg he became professor of physiology at the Medical Academy and director of the physiological department of the Institute of Experimental Science. His early work dealt with blood circulation and digestion. For his book *Lectures on the Work of the Digestive Glands*, published in 1897, he received the Nobel Prize in 1904.

It is important to emphasise, however, that this shift from romanticism to realism, occurring throughout Europe, did not entail a shift from "literature" to "science". Rather it was a shift that occurred within *both* domains, simultaneously. The Romantic poet is replaced more or less by the scientifically oriented novelist. Both novelists and scientists become interested in physiology and experimentation. Indeed, the second half of the nineteenth century not only sets the stage for the rise of the modern laboratory and the breakthrough of experimental research on an unprecedented scale (carried out in a systematic and professional manner), it also sets the stage for the emergence of the "experimental" novel – a concept that will be explained in more detail in this chapter. In other words, we will analyse the experimental style of thinking in science as well as in literature. What is a literary experiment – or even: a literary "animal experiment"? What kind of knowledge does it produce? Is it "really" an experiment? Can we use the logic of the experimental design to clarify the structure of the realistic or naturalistic novel? And what about the scientific experiment? Does it display similar structures as these literary works, or are we rather confronted with different kinds of genres, producing different kinds of insights into living nature, notably animals such as dogs? These are the questions to be addressed in this chapter.

The chapter consists of three "steps". First of all, we will analyse scientific experiments with animals. Our focus will be on the experimental work of Claude Bernard and Ivan Pavlov, two prominent exponents of the new animal science that emerged in the second half of the nineteenth century. Moreover, both researchers experimented extensively with dogs. Yet, I will emphasize that their views on animals, notably dogs, and on conducting experiments with dogs, were quite dissimilar – to put it mildly. Whereas Bernard subjected his research animals to "acute" experimentation (often with fatal results), Pavlov's experimental style become known as the "chronic" method, which basically meant that he allowed his dogs to recover after being

operated upon. Indeed, interest in the health and well-being of his experimental dogs became an inherent part of his approach.

Subsequently, I will analyse how dogs are presented in novels of this period. I will regard these texts as literary experiments. To begin with, I will explain Zola's idea of the experimental novel, notably his view that physiology and novel-writing are basically identical. As a case study, I will apply this idea to a classic dog novel: *The Call of the Wild* by Jack London. On the basis of a close reading of Bernard and Pavlov on the one hand and London on the other, a comparative epistemology of these two genres (scientific experiments with dogs versus dog novels) will be fleshed out.

Yet, in order to put the research practices of Bernard and Pavlov in their proper historical (i.e. "diachronic") perspective, I will first of all present a short history of experimental research with animals. This will serve as a backdrop for the synchronic (episodic) approach that will be adopted in the later sections. Writing about the history of animal experimentation is a hazardous task. In the course of time, a variety of (more or less scientific) animal practices has emerged. When should we refer to a particular animal practice as "scientific research", and to particular forms of scientific research with animals as "animal experiments"? Experiments with animals are often referred to as "vivisection", but there are many possible forms of animal experimentation and vivisection (the dissection of living bodies) is merely one of them, while not all forms of vivisections are experiments: notably in antiquity, vivisection was a public demonstration, a spectacle even, rather than an experiment – the experimental design (hypothesis, control group, manipulation of conditions, etc.) was usually lacking. Be this as it may, the diachronic backdrop will set the stage for a more detailed synchronic analysis. It will allow us to define what the concept of an "animal experiment" entailed in the era of Bernard and Pavlov, in scientific as well as in literary works.

5.2 A Short History of the Research Animal

In his short treatise *On respiration* Aristotle makes the remark that animals such as have spongy lungs need breathing less than others. The frog and the tortoise, he tells us, can remain under water for a long time, but "if one holds it down too long, an animal of this kind is drowned" (p. 431/470 b 23/24). This is something that does not happen in the case of fishes, "try as we will" (p. 435, 471 b 1–5).

We do not know whether Aristotle really *performed* (or supervised) such an "experiment", but if he did, it will be one of the first recorded animal experiments in history. Yet, Aristotle's extensive knowledge of animals was predominantly based on the dissection of dead animals. It was in ancient Alexandria, the "new" Athens founded by his pupil Alexander, that researchers went a step further by introducing vivisection: the dissection of live animals. The Greek physician Herophilus (330–260) and his younger colleague Erasistratus (304–245) consciously

decided to open up living bodies of mammals in order to see what goes on inside – and they preferably did this in public. Their argument was that, while anatomy of cadavers may tell us something about the internal structure of a body, it is not very informative when it comes to the living function of organs (Guerrini 2003, p. 7). As was already indicated above, their research cannot really be regarded as animal *experimentation*. Rather, it was a particular branch of anatomy, namely "anatomy of living beings" – or *anatomia animata* as it later came to be called in Latin.

Although the work of Herophilus and Erasistratus was influential, opening up new prospects for research, the true champion of ancient vivisection was Galen (129–216) no doubt, who performed many public dissections on live animals, apparently without much pity or compassion – the medical equivalent of gladiatorial combats, but now between *scientific* combatants (Guerrini 2003, p. 13), armed with a scalpel rather than a *gladius*, who stepped forward to put the relative strength of competing views to the test before a lay audience. Galen described his views and methods in a manual entitled *De anatomicis administrationibus* (*On Anatomical Procedures*). The rediscovery of this work in 1531 prompted a revival of vivisection in early modern times (Guerrini 2003, p. 26).

The epistemological importance of vivisection became evident when, in the third decade of the seventeenth century, René Descartes and William Harvey produced conflicting accounts concerning the circulation of the blood in human and animal bodies. Whereas Descartes relied on deductive reasoning (*more geometrico*), Harvey had recourse to experimentation, that is, active intervention, directed at achieving replicable results. Descartes was not really and experimenter. He performed very few experiments, spent much time dissecting dead animals, but seldom experimented on live ones. Although occasionally he dissected living animals such as rabbits and dogs (Watson, p. 167), the bulk of his work in this area was anatomical research performed on cadavers. On this type of research (quietly analysing bodily parts, e.g. eyes and legs) he based his famous conviction that animals are machines. As Herophilus and Erasistratus had already argued, however, although anatomical data may provide us with important insights concerning the internal structure of the animal body, they are usually not very enlightening when it comes to determining the *function* of the structures and organs thus described. For that reason, Descartes' contemporary William Harvey began to perform dissections on live animals – *anatomia animata* as it was then called. He sliced through the breast bone of a living animal, a rabbit, for example, exposing the heart, the aorta, or other veins and arteries, manipulating them by means of ligature, repeating his experiments many times over, preferably before an assembly of colleagues and students. This kind of procedure proved a significant epistemological advantage. Because of the animal experiments he performed, on rabbits, snakes, frogs, and other species, Harvey discovered that blood runs in one direction only – a decisive step on the way to his discovery of blood circulation. He could not have made his discovery had he restricted himself to dissecting the bodies of dead animals, as Descartes usually did. The virtual absence of systematic in vivo research in the latter's work proved a fatal epistemological flaw. Important aspects of animal life can

only be observed in living animals. Anatomy (the analysis of structure) had to be complemented by physiology, or "vivisection", the practice of dissecting living bodies. Yet, Harvey's success did not silence the debate. For some time to come, sceptics would continue to argue, for instance, that vivisection was unreliable because it significantly impaired the object of research, causing severe damage in the organism, so that less violent, more refined forms of research, for example, with the help of a microscope, were preferable – with a focus on observation rather than on manipulation. Experimentation involves an active, often even a violent stance towards the object of research. It entails deliberate manipulation and, epistemologically speaking, there are both tremendous benefits and substantial drawbacks involved in such a procedure.

Albrecht von Haller (1707–1777), one of the most prominent physiologists of the eighteenth century, wholeheartedly accepted Harvey's epistemological axioms. He performed lengthy series of experiments on live animals in the early 1750s. By doing so he discovered that Descartes was wrong, not only concerning the circulation of the blood, but also on a more fundamental, ontological level. Animals are *not* machines. The properties of muscle tissue, for example, cannot be explained in a purely mechanical manner. It displays an intrinsic tendency to react when it is excitated (a phenomenon Von Haller referred to as "irritability"). Its behaviour is not completely determined by external forces acting upon it, and therefore it is misleading to compare muscle tissue to a spring. Yet, this important insight confronted Von Haller with an ethical dilemma. In order to explore animal life, and to do away with philosophical prejudices (e.g. the scholastic idea that animals are machines), experiments had to be performed on living animals. But by doing so, one is likely to discover that animals (notably mammals) are sensitive living beings, capable of experiencing pain and distress. In others words, in order to uncover the animal's "animality", vivisection was both necessary (from a methodological point of view) *and* problematic (from an ethical point of view). Initially he argued that, although performing experiments on live animals is inevitably revolting, in the interests of truth it could not be avoided (Nordenskiöld 1946, p. 236). Yet, in one of his publications he explicitly confessed that, after having examined a hundred and ninety animals, he experienced great reluctance concerning this kind of "cruelty" (Guerrini 2003, p. 65). The vivisections which he performed increasingly began to trouble his sensitive mind. Finally, they became too repugnant to him (Nordenskiöld 1946, p. 235). Unable to solve his problem, he eventually decided to leave the field of physiology altogether and to devote himself to theology, botany and verse-writing instead – the passions of his youth, uncovering and documenting the beauty and richness of Alpine nature, both as a botanist and as a poet. Thus physiology lost one of its most outstanding and productive pioneers. His colleague Stephen Hales (1671–1761) had made a similar decision. After experimenting on horses in the context of his research on blood pressure, he eventually turned to studying plants because of the "disagreeableness" of experimenting on animals (Guerrini 2003, p. 58).

Throughout the nineteenth century, physiologist continued to wrestle with this problem, especially in Germany. Some German physiologists, such as Johan Conrad Brunner, whose experiments involved the removal of the pancreas from the bodies of living dogs, apparently was not troubled by a bad conscience very much, but his

talented colleague Carl Asmund Rudolphi decided to abstain from animal experimentation altogether. This, of course, greatly restricted the agenda of his research as well as the reliability of his results. After Rudolphi's retirement, Johannes Peter Müller became the most prominent German physiologist of his generation. His career reflects the typical shift described earlier, in Chapters 1 and 2, from speculative natural philosophy along the lines of Hegel and Schelling towards physiological research (Nordenskiöld, p. 382). By doing so, he inevitably had to face the dilemmas described above. He tried to alleviate the problem by performing his experiments on frogs rather than on dogs. This had methodological benefits as well, as frogs are of a more enduring nature and therefore lend themselves to more careful observation (p. 384). Furthermore, insofar as he continued to work with mammals, he decided to use anaesthetics to mitigate the pain experienced by his research animals. Indeed, when in the 1840s anaesthetics were introduced (ether, morphine), this opened up prospects for applications in physiology. In fact, it changed the relationship between animal and experimenter (Guerrini 2003, p. 78). Curare was also applied, although it merely immobilises the body without removing the pain. Anaesthesia eliminated some major objections to vivisection, notably by reducing animal suffering, but precisely *because* it made vivisection less disagreeable, it also led to an increase in invasive experiments. Moreover, researchers like Müller clearly recognised the methodological problems involved. A benumbed animal is not a normal animal, it cannot be expected to respond in a normal or natural manner and for that reason it cannot be regarded a reliable model. In other words, although laudable from an ethical point of view, the use of anaesthetics was highly problematic from a methodological standpoint. Like his predecessors, Müller was unable to solve his problems in a satisfactory manner. Eventually, he also gave up physiology. According to his own statement, he shared Rudolphi's dislike of experimenting on live animals. Clearly realizing that physiology could not be carried any further without it, he went over entirely to comparative anatomy (Nordenskiöld, p. 386). It is at this point in the history of animal research, more or less, that Claude Bernard steps in.

5.3 Claude Bernard: The Epistemology of Destruction

Claude Bernard's life and work reflect the shift from romanticism to realism in various ways. As a provincial youth, it had been his desire to become a romantic playwright and it was this desire that had brought him to Paris. He had had no formal training in the natural sciences at all, but some experience as an apothecary assistant. As a novice playwright, he had met with some success, receiving a fee for his first vaudeville comedy *La rose du Rhône* (now lost). Encouraged by this success, he began to write a historical drama called *Arthur de Bretagne* in Romantic fashion (published posthumously in 1887). When at the age of 21 he went to Paris to discuss his work-in-progress with a prominent literary critic called Saint-Marc Girardin, the latter managed to persuade him to abandon his literary aspirations altogether and to take up the study of medicine instead. The fact that his scholarly writing is so emphatically beyond anything that could be called "sentimentalism"

may perhaps be explained in terms of this epistemological as well as biographical "rupture", his decision to repress the "softer" career alternative he had considered so seriously in his youth. And although his research practices were perhaps not as sadistic and sinister as is sometimes suggested by his many critics, they were certainly at odds with the moral sensitivity towards animals that began to emerge among the educated public – to which also his wife and two daughters belonged, who fiercely criticized him for what he was doing to his research animals, throughout his married life. Indeed, his marriage was anything but Romantic. It was a fierce struggle between the sexes, with the debate on the moral status of dogs as its major battlefield. Domestic disagreements over animal experimentation were so intense that they actually ruined his marital life. The staunch detachment evident in his style may well have evolved from his effort to draw a firm epistemological demarcation between his work as a scientist and the type of debate in which he was (rather reluctantly no doubt) involved in private. As in the case of Victor Frankenstein, it was simply impossible for him to discuss his work and views with his relatives at home. Indeed, from an epistemological point of view one could say that Bernard's problems were quite reminiscent of those of Frankenstein. A romantic poet allows himself to be converted to modern science and becomes involved in research practices that are so much at odds with the "delicacy", the moral sensitivities of his cultural environment, that he desperately conceals them from others, as they would certainly produce something of an outrage among the uninitiated.[5]

This does not mean that Bernard neglected the ethical dimensions of his animal practice, quite the contrary. In a famous passage in his *Introduction* he explained that scientists have an unconditional right, a duty even, to perform experiments on animals for the benefit of future human patients.[6] Physiology is inevitable if we want to transform medicine into an evidence-based practice and physiology necessarily involves vivisection. It is immoral to perform an operation on patients, or to subject patients to certain treatments that have not been tested on animals before, preferably on mammals. Moreover, he urgently advises his students *never* to enter into a discussion with lay persons on the moral aspects of animal experimentation. The public at large, he tells them, may well be invited into the drawing room of science, where the achievements of scientific research are proudly displayed, but they should never be allowed to enter the secluded, damp "kitchen" where the dirty work is being done. Whereas scientists have come a long way to acquire their scientific attitude of detachment, untrained visitors cannot be expected to understand the importance and inevitability of this type of research.[7] In the case of lay persons,

[5] In fact, also humans suffered. Bernard spent long days of hard work in a cramped laboratory that eventually made him ill.

[6] "Il est essentiellement moral de faire sur un animal des expériences, quoique douloureuses et dangereuses pour lui, dès qu'elles peuvent être utiles pour l'homme" (Bernard 1965, p. 153).

[7] "[La science de la vie, c'est] un salon superbe tout resplendissant de lumière, dans lequel on ne peut parvenir qu'en passant par une longue et affreuse cuisine" (p. 28); "Il faut avoir été élevé et avoir vécu dans les laboratoires pour bien sentir toute l'importance de tous ces détails de procédés d'investigation" (p. 44).

the spectacle of (often severe) animal suffering will cause uneasiness or even bewilderment. Therefore, uneducated visitors are likely to react in a sentimental manner, while scientists performing the experiments are trained to ignore (or to become insensitive to) the research animal's distress.[8] Unlike Galen, or, in later times, the "showman" Vesalius (Guerrini 2003), he abstained from public demonstrations, firmly closing the doors of his esoteric laboratory.

According to Bernard, to conduct an experiment basically means that a living animal is destroyed step by step in a way similar to how a machine is dismantled if one wants to study its inner mechanism.[9] Moreover, in order to acquire reliable scientific knowledge, a *considerable number* of research animals have to be sacrificed, and experiments have to be repeated over and over again. When Claude Bernard lectured on animal physiology at the *Collège de France*, a research animal (usually a dog) would be brought into the room and tied to the operation desk. His vocal cords would be cut and subsequently, sinews would be severed or organs would be removed, in order to observe the physiological effects of the injuries thus inflicted, until the animal died (during or shortly after the lecture). Bernard, a workaholic, dissected over and over again, working for long hours, at times supplementing dissection by administering chemical substances. Poisonous substances became his favourite research tool during his later years. Although according to Olmsted and Olmsted he began to use anaesthetics in his laboratory "as soon as [they] were introduced" (1952, p. 114), Guerrini claims that he did so not to relieve pain, but primarily to increase his power over the animal's body.

Important discoveries (e.g. the functions of the liver and the genesis of diabetes) resulted from his research, but throughout Europe his work met with moral indignation and protest from outsiders, notably in England. According to Ryder (1975), Bernard, more than any other researcher of the nineteenth century, was responsible for determining the public image of vivisection as a method (p. 174/175). Vivisection became a public pejorative – and an important cause of the growing estrangement between lay audiences and the world of science. Poets of the Romantic school such as Alfred Tennyson and Robert Browning supported the anti-vivisection movement. Yet, public and literary aversion was far from unanimous. Besides outraged critics, there were enthusiastic supporters as well, not only in biomedical circles, but also among literary authors. The most enthusiastic literary supporter was Emile Zola, who regarded Bernard as an example for novelists and introduced the idea of the experimental novel.

In the context of literary writing, the term "experiment" may well be a source of confusion. Usually, the term "experimental novel" refers to texts that try to go

[8] "Le physiologiste n'est pas un homme du monde, c'est un savant, c'est un homme qui est saisi et absorbé par une idée scientifique qu'il poursuit: il n'entend plus les cris des animaux, il ne voit plus le sang qui coule … il n'aperçoit que des organismes qui lui cachent des problèmes qu'il veut découvrir.… Nous considérons comme oiseuses ou absurdes toutes discussions sur les vivisections" (p. 154).

[9] "Il faut en quelque sorte décomposer successivement l'organisme, comme on démonte une machine pour en reconnaître et en étudier tout les rouages (p. 111).

beyond any established standards of literary discourse – something like "beyond method" or, *anything goes*. But when Emile Zola (1880/1923) introduced the concept of an experimental novel in 1880, he had something completely different in mind. Indeed, he was rather thinking of a very *methodical* type of novel. According to Zola, the concept of an experimental novel would put the art and practice of novel-writing on a scientific footing, more or less as Bernard had done with the art and practice of medicine. He claimed that, in Bernard's text one only had to replace the word "physician" by the word "novelist" and the manifesto of experimental literature was already written.

Bernard was not his only source of inspiration. His model was Flaubert's *Madame Bovary* – an *exact* reproduction of life in which every trace of Romanticism was absent, a monument of exact art as well as of exact science. This type of author was no longer a moralist, but an "anatomist" (p. 129), relying on careful research and observation. Bernard's text allowed Zola to articulate the methodology behind this type of novel. Rather than describing the world as it presents itself to us, the experimental novelist should actively intervene in order to expose his characters to specific circumstances and events. Subsequently, like a real experimenter, he must carefully study their responses. According to Zola, the naturalistic novel *is* an experiment, in a strictly scientific, Bernardian sense of the term. The novel is a laboratory setting where physical, psychic and social phenomena may be studied systematically. Naturalistic novels must display the same level of detachment and precision as scientific research reports. In short, he saw Bernard's *Introduction* as a manual for novelists. In his novel *La bête humaine* (*The Human Beast*) for instance, published in 1890, the principal character is a man with a paralysing psychic problem, apparently of a hereditary nature. Whenever erotic interests for women is aroused in him, he finds himself overwhelmed with an uncanny desire to strangle or otherwise kill the woman in question. This makes it impossible for him to become involved in love relationships. Beset with this psychic complex, Zola exposes him to a series of conditions. Eventually, he manages to contain his aggression, and becomes involved in an intricate love affair, namely when he happens to encounter a woman who is – a murderess herself. But before going into the experimental novel in greater detail (in the final sections of this chapter), I first want to introduce a second key character in the history of animal research, someone who took a completely different approach to experimentation with animals – notably dogs – namely Ivan Pavlov.

5.4 Research Animals as Partners? Ivan Pavlov's Chronic Method

Ivan Pavlov criticizes Bernard and other vivisectionists by stressing that a dog who is subjected to "acute" experimentation ("vivisection") cannot be regarded as a reliable animal model. Rather than with normal physiological processes, the scientist is confronted with the effects (upon the maltreated animal) of his own doings. An animal is a complex organism and severe injuries or stress may result in a plethora

of unforeseen physical consequences.[10] Pavlov therefore initiated a new style of laboratory research, of which concern for the research animal's welfare constituted an integral part.

Ivan Pavlov (1849–1936) studied physiology at a time when this was a rather strategic discipline: the field of research that was going to replace a more philosophical view on man. As recommended by Smiles and exemplified by Bazarov, Pavlov opted for a life of prolonged and disciplined scientific work, spending long hours in his laboratory. Although now famous for his later publications on conditioned (or acquired) reflexes, he initially made his name with a series of experiments he conducted (or rather designed and supervised) on digestion (and out of which the research concerning reflexes evolved as a kind of side effect). At the university of St. Petersburg, his most important teachers were Cyon (or Tsion), who had studied with Bernard, famous for his technical skill as an experimenter, and Sechenov, already mentioned above. Although the latter's *Reflexes of the Brain* (first published in 1863) was more speculative than experimental (he only very reluctantly performed vivisection on animals and limited himself mostly to using frogs), it provided Pavlov with a sense of direction (Todes 2000, p. 20). But it was Cyon who demonstrated before his students how to perform vivisection on large animals such as rabbits and dogs in a truly Bernardian fashion.

At the age of 41 Pavlov was given his own "laboratory": a small wooden bathhouse, poorly equipped and with hardly any funds to buy animals for experiments – one of his reason for taking good care of his dogs. He loved to work extremely hard and liked the heavy labour that the new science involved (Frolov 1938/1970). He simply had a taste for laboratory work, which involved a combination of manual (technical) and intellectual (theoretical) activities. Throughout his life, he designed, performed and/or supervised an incredible number of experiments, well aware of the fact that in physiology, experimental work has to be repeated, checked and improved continuously. According to Pavlov, the best place to learn how to think scientifically was the scientific laboratory. He worked almost exclusively with dogs.

In 1891 Pavlov, who until then had been a lone investigator, became a laboratory chief, the director of a large and productive research group, the *Physiology Division of the Imperial Institute of Experimental Medicine* in St. Petersburg (Todes 2000, 2002). His laboratory changed from a small-scale "workshop" to a highly efficient knowledge "factory". In this laboratory, he and his collaborators often developed long-term affectionate relationships with their dogs. Pictures taken in Pavlov's research premises show animals and researchers exchanging friendly glances. Eventually, a monument for the experimental dog was erected at the Institute of Experimental Medicine, bearing the following quotation: "Let the dog,

[10] According to Pavlov, the research animal should be seen as a complex chemical factory. When one of the elements is damaged, the researcher can never be certain how and where the system at large will be affected. Even the slightest injuries may have serious and unpredictable results. Therefore, the researchers should take care to cause as little damage as possible to the animal's body (1955, p. 84).

man's helper and friend since prehistoric times, offer itself as a sacrifice to science. But our moral dignity obligates us to ensure that this always occurs without unnecessary pain" (Todes 2000, p. 100). Pavlov headed his laboratory for decades. During the Russian Revolution, as his co-workers left for the front and his dogs were dying of starvation, he wrote a famous letter to Lenin. The Russian authorities sympathized with his work (seeing themselves as experimentalists working with human subjects on a grand scale, conditioning them for future times) and decided to build a special scientific village near St. Petersburg (at Koltushy) for Pavlov, his staff, and their research animals. In this isolated scientific village, every aspects of the life of an experimental dog could be completely controlled and monitored.

Pavlov rejected the methodology of destruction ("acute experimentation") as practised by Claude Bernard, dismissing it as crude and unscientific. He regarded it as unsuitable for studying the intricate workings of digestive glands or of the nervous system. An animal that experiences severe pain and whose body is seriously damaged, can no longer be regarded a reliable research model. Yet, he had similar problems with alternative solutions, notably the use of chemical compounds such as curare to alleviate the suffering (or to make animals more easy to handle). According to Pavlov, anaesthetics will have a distorting effect on the actions of the organism. A benumbed animal does not constitute a realistic model. He insisted on studying the functions of an intact animal under *normal* conditions. In order to achieve this goal, he began to construct (by way of highly skilled surgery) openings or "windows", such as a manometer or a fistula, that allowed the researcher to study the normal functioning of blood circulation or of a particular digestive gland for an extended period of time. He explicitly contrasted his "chronic" (or surgical) method with the "acute method" of the Bernard school. He wanted to interfere as little as possible with the normal, healthy functioning of the animal (Wells 1956, p. 18) and did this by training experimental dogs to lie calmly on the operating table to undergo (without narcosis if necessary) all the manipulations of an elaborate and lengthy experiment, incising the skin and surface tissues, disclosing arteries and connecting them with instruments for registering blood pressure, and similar procedures (Wells 1956, p. 17). In other words, he educated his dogs to act as cooperative research animals, as partners in the research, as members almost of the team[11] – as the researcher's best friend.[12] Indeed, in publications he expressed his gratitude to his dogs, formally thanking them for their assistance.[13] In a public lecture he states: "We must painfully acknowledge that, precisely because of its great intellectual development, the best of man's domesticated animals – the dog – most often

[11] According to Pavlov, the dog was "almost a participant in the experiments conducted upon it, greatly facilitating the success of the research by its understanding and compliance" (Todes 2002, p. 52).

[12] Pavlov's favourite dog, whose cooperative behaviour "contributed" greatly to the writing of his *Lectures*, was called *Druzhok* ("Little Friend").

[13] "[T]his method was adopted as a result of a hint given by one of the dogs subjected to the operation. We (dr. Kuvshinski and I) gratefully acknowledge that by its manifestation of common sense the dog has helped us as well as itself" (1955, p. 89/90). Elsewhere, Pavlov emphasizes that "physiology in general owes much to the intelligence of the dog" (p. 104).

becomes the victim of physiological experiments.… During chronic experiments, when the animal, having recovered from its operation, is under lengthy observation, the dog is irreplaceable.… It is almost a participant in the experiments conducted upon it, greatly facilitating the success of the research by its understanding and compliance" (Pavlov 1893; cited in Todes 2000, p. 52). Elsewhere he writes: "Our healthy and happy animals did their laboratory work with real gusto; they always rushed from their cages to the laboratory and readily jumped on the tables where our experiments and observations were conducted. Believe me, I am not exaggerating one iota. Thanks to our surgical method in physiology we can demonstrate [the phenomena of digestion] without a single scream from the animal undergoing the experiment" (1955, p. 132).

His *praktikanty* (research associates) were in the habit of petting and caressing their dogs, taking them for strolls on the laboratory compounds. Pavlov devised ingenious and delicate operations that made the normal internal functioning of organs accessible for continuous observation, while impairing the organism as little as possible. In order to obtain gastric juice from a dog during an extended period of time, for example, an artificial "miniature" stomach was produced, but Pavlov assures his readers that "this operation does not cause any serious discomfort to the animal and does not endanger his life" (1955, p. 98). Pavlov and his co-workers claimed in their publications that they performed their research work on entirely happy and healthy animals. Indeed, "Pavlov's laboratory consistently represented its experimental dogs as normal – happy, energetic, and long-lived" (Todes 2002, p. 87). In short, in his laboratory, Pavlov seemed to have succeeded in developing a completely new and rather animal-friendly research practice in which the relationship between researcher and research animal had dramatically changed. Concern for the long-term well-being of the research animal became an important and *inherent* aspect of his approach, a policy in which ethical and methodological considerations seemed to converge. Animals should be subjected to the most advanced surgical techniques that were also applied to humans,[14] in order to allow them to fully return to post-operative normalcy: "I regard the promotion of our surgical technique to be a matter of greatest importance, because the usual method of simply vivisecting the animal in an acute experiment is … a major source of error, since the act of crude violation of the organism is accompanied by a mass of inhibitory influences on the functions of the different organs. The organism as a whole, the realization of the most delicate and most expedient linking of an enormous number of separate parts, cannot, in the nature of things, remain passive to destructive agents" (p. 101).

Whoever compares Bernard's *Introduction* with the writings of Pavlov will be struck by the differences in the way the research animals are represented. In Pavlov's work, the research animal is emphatically present. In various instances, he describes

[14] "The desire … to spare our experimental animals as much as possible made us strictly observe all the precautions taken by surgeons in respect to their patients" (1955, p. 132); "Pavlov's dogs were operated upon and cared for almost as if they were human patients in a good hospital (Todes 2000, p. 51).

the behaviour of his dogs, as well as the human–animal interactions as they developed within his laboratory, in detail. From his writings it is clear that Pavlov was sensitive and alert to the behaviour and attitude of his dogs, paying attention to signs of uneasiness and restlessness. Indeed, whereas his *praktikanty* remain anonymous – human beings without a face – some of his research animals acquire a distinctive identity of their own – notably Druzhok, Pavlov's favourite research animal, his own "best friend". As a consequence, Pavlov's text becomes something of an epistemological hybrid: a research report containing stories and anecdotes on recognisable dogs, besides technical and scientific data on his laboratory endeavours. The dogs are presented as partners, as "heroes". To a certain extent Pavlov's texts can be read as novels in which dogs play a decisive part – as dog novels.

This makes proper treatment of his research animals a rather natural thing to do. Although Pavlov concedes that experimental treatments will always cause some damage to the animal's organism, he stresses that "after remaking the animal's organism after our design", he would always try to find a *modus vivendi* that would eventually ensure a normal and long life for it (p. 132) – as well as the development of a normal and lifelong relationship between a human being and his dog, the latter accompanying the former on his difficult path to sustainable scientific knowledge claims. All forms of animal suffering should be remedied as much as possible. In order to perform a particular experiment in which Pavlov anatomically separated the mouth and stomach cavities of some of his research dogs, he pointed out that "animals subjected to this operation fully recover if well cared for" (p. 95).

Yet, Pavlov's research practice was not always as idyllic and animal-friendly as is suggested in his own writings. He did perform mutilating experiments, for example by extirpating the cerebral hemispheres of dogs, after which they became complete invalids, no longer able to look after themselves, to lead a "normal" life, unable to survive without intensive care (p. 185). He even continued to perform acute experiments, for example, to study the nerves of the heart.[15] And although Pavlov took great pains to cultivate the image of normal and happy laboratory dogs, the reality was often somewhat different (Todes 2002, p. 98). Many dogs died and survivors would often develop chronic health problems or even fatal conditions. In the end even Druzhok became ill.

Gradually, the focus of his research shifted from physiology to animal behaviour. He designed an entirely new type of laboratory, known as the "Towers of silence", affording the researcher "maximum control over the environment of animals" (Todes 2002, p. 349). In these new facilities, the friendly interaction between researcher and research animal became somewhat disturbed. An extreme simplification of experimental conditions could be ensured (Pavlov 1955, p. 192), a maximum of con-

[15] In 1904, at the height of his career, when he was under attack by the Russian Society for the Protection of Animals, Pavlov formulated a personal, but at the same time rather conventional confession, in the line of Von Haller, Müller and others: "When I dissect and destroy a living animal, I hear within myself a bitter reproach that with rough and blundering hand I am crushing an incomparable artistic mechanism. But I endure this in the interest of truth, for the benefit of humanity" (Babkin 1949, p. 162; Todes 2000, p. 65).

trol over even the smallest details could be achieved (Todes 2000, p. 78) – but at the expense of the former researcher–animal partnership. The animal became an anonymous object, rather than a research participant. Even in Pavlov's animal practice, the dog was finally reduced to a functional element in a circuit, in which his presence *as a dog* was neutralized as much as possible (p. 192). As a consequence, in Pavlov's research reports the narrative, story-like elements begin to disappear.

From a Foucauldian perspective, the genealogy of the power relationship between Researcher and research animal as it developed in the course of the nineteenth century displays a recognisable pattern. The public demonstrations of the early modern days of animal experimentation are similar to the public executions described by Foucault (1975) in the first chapters of his *Surveiller et punir* ("Discipline and Punish"). In the context of these public spectacles, the living body (of research animals as well as of convicted criminals) was opened-up, dismembered, mutilated. In animal experimentation as well as in human torture, pain was regarded as inevitable in order to allow the tortured body to produce reliable answers to a series of questions. At a certain point, however, these atrocious practices were replaced by more humane forms of inquiry. Care for the well-being – of animals and of prisoners – becomes an integral part of the regime. The trials to which animals and prisoners find themselves subjected are meant to educate them, to condition or recondition them. Yet, there is another side to this as well. A new power regime emerges, granting the researcher almost complete control over the research animal's behaviour. Ideally, in the "humane" facilities of the new power regime, all aspects of behaviour (of prisoners as well as of experimental dogs) can be monitored and controlled. Moreover, although the punishments applied are less severe, less damaging, less acute, the *number* of animals to be tested upon (as well as the number of human individuals subjected to practices of behavioural modification) increases exponentially.

To what extent are Pavlov's publications really comparable to animal novels? To a much greater extent than Bernard's. In retrospect, it is rather astonishing that Zola developed his concept of the experimental novel after reading Claude Bernard. The latter's writings do not resemble novels at all. The dog *as a dog* is virtually absent. Subjecting his research animals to "acute" experiments, from which (as a rule) it was impossible to recover, the life stories of his experimental dogs were fairly predictable and dramatically short. The experiments conducted by Zola himself, as an "experimental novelist", were of a much more *chronic* kind. There was some amount of damage done, but the individual involved was usually given the opportunity to recover – to a certain extent at least. Indeed, although the characters in his novels occasionally suffer psychological or physical injuries, or even traumas, their lives usually continue for some time, so that the novelist can patiently study what effects the inflicted injuries have on the future course of the character's biography, in the light of various environmental and hereditary factors. More often than not, the injury will not be lethal. For the typical Bernardian dog, on the contrary, experimentation usually entailed a horrible – *short* – story. If we follow Zola's logic, Ivan Pavlov, rather than Claude Bernard, should be regarded as the model scientist, the model scientific writer after whom naturalistic novelists should want to fashion

themselves. Zola's euphoric identification with his hero Bernard was, epistemologically speaking, a misunderstanding. Indeed, it is rather difficult to regard Bernard's research practice as a model for novel-writing. His dogs remained completely anonymous, they were simply research "material", without a name or a life of their own. The animal experiment was the final moment of their life and no relationship whatsoever developed between researcher and research animal. These dogs were completely passive, deprived of every opportunity to interact with their environment or to *respond* to the situation. In the case of Pavlov, on the contrary, we are faced with a completely different story. Now, being an experimental dog becomes a substantial chapter in the dog's biography, and many dogs spent the larger part of their lives in Pavlov's research facilities. A real interaction between the experimenters and their dogs developed and the typical Pavlovian dog really had the opportunity to respond to what was happening to him. These conditions constitute, so to speak, the minimal requirements for an experimental novel.

So far, we have compared Zola's conception on the one hand and Bernard's and Pavlov's writings on the other merely on a conceptual level. Interestingly, however, as Pavlov was conducting his experiments with dogs, novelists had begun to write experimental novels featuring dogs as well, as a complementary effort so to speak. Notably during the first decade of the twentieth century, at a time when Pavlov became increasingly interested in the psychological and behavioural (rather than the physiological) characteristics of his research animals, the *dog novel* as a genre came in vogue. This makes it possible to flesh out our comparative analysis with the help of case studies, analysing documents that coincide in terms of time. A similar experimental desire seems to have inspired Pavlov as well as some of his literary contemporaries. What happens if dogs are exposed to a variety of settings? How will the animals respond? This is the type of question that can be answered by means of a scientific experiment, but also through novel-writing. The most important dog novelist among Pavlov's contemporaries was, beyond doubt, Jack London (1876–1916). To his experimental dog novels the larger part of the remainder of this chapter will be devoted.

5.5 Animal Experiments in Literary Documents

The basic structure of an experiment can be articulated in the form of a rather straightforward question: "What happens if?" This is the basic sentence that guides experimental scientists in their laboratories as well as literary authors in their novels. Research subjects in an experimental setting, as well as principal characters in a novel, are exposed, by scientists and novelists alike, to a variety of circumstances and events in order to provide their readership with a viable answer to the question *What happens if?* Although novelists usually work with human subjects, they may decide to work with animals at times. In that case, their novels and stories become similar to animal experiments, to some extent at least.

One of the fairy tales by Hans Christian Andersen, for instance, called *The Ugly Duckling* [1844] may be regarded in this manner. To begin with, the "research animal" is exposed – at a very early age – to a particular environment, namely the

nest of a species other than that to which he himself belongs – experiments of this kind *have* been conducted in animal laboratories. Subsequently, he is exposed to a variety of meteorological conditions, referred to as "summer", "winter", etc. What kind of responses will be triggered, what kind of behavioural repertoires will be activated, under such circumstances? Thus, the author tries to capture the impact of the conditions in question on the research animal, in combination with other variables, such as age and gender. The effects of weather, age and various untoward experiences are determined experimentally, more or less. Thus, Andersen studies the impact of age, for instance, on behaviour patterns such as sociability – the subject's interactions with other members of his species, or with members of other species, in various seasons.

An important difference between a "real" experiment and its literary counterpart is, no doubt, that whereas in the first case the experiment is documented from a "third person" or "outsider" perspective, in the case of Andersen the swan's experiences are recorded "from within", so to speak. The author tries to place himself in the swan's position in order to see and experience the world through the research animal's own eyes. This element does not eliminate, however, the basic experimental structure of the story. Moreover, there are epistemological benefits as well as risks involved in such a procedure. In terms of benefits one might argue that Andersen's method may be a viable strategy for producing a recognisable and readable account. In a laboratory setting animals are usually deprived of their "animality". They are reduced to the status of "research material" – the animal as a test tube for producing vaccines, or as a receptacle for studying the effects of particular chemical compounds on various kinds of tissues. As a rule, the laboratory researcher is not interested in the ways in which the animals themselves experience their world. Rather, the researcher is interested in their behaviour insofar as it is triggered by environmental cues emerging from within the laboratory setting. The animal is taken out of its own environment. In the case of Andersen, however, the experiment is conducted in a more or less natural setting, allowing the animal to display its species-specific patterns of behaviour. On the other hand, there are evidently some risks involved as well. The most important one is the risk of producing an anthropomorphic account. In such an account, the animal will once again disappear from view, it's "animality" will once again be lost.

This is the case, for example, in Anna Sewell's famous story *Black Beauty*, published in 1877 (1877/1954). Let me just quote the story's opening lines:

> My Early Home
> The first place that I can well remember was a large pleasant meadow with a pond of clear water in it. Some shady trees leaned over it, and rushes and water-lilies grew at the deep end. Over the hedge on one side we looked into a plowed field, and on the other we looked over a gate at our master's house, which stood by the roadside; at the top of the meadow was a grove of fir trees, and at the bottom a running brook overhung by a steep bank.
>
> While I was young I lived upon my mother's milk, as I could not eat grass. In the daytime I ran by her side, and at night I lay down close by her. When it was hot we used to stand by the pond in the shade of the trees, and when it was cold we had a nice warm shed near the grove. As soon as I was old enough to eat grass my mother used to go out to work in the daytime, and come back in the evening.

Sewell's story is often regarded as one of the first animal novels. Moreover, it is a novel with a mission: the author's purpose in writing it was to induce sympathy and understanding for horses among its readers. Yet, epistemologically speaking, there is a prize to pay. Charming as it is, Sewell's narrative suffers from a fatal epistemological flaw. The animal *as animal* disappears. The experiences described in the first lines of the novel – and in the rest of the novel as well – are *human* experiences. It is not very plausible – to put it mildly – that this is how horses themselves experience their world. It is how *we* would experience it – if we were to be a horse, but we are not.

Although there are novels devoted to horses, cats, rabbits and other animals, a relatively large number of literary experiments with animals involve dogs. This will not come as a surprise, of course. Under real life circumstances, the daily interactions between humans and their dogs already contain both narrative and experimental aspects. Dog owners tell stories, life stories – about their dogs. But they also expose their dogs to a variety of conditions in order to modify their behaviour, or simply to test their responses, often in a playful manner. Literary experiments can be seen as systematic elaborations, building on these everyday, quasi-experimental practices. Many humans who become involved in a relationship with a dog really try to understand how the animal experiences its world and what determines its responses. Literary documents can be seen as extrapolations and elaborations, building on these typical, daily interactions and behaviours.

From a scientific point of view it will be difficult to regard novels and other literary documents – as well as the life-world practices on which they build – as "experiments". An important issue in this respect is the tendency of both pet-owners and novelists to describe the dog's behaviour in a more or less anthropomorphic fashion. Scientists and other critics of everyday knowledge tend to deplore the tendency towards "hominization" in life-world accounts. But before addressing this complaint in more detail, we will have to ask ourselves what a literary experiment involving animals (notably dogs) actually looks like. How is it structured, how is it worked out? What kind of insights does it claim to produce? How are the pitfalls of anthropomorphism avoided? Again, as in other chapters, in order to answer these questions we will opt for a case study approach. We will analyse one particular example (indeed, a particularly famous and ground breaking example) of a literary experiment involving a dog, namely Jack London's novel *The Call of the Wild* written and published in 1903, at a time when Ivan Pavlov was about to receive his Nobel Prize and had just launched his extended series of experiments on conditional reflexes. Indeed, I intend to read Jack London's animal experiment as the literary counterpart of Pavlov's research.

5.6 An Experimental Dog Novel

The dog in London's novel (1903/1981) is a huge, sturdy animal called Buck. At the beginning of the book, he lives the easy life of a "country gentleman" in the "sunny state" of California (p. 22). But he is kidnapped and shipped to Alaska, in

order to serve as a sledge dog at the time of the Klondike Gold Rush. In other words, his life (as well as the language in the novel) reflects a rather abrupt shift from sentimentalism towards grim realism. The change is sudden and dramatic. He finds himself exposed to a completely different set of conditions: to the snow, cold and frost of the Arctic darkness, the sad and lonely North, the ghostly calm of a white and silent vastness, and (last but not least) to the incredibly hard labour of the sledge dog. Under these circumstances, he encounters a new type of animal and a new type of man, adapted to these conditions. All of a sudden, he finds himself "jerked from the heart of civilization and flung into the heart of things primordial" (p. 30). His new life is one of continuous peril, where both man and animal must be constantly on the alert. It is a "retrogression" (p. 38) and his civilized self is gradually erased. This new and rather demanding world is ruled by a completely different set of moral laws. The Californian ethic of love, fairness and mercy gives way to the law of primordial life, the struggle for survival, as well as for supremacy: master or be mastered, kill or be killed.

Buck, the experimental dog, quickly accommodates to his new life. The novel describes the "inevitable" disintegration of his canine morality. He learns how to fight and steal, learns how to be patient and how to sustain hunger. He develops a completely new behavioural repertoire. Everything about him changes: his habits of sleeping and eating, his senses even. His body changes, from his muscles to his feet, and he develops a much keener sight and scent, while his hearing acquires a new acuteness. The effect of his prolonged exposure to this new set of circumstances is dramatic. It entails a complete metamorphosis. His moral sense, a handicap in the ruthless struggle for existence, quickly decays (p. 37), until eventually his decivilisation is complete. At the end, the repressed "primordial beast" in him becomes dominant again. His doggish ego gives way, so to speak, to his alter ego, the primitive Id. Instincts long dead become alive again. Millennia of domestication disappear step by step. In the stillness, the cold, and the dark of his new environment he vaguely begins to remember the life and world of his prehistoric ancestors. Scenes and habits from times long ago come to his mind. As London tells his readers, instincts are simply the memories of forebears becoming alive once again, becoming habits once again. There is even a vague image of a primal domestication scene, the diffuse vision of a primitive man, a kind of "missing link", short-legged and with a furry skin, who does not yet stand erect and still feels himself at home in the trees, and who is utterly terrified by darkness. As London phrases it, the most salient feature of this dim, lost world, in which the first steps towards domestication took place, was fear. The hominisation of man and the domestication of the dog took place simultaneously, in a fearful environment. They coincided in time.

The novel describes how day after day the claims of civilization and of mankind become weaker. In the end, only one tie still attaches Buck to the civilized world, the love for a man (Thornton) who saved his life and whose companion he became. For some time, this man restraints him from decivilising completely. When Thornton is killed, however, the transformation is complete. In other words, when in the context of the experiment this one decisive factor is modified, the effect is

immediately visible, resulting in a significant behavioural change. Buck had already become increasingly aware of a strange call sounding in the forest, the "call of the wild". It filled him with strange unrest and wild desires. An irresistible impulse had begun to seize him. Vague and indistinct at first, it finally takes the shape of the howl of a wolf. After Thornton's death, he is finally able to answer it. The last tie is broken. He really becomes a "thing of the wild". And this is an atavistic strain noticeable in several others of London's books as well. Buck is not the only protagonist who reverts to the savage stage of remote ancestors. This is a basic idea in London's work: the return to a prehistoric past, when the subject is placed under extreme conditions.

In the context of the broader experimental design that dominates the novel, a number of smaller experiments are carried out as well. For example, at a certain point Thornton literally conducts an experiment in order to demonstrate Buck's complete loyalty and obedience to him:

> John Thornton was sitting near the edge [of a cliff], Buck at his shoulder. A thoughtless whim seized Thornton, and he drew the attention of Hans and Pete to *the experiment* he had in mind. "Jump, Buck!" he commanded, sweeping his arm out and over the chasm. The next instant he was grappling with Buck on the extreme edge, while Hans and Pete were dragging them back into safety. "It's uncanny," Pete said, after it was over and they had caught their speech. Thornton shook his head. "No, it is splendid, and it is terrible, too. Do you know, it sometimes makes me afraid." (p. 78)

At various occasions in the novel, Buck is put – quite literally – to some kind of test.

If, against the backdrop of the history of animal experimentation, the question is asked *what kind of experiment* Buck is actually subjected to, the answer clearly is that, first of all, London describes a *chronic* rather than an acute experiment. Although the research animal suffers a trauma at the beginning of the experiment (Buck is knocked unconscious before being kidnapped and transported to Alaska), he is treated more or less professionally by his first owners and he is allowed to recover, to restore his health and vigour. His owners have an interest in his well-being. The author tries to determine (in a literary way) the effects which the new "experimental" conditions are likely to have *on a healthy animal* – over the course of time. After having recovered from his injuries, Buck becomes a normal animal once again, in the sense that the changes that eventually occur (the bodily and behavioural changes that develop in the course of the experiment) can be attributed to experimental variables (e.g. the climatologic and social circumstances) to which the animal is exposed. Therefore, in this respect at least, London's experiment can be regarded as a true counterpart to Pavlov's experimental work with dogs.

Furthermore, we can say that, although London's novel is in part an experiment in animal physiology, it is for the greater part an experiment in animal *psychology*. Indeed, there is a gradual shift in emphasis, in focus, from the physiological to the psychological dimension – as was the case in Pavlov's work as well. Initially, the focus is on the physiological changes, the effects the new environment has on the dog's senses (sight, scent and hearing) as well as on his body (his fur, his body weight, his muscular strength, etc.). Eventually, however, the focus shifts to animal psychology, notably when the author describes the resurgence of visions and

images that are part of his collective "species memory". This shift from physiology to psychology mirrors Pavlov's experimental trials.

In terms of theoretical framing, however, the differences are significant. Whereas Pavlov restricts himself as much as possible to describing and analyzing *behavioural* changes, in a more or less "behaviouristic" fashion, London's work can be regarded as an example of animal *psychoanalysis* – albeit in a Jungian rather than a Freudian sense – as the focus is on the collective, rather than on the individual unconscious.

The idea that a novel can be, or even should be, structured as an experiment was already worked out by Zola, as described above. In fact, his most famous "experimental novel", *La bête humaine* (*The Human Beast*, already mentioned above), is remarkably similar in many ways to London's famous story, notably insofar as the psychological content is concerned. Its male protagonist is haunted by (to use Jack London's term) the "primordial beast", hidden in his unconscious, taking the form of the uncanny, unconscious desire to kill any women that arouse his sexual desire.[16] The protagonist himself is firmly convinced that this pathological longing goes back to some kind of traumatic injury, suffered by his forebears very long ago, during the dawn of humanity.[17] He tries to fight this terrible longing desperately, as unlike Buck he remains part of the civilized world, so that his ego remains in place more or less, but Zola nonetheless exposes him to a series of circumstances that are bound to bring his strange desire to life again. Zola's novel is, one could say, a parallel experiment, involving a human instead of an animal subject, but devoted to the same idea, namely that we are driven by unconscious desires fuelled by ideas lingering in our collective memory, dating from the obscure era of domestication and anthropogenesis, the first chapter in the history of co-evolution of humans and dogs, as well as of women and men – that is, the era of the cave dwellers and fire-makers.

Jack London's story was not a creation *ex nihilo*, but rather a contribution to – as well as a criticism of – a genre already flourishing and quite popular at the time, the genre of the dog story. Other authors, such as Ernest Thompson Seton,[18] had been writing stories with the explicit goal of increasing public awareness of the life of animals (wild and domesticated), often telling their stories from the animal's point of view. The dog stories by Nobel Prize winner Rudyard Kipling, notably *Thy Servant a Dog* (1930/1960), may also be mentioned in this respect. Although there is accuracy and realism in these tales, the authors involved were nonetheless accused of sentimentalism and anthropomorphism, notably because of their ten-

[16] "[C]e tressaillement involontaire, qu'il tâchait de maîtriser, chaque fois qu'il abordait une femme" (1890/1953, p. 43).

[17] "[C]'était comme une soudaine crise de rage aveugle, une soif toujours renaissante de venger des offenses très anciennes, dont il aurait perdu l'exact mémoire. Cela venait-il donc de si loin, du mal que les femmes avaient fait à sa race, de la rancune amassée de mâle en mâle, depuis la première tromperie au fond des cavernes (p. 65).

[18] Although tales such as "Bingo: the story of my dog" or "Thy servant a dog" contain elements that can be found in Jack London's version as well, these charming, anecdotal, domestic stories clearly lack the grandeur and scope of *The Call of the Wild*.

dency to identify themselves with their animal protagonists, but also because they tended to ascribe human emotions and human deliberations to dogs. John Burroughs, a naturalist of some renown and a personal friend of President Roosevelt, published an article in the *Atlantic Monthly* in 1903 entitled "Real and sham natural history" in which he tried to substantiate these accusations: literary authors produce a view of animals, notably of dogs, that is quite at odds with scientific evidence (Burroughs 2003, cf. Lutts 2001). Roosevelt himself joined the debate, nicknaming these authors "nature-fakers" (Clark 2007). He did not object to writers like Kipling who (in *The Jungle Book* and similar writings) remained within the fable tradition more or less, but he did object to authors who feigned realism. Although Jack London also was involved in this dispute, he did not respond immediately. His formal defence appeared in 1908 under the title "The other animals", an interesting piece of work because it focuses on the epistemological issues and problems involved in the writing of dog novels.

According to London, rather than suffering from anthropomorphism, *The Call of the Wild* was actually written as a protest against the tendency to "humanize" animals displayed by some of the other "animal writers". At the same time, however, he criticizes Burroughs for his view that animals are basically automatons, only able to produce mechanical and reflexive behaviour. According to London, Burroughs' view that only humans are reasoning animals, whereas all other animals are deprived of reason and solely motivated by instinct, is a medieval and scholastic view that can no longer be regarded as credible in the light of evolution.[19] Human reason is the outcome of a long evolutionary trajectory and, notwithstanding our impressive intelligence as a species, we are still similar to other animals in many ways. In *The Call of the Wild* London already emphasized that Buck, in his responses, was mostly moved by instinct and emotion, but he regarded it as untrue to life to deny that animals such as his protagonist share at least a rudimentary ability to reason. According to London, Burroughs' view was not based on scientific facts, but rather on a pre-Darwinian, "homocentric" and narcissistic conviction, namely that humans are absolutely special and unique, quite unlike other animals.[20] London explains that, in his novel, he intended to transcend a number of established dichotomies, such as between science (speaking about "facts") and literature (speaking about "emotions") as well as between animals (acting on the basis of instinct and impulse) and humans (acting on the basis of reason). His dog novel is an effort to analyse the ways in which a dog experiences his world that surpasses not only previous animal novels but also the kind of scientific literature Burroughs was referring to. And London even goes a step

[19] "[Burroughs asserts] that all animals below man are automatons and perform actions only of two sorts – mechanical and reflex – and that in such actions no reasoning enters at all. They believe that man is the only animal capable of reasoning and that ever does reason. This is a view that makes the twentieth-century scientist smile. It is not modern at all. It is distinctly mediaeval" (London 1908).

[20] Interestingly, London (the "dog psychoanalyst") elaborates a line of argument here that will be taken up later by Freud himself in his famous essay "Eine Schwierigkeit der Psychoanalyse" (1917). Scientific breakthroughs such as the theory of evolution contain a "narcistic offense".

further. Burroughs' views are not science-based, he argues, but rather symptoms of the author's anthropocentric ego. Although London agrees that many instances of animal behaviour can be explained on the basis of instinct alone, he also (in a more or less anecdotal fashion) sums up a number of personal experiences with animals that obviously seem to indicate that, although instincts evidently play a role, dogs are nonetheless able to learn and reason, to some extent. The divide between man and animals is not impassible. Burroughs' view of rationality is far too abstract, too restricted, it fails to appreciate the evolutionary continuity between humans and other animals – animals whose history is part of *our* history. In other words, whereas scientists like Burroughs are more or less metaphysically conditioned to think along the lines of Cartesian scholasticism, some of the animal authors indeed represent the other extreme: they depict animals in a much too sentimental and anthropomorphic fashion. London, however, believes his own book steers a middle course, sensitive to the continuities as well as the discontinuities between humans and animals. Only in this manner, a truthful and credible view of animal life is possible.

In 1906 London wrote *White Fang*, a sequel that perfectly mirrors *The Call of the Wild*. Whereas the latter novel is a story of regression, a migration to the primitive sub-Arctic world, describing a return of the unconscious and the repressed, *White Fang* is a story about domestication, compressed into the biography of one single dog. Wild Fang is transformed from a wild wolfish state into a civilized version of himself. The first chapters have all the characteristics of a nature documentary, faithfully documenting the growing up of a wolf cub, whose mother happens to be half wolf – half dog. The inevitable clash with civilization, however, presents itself in the form of the Klondike Gold Rush, adding drama to the story and putting it within a larger frame.

The first chapters tell the tale of a more or less natural development, a coming of age, without any "intervention" on the part of the author. The efforts to domesticate the young wolf in an Indian settlement are described as a reiteration (more or less) of the primal domestication scenes that must have occurred continuously during times long ago. It is only in the final chapters, when the animal protagonist finds himself exposed to rather unusual circumstances, that the contours of an experimental setting really emerge. The book is interesting mainly for three reasons. First of all, it contains (in its final chapters) the story of an experiment: the sudden introduction of a semi-tamed wolf into a civilized, Californian environment. Secondly, the novel contains reflections on dog intelligence, as compared to that of the "man-animal" – intensified perhaps by London's dispute with Burroughs as described above. Indeed, much more explicitly than in *The Call of the Wild*, London tries to address the issue of the "animality" of animals. And finally, there is the issue, already referred to above, of a dog's "collective unconscious".

In contrast to *The Call of the Wild*, London's sequel begins in the desolate cold and silence of the Arctic Northland and ends in the sunny and easy climate of the Californian Southland. It depicts, so to speak, an animal's biography in which the sequence of events (or rather: the sequence of experimental conditions) has been reversed. When White Fang encounters human beings for the first time, they appear to him as exceptionally powerful, as δεινος, as superior beings, notably as "makers of

fire". His experiences reiterate those of his distant forebears. He hears another call than Buck: the call of fire and man. A great awe descends upon him. He perceives them, not only with his own eyes, but "out of the eyes of all his ancestors" (168). There is an immediate awareness of the fear and the respect born of the centuries of struggle and the accumulated experience of generations. His willingness to submit himself to human power comes from a compelling unconscious "heritage" (168). Much more awe-invoking even than the Indians he initially encounters are the white men – who build huge forts and monstrous steamers. A representative of this race, a civilized human being, decides to take White Fang with him to California. The latter's "civilization" is explicitly referred to as an "experiment" (267). *White Fang* is clearly a companion piece to *The Call of the Wild*. The civilization of a dog as described in this book is a "reverse angle on the same theme" (O'Connor 1964, p. 234).

As was the case in *The Call of the Wild*, the story is written "from within". The author identifies himself with his protagonist and sees the world through his eyes. Yet, this does not amount to a complete "humanization" of the animal involved. When White Fang begins to explore the outside world, for example, his mental life is described in the following terms:

> In fact, the gray cub was not given to thinking – at least, the kind of thinking customary of men. His brain worked in dim ways. Yet his conclusions were as sharp and distinct as those achieved by men. He had a method of accepting things, without questioning the why and wherefore.… Logic and physics were no part of his mental makeup. (p. 150)

After successfully catching his first prey, London once again described the wolfish nature of his mental processes:

> In his own dim way he learned the law. *Eat or be eaten*. He did not formulate the law in clear, set terms and moralize about it. He did not even think the law; he merely lived the law without thinking about it at all. Had the cub thought in man-fashion, he might have epitomized life as a voracious appetite. But the cub did not think in man-fashion. He did not look at things with wide vision. He was single-purposed. (p. 166)

In these and similar sections, London adheres to the view that the mental life of dogs is different, even deficient, in comparison to humans. The mental life of animals is characterized by dimness, by a "lack" of ideas such as causality. Although in his actual descriptions London often depicts his hero as sensitive, acute and intelligent, this impression is corrected more or less in "disclaimers" such as the ones just mentioned. Indeed, when describing White Fang's perfect feel for timing, he writes:

> Not that he did this consciously, however. He did not calculate such things. It was all automatic. His eyes saw correctly, and the nerves carried the vision correctly to his brain. The parts of him were better adjusted than those of the average dog.… His was a better, far better, nervous, mental and muscular coordination.… His was a more perfected mechanism. (p. 213/214)

Eventually, after a number of difficulties and drawbacks, as is usually the case in experimental work, the trial becomes a great success. Due to the chronic exposure to his new, friendly environment, White Fang manages to suppress his natural impulses and to control his aggressive instincts. By becoming tame, he actually qualifies himself for civilization. He learns to master himself. When badly wounded by an escaped and armed convict, a "human beast" who had wanted to murder the judge who had

sent him to prison, White Fang is treated with the utmost respect, almost as a human being, a human patient. Indeed, he is treated much more humanely than the violent convict himself, the subject of a manhunt. A man and a wolf change places, so to speak. While the convict is shot off like a wild animal, White Fang is operated upon, by the best available surgeon, and the most advanced technologies are put to use, such as an x-ray. A medical expert is summoned by means of a telegraph to San Francisco. He is nursed as one would nurse a human being, a hospital patient, a family member – a Pavlovian dog. He is given the best available surgery so that he may survive the most hazardous phase of the experiment to which he was subjected. While recovering, he takes to dreaming and in this manner, reminiscent of a psychoanalytical session, he works out the story of his life, a compressed version of the collective narrative of domestication and civilization of his species *as such*.

In important respects, *The Call of the Wild* and *White Fang* are literary counterparts to Pavlov's animal practice. Experimenters and their dogs interact patiently in experimental settings. Dogs are trained to adjust to new environments and although the experiment implies a certain amount of suffering, the researchers take a keen interest in their well-being. But, as I said, in terms of theoretical framing, London's view on animals is psychoanalytical (Jungian) rather than behaviouristic (Pavlovian). Buck and White Fang are animals with a "soul".

5.7 The Experimental Animal-self

The vicissitudes of Buck and White Fang, Jack London's most famous "experimental dogs", mirror (in a variety of ways) the author's own life. Besides *The Call of the Wild* and *White Fang*, London wrote a number of other dog stories, and he clearly identified himself with his dog-protagonists. He called his self-built house *Wolf House*, signed some of his letters with "Wolf" and clearly liked to compare himself with this hardy animal, at home in a desolate landscape, the atavistic alter ego of the domesticated dog.

Like Buck, Jack London grew up in California, from where he plunged himself into the desolate sub-Artic climate of the Klondike Gold Rush. In fact, in the course of his eventful life, London voluntarily exposed himself to a series of rather extreme conditions: from the Yukon region in wintertime to the Pacific Ocean on a sailing boat, from Korea during the Russo–Japanese war to the rural arcadia where he was to spend his final years. Indeed, his own biography can be regarded as a series of experiments, a test-ground for trying out the theories of a number of favourite authors, such as Marx, Darwin, Nietzsche and Jung. The effects of these experimental conditions are recorded faithfully and accurately in an impressive number of stories and novels. His most autobiographical novel is called *John Barleycorn*, describing the genesis and impact of his alcohol addiction. In a rather systematic manner, London analyses the disastrous long-term mental and physical effects of a chronic, more or less continuous exposure to large quantities of alcohol. In this novel, his life emerges as a chronic experiment, designed to study the consequences of living on alcohol.

The first extreme climate to which he willingly exposed himself, using his own physical and mental being as a "research animal" so to speak,[21] was the sub-Arctic stillness and whiteness of the Klondike region. Together with thousands compatriots, he all of a sudden decided to set out for this desolate wilderness, thousand miles from civilization, in order to subject himself to frost, melancholia and malnutrition. Yet, in this (rather exceptional) case, the adventure proved quite beneficial. The Klondike became his "goldmine", but in an unexpected manner – his goldmine as an author. One winter in the Yukon area provided him with enough materials for years of writing. It allowed him to make a name for himself as an author. In an unprecedented way he described the immense stillness, silence and desolateness of the North, the terrors of extreme cold, darkness and starvation. It was an Odyssey towards self-discovery. All biographers agree that, had it not been for the Klondike experience, he probably would never have become a writer. In his Darwinian descriptions of the gold-rush epoch, the emphasis is on survival through adaptation. Some men and animals survive, whereas others fail, due to certain physical and psychic characteristics. All individuals involved are put to the test, in the context of a large scale experiment. His stories and novels can be read as protocols of these relentless trials, designed to test the theories of Darwin, Nietzsche and others. In London's work, nature emerges as an infinite and overwhelming wilderness, as the sublime in the sense of *das Erhabene*, where only the exceptionally strong and confident can feel at home.

The influence of Nietzsche is clearly noticeable in a series of stories and novels set in a rather different environment: the sublime vastness of the Pacific Ocean. Again, these literary documents to a certain extent can be regarded as protocols of experimental trials with the author himself as the primary research subject. They are based on personal experience and observation: Jack London was Jack London's own favourite research subject, his own favourite physiological and psychological "model animal". The experimental nature of his own sea journeys is emphasized by the fact that it was done on a self-built boat, an artefact produced for the purpose of conducting a hazardous experiment – that all but ended with the death of the most prominent "research animal" on board. Although he once again managed to survive starvation and disease, the experiment further undermined his health. Before setting off on his sea voyage, Jack London had had rather romantic views concerning life in the Pacific and on the South Sea islands. Although these idealizations did not stand the test of time, the stories and novels he produced were only partly to profit from his experiences. They are mixtures of realism and romanticism. Apparently he was not really willing to put some of his romantic expectations to the test.

Two other literary experiments deserve to be mentioned here, although they are "thought experiments", rather than experiments in a strict sense, and the theories put to the test in these novels are those of Jung, rather than those of Darwin and Nietzsche. The first one is his novel *Before Adam*. It is an experiment in introspection, exploring human life during prehistoric times in the context of an inward mental journey. It is a mental effort to return to early human existence, before the

[21] Cf. F. Nietzsche: "Mein Leben ist Tierquälerei".

onset of civilization and domestication, the life of caves and firesides, already vaguely present in *The Call of the Wild* and *White Fang*. As London sees it, traces of world are stored somehow in our collective memory. Individuals who feel at home in these surroundings, rejoicing in the mental and physical challenges they provide, are bound to feel somewhat out of place in a modern world.

Another "thought experiment", another experiment in introspection, is his novel *The Star Rover* [The Jacket] (1915/1915). A San Quentin prisoner finds himself exposed to solitary confinement for an extended period of time. In order to survive such a damaging condition, he learns that other prisoners have developed a psychic technique that can be employed in order to safeguard the individual Self from loneliness, despair and mental degradation, namely: travelling backward in time by means of intense concentration, exploring the prehistoric layers in one's own unconscious.

In all these experimental novels, two "conditions" are contrasted: life in a more or less original, free, natural and open world as compared to life under modern, urban circumstances. Although the wilderness is a highly demanding environment, both mentally and physically, some individuals who experience unhappiness and unease in a modern society (e.g. Jack London himself) are bound to flourish in more physically challenging, more primitive settings. At times, his novels take a Marxist position, depicting the effects of modern urbanization in terms of class, as in *The People of the Abyss* [1903]. In other novels, however, race rather than class becomes the "independent variable" – for although London was a man of left-wing, socialist convictions, he was also highly sensitive of ethnicity. This is the case, for example, in *The Valley of the Moon* (1913/1913), where a man and a woman suddenly recognize that they share the same ethnic descent. All of a sudden they realize that they are "Saxons", a race of people described as "wild, like Indians", but white, with blue eyes and yellow hair – "and they were awful fighters" (p. 21). In London's novel, this common ethnic background reinforces (and explains) their mutual and unconscious erotic attraction. What the novel basically sets out to prove and explain, however, is why individuals endowed with such a genetic heritage could flourish during the pioneer days (happily migrating across the great plains), but are having such a hard time adapting to city life and industrial labour. Modern conditions are beneficial to some, but harmful to others.

The most important experiment to which Jack London relentlessly subjected himself, however, documented by him in a meticulous and faithful manner, lasted the greater part of his life, from his adolescence up to his final days, spent on his Californian ranch. This experiment consisted in the ongoing exposure (of mind and body) to severe and more or less continuous alcohol intake. Jack London was, throughout his adult life, a heavy drinker. According to O'Conner (1964) the novel *John Barleycorn* (1913/1914) describes how, eventually, he was "maimed" by alcohol. But it would be one-sided to depict alcohol merely as a damaging factor. It was both his poison and his fuel. Most of his novels seem to display something of an alcoholic curve: in the beginning they abound in energy and enthusiasm, but before long there is a decrease in creative power, a gradual onset of weary numbness. Indeed, one could say that this same alcoholic curve even structures his biography as such.

Apparently, due to the self-revelatory frankness of the book, *John Barleycorn*, the autobiography of a heavy drinker, was recognized as true to life to such an extent that it became a major weapon in the anti-alcohol campaign that emerged shortly after his death and eventually succeeded in bringing prohibition to the USA. It also contained an answer to the question why, gradually but inevitably, London's own talent died out. As O'Conner puts it, the book, in a clear and convincing manner, describes (introspectively, from a first-person perspective) how continuous alcohol intake changes human behaviour as well as mental functioning (p. 333). Therefore, it is a scientific novel, the report of a lifelong trial. According to London, alcoholism is a slow form of suicide. Yet, although the book was apparently written to convert people with alcohol problems to switch to a more sober lifestyle, the writer himself was unmoved by his own admonitions. He remained faithful to his excessive drinking habits, even when they began to ruin his kidneys, bringing him bouts of severe pain and various other forms of physical disintegration. He committed suicide in 1916 by taking an overdose of morphine.

Comparing London's dog novels with the story of his own life, one could say that his literary "Experiments with Dogs" are, to some extent, exaggerations and idealizations. In these novels, the adaptation of the research animal to the challenging new environments is somewhat too perfect. As far as Jack London himself was concerned, he never really adapted himself, neither to the sub-Arctic wilderness (as did Buck), nor to the healthy and happy life he had wanted to experience in his Californian arcadia (as did White Fang). London's own case is reminiscent of "real" laboratory dogs. They are allowed to recover to some extent, but the damage cannot be completely undone. In the end, the trials prove too demanding. It is difficult to extrapolate the vicissitudes of his experimental dogs to real life biographies. Eventually, in real-life experiments, the research animal is bound to succumb to the adverse conditions to which he is exposed. It is beyond doubt, in short, that *John Barleycorn* is more realistic, more "scientific", than *The Call of the Wild*.

The next chapter is a sequel to this one. Again we will analyse a literary document that describes the effects of modern life on human beings, comparing it to the impact of domestication on wild animals. And once again, we will read a literary document as a literary experiment. Yet, whereas in this chapter our focus gradually shifted from science to literature, in the next chapter we will move in the opposite direction: we will begin with literature, gradually moving towards science. Furthermore, whereas the focus in this chapter was on physiology and, to a lesser extent, on behavioural research, the focus in the next chapter will predominantly be on animal behaviour (animal psychology, ethology). Finally, whereas this chapter was predominantly devoted to dogs, Chapter 6 will focus on the vicissitudes of a different kind of research animal – a wild duck.

Chapter 6
The Birth of a Research Animal

Ibsen's *The Wild Duck* and The Origin of a New Animal Science

6.1 Introduction

Ibsen's play *The Wild Duck* was written and published in 1884. The initial response to it was one of bewilderment. It left the audience baffled and perplexed. Generations of critics continued to regard it as obscure, undefined, unfathomable, ambiguous, evasive – not in the least because of the mysterious symbol that held it together: an untamed bird in its close and miserable garret, captive to circumstances and with no hope of escape (Meyer 1985).

In this chapter, I intend to *re-read* the play in a particular manner, namely as a document that records an important event in the history of human–animal interaction. *The Wild Duck* stages a new and unprecedented animal practice. If we read it in this manner, the play turns out to be remarkably coherent, and apparently futile details suddenly become important and meaningful. It is not my intention, however, to add yet another Ibsen interpretation to those already propounded. Rather, the purpose of this chapter is an epistemological one. I will emphasize that what is happening to Ibsen's duck on the stage, is remarkably similar to what is happening to some of its contemporaries in a new type of animal research, emerging precisely at that time, destined to become one of the most important forms of animal research of the present.

In other words, the idea (already proposed in Chapter 5) that literary texts involving animals may often be seen as structured in a way that is similar to animal experiments, will be further elaborated in this chapter, but now applied to a play. Moreover, Pavlov's work already displayed a gradual shift of focus from animal physiology to animal behaviour, or rather animal "psychology". Also in this respect, the present chapter constitutes a sequel to the previous one. Notably, I will call attention to the work of two pioneer biologists, contemporaries of Ibsen, who initiated a new scientific animal practice, the experimental study of animal behaviour, namely Douglas Spalding and Conwy Lloyd Morgan. Their focus is on behavioural trials. My purpose is to show that in all the documents involved, both the scientific and the literary ones, one and the same event is being recorded – the birth of a new type of research animal. The import of Ibsen's play for animal ethics resides in the fact that it stages the struggle between a romantic and a scientific perception of

H. Zwart, *Understanding Nature*

animals and allows us to discern crucial aspects of our present moral relationship with animals. For indeed, the struggle between the scientific and the romantic view, acted-out in *The Wild Duck*, is still structuring the ethical debate on animals in the present.

Before submitting *The Wild Duck* to a close reading, I will briefly discuss the play that immediately preceded it and prepared the ground for it – *An Enemy of the People*, better known as *A Public Enemy.* For although a more thorough analysis of it will be given in Chapter 8, it can be regarded as a prelude to *The Wild Duck*. Therefore, I will briefly summarize the basic story line in this chapter. Subsequently, in my analysis of *The Wild Duck*, I will concentrate on the human–animal interaction that evolves in it, noticing how closely this interaction coincided with pioneer initiatives that (towards the end of the nineteenth century) succeeded in inaugurating a new type of animal research. Finally, I will indicate how Ibsen's play allows us to flesh out the moral dimension of this new practice – one that was to become a large-scale phenomenon in the course of the twentieth century.

6.2 Preliminary Remarks

Before publishing *The Wild Duck*, Ibsen had already paid attention to the emergence of the modern scientific outlook, and its inevitable clash with other views on nature, such as romanticism. His most important effort to represent the rise of the scientific mode of thought is his play *An Enemy of the People*.

As will be explained more thoroughly in Chapter 8, *An Enemy of the People* is a play dealing with a rather modern theme, namely environmental pollution. Its principal character, Dr. Stockmann (who is repeatedly referred to as a *man of science*), had been working quietly a whole winter, analyzing the water at the public baths and sending samples of it to a university laboratory, in order to assure himself that the local health facilities were contaminated by millions of *animalculae* or *infusiora* – mysterious living beings that could only be detected with the help of scientific equipment. After a series of events, however, that we will deal with more thoroughly in Chapter 8, Stockmann publicly declares that the most dangerous enemy of science (besides authoritarian politicians) is common sense, accepting only those truths that are generally acknowledged, and therefore hopelessly outdated. Its stupidity and ignorance must be attributed to lack of oxygen in houses. In a dramatic lecture-scene, Stockmann poses as a *free-thinker* who, in a rather Nietzschean tone of voice, compares the difference between the majority of mankind and the "intellectually superior few" to that between mongrels and pedigree stock. The final act contains a number of Darwinisms – that is, quotes borrowed from popular Darwinism such as *struggle for existence* and *survival of the fittest* – and it all ends with Stockmann deciding to become a teacher for human mongrels: "Just bring me a few.… I'm going to try an experiment on some mongrels… there may be some excellent material among them" (p. 218). Many of these elements (popular Darwinism, the emergence of the scientific perception and the idea of

conducting an experiment, on animals as well as on human subjects) are further elaborated in *The Wild Duck*.

The principal character of *The Wild Duck* is Hjalmar Ekdal, a photographer, lazy, self-centred and sentimental, dreaming about an "invention" that will transform photography from a mere handicraft into a true "science" (p. 167). His studio (also functioning as living-room) is an attic, opening into a loft whose interior is somewhat unusual. It is an artificial forest of chimneys and Christmas trees – in which Hjalmar and his father keep hens, rabbits and pigeons. Bored by his profession, Hjalmar becomes "active and purposive as soon as there is an excuse for tinkering in the loft" (Knight 1962, p. 56). Other important characters are his wife Gina, their daughter Hedvig and a former school friend (Gregers Werle) who pays an unexpected visit to the Ekdal family and decides to use Hjalmar as a research subject in a moral experiment, with the intention of "opening his eyes" and transforming him into a free-thinking, independent human being. The bleak, distressing plot seems to convey the moral message that people simply cannot be improved.

Besides the species already mentioned, the loft is inhabited by a semi-domesticated duck. Various theories have been advanced as to what the bird is intended to stand for, Meyer tells us (p. 561). It is a strange creature that (unlike the birds and frogs in Aristophanes' comedies) never appears on stage, never shows itself to the public. Apparently, she mirrors the fate of those who, in Ibsen's own words, have forgotten what it means to live wild, have grown plump and tame and content with their basket (p. 562). The duck represents a primal domestication scene. Yet, besides being merely a moral *image* reflecting the dismal conditions of the human individuals around her, I believe that there is another, more "positive" side to this "strange creature of wild life, mysterious as life itself" (Knight 1962, p. 65). The duck must be regarded as *a phenomenon in its own right*, and my reading will concentrate on what goes on in the loft, where the animals dwell, rather than on what happens in the living-room (the human realm). Or, to put it differently, I will focus on the experiment with animals, rather than on the experiment with human subjects. Ignoring for a while the interesting dispute between Romanticism (represented by Gregers Werle) and Social Darwinism (represented by his successful father) in *Act One*, I will at once address the loft-scenes in *Act Two* and *Three*.

6.3 *The Wild Duck*: Close Reading 1

Act Two is set in the studio/living-room, with professional apparatus, instruments and tools. A conversation between Gina and Hedvig is evolving when, suddenly, Old Ekdal (Hjalmar's father) appears on stage. He slides the door in the rear wall a little to one side, looks into the loft for a moment, closes the door carefully and utters the following line:

> He, He!… she's lain down in her basket. He, He!

As Hjalmar enters the attic, the following dialogue develops:

HJAMAR. Have you looked in there this evening, father?
EKDAL. Yes, of course I have, she's gone into the basket.
HJAMAR. Gone into the basket, has she? She is beginning to get used to it, then?
EKDAL. What did I tell you? Well, now, there are one or two little-
HJAMAR. Little improvements, yes.

Before pointing out the significance of these apparently trivial lines, let me pursue this scene a little further. An unexpected event occurs. Gregers Werle pays a visit to the Ekdal family, with the intention of initiating his moral experiment. He starts off by bluntly asking old Ekdal how he, a former hunter, manages to live under such depressing conditions, "boxed between four walls". What about the life in the forest, the wide open spaces? Ekdal smiles and says: "Hjalmar, shall we show it to him?" The latter hesitates, but Ekdal insists. Gregers finds the whole scene rather confusing. What are they talking about? Finally, the sliding doors are opened. A long and irregularly shaped loft can be seen, full of dark nooks and crannies, with a couple of brick chimney pipes coming through the floor. Moonlight shines in on various parts of the loft, while the rest lies in shadow. "What is it, exactly?" Gregers asks. He is shown some chickens. "Why, you keep chickens!", he exclaims. There are pigeons too, and rabbits. Finally, Ekdal says: "But now I'll show you! This is really something …" (p. 150). He shows him the wild duck. "It's a wild duck … that's what it is". Gregers, perplexed, does not know what to make of it and asks: "But can it live up here in this loft?"

What are *we* to make of it? What is happening here? Two important clues allow us to find at least the beginning of an answer. Francis Bull (1932) has suggested that Ibsen, in choosing the theme of his play, may have been influenced by Darwin's account of how wild ducks degenerate in captivity. Darwin's *The Variation of Animals and Plants Under Domestication* (1868/1988), already discussed in Chapter 3, indeed contains the following line: "We have seen how soon the wild duck, when domesticated, loses its true character, from the effect of abundant food, or from taking little exercise" (p. 331). The fate of Ibsen's duck, then, seems a dramatization of a quote borrowed from Darwin.[1] The importance of this clue is underlined when it is brought into contact with a second one. Among the draft materials and notes, jotted down by Ibsen as he was designing his play, there is an awkward line, apparently without any connection to other entries. Nor can a trace of it be found in the final text: "It is illicit for scientists to torture animals to death. Let physicians experiment with politicians and journalists" (Arpe 1972, p. 109). The jeer in the second sentence, directed at politicians and journalist, is an entry belonging the problem-domain of *An Enemy of the People*, the play he was still preoccupied with at that time, and should not distract us here. More important is the remark concerning scientists torturing animals to death – one that must be given some further thought.

[1] The issue of any direct influence from Darwin on Ibsen, who probably relied on secondary (notably newspaper) sources, is not relevant to my argument. Darwin was "in the air" in those days, and Darwinian ideas and phrases were collective cultural property, inciting intellectual discussion and comments in a variety of circles throughout Europe. An important aspect of Ibsen's talent was his seismographic sensitivity for the major intellectual discussions of his era. For more details on Darwin's influence on Ibsen see: Shideler (1997).

As we have seen in Chapter 5, experimentation with animals was an important issue in the second half of the nineteenth century, described by Ryder (1975) as "the golden age of vivisection". In Ibsen's time, the issue had reached its climax (Breitschneider 1962). Whereas opponents accused researchers such as Claude Bernard of submitting large numbers of animals to atrocious experiments, the professional research community discarded public outrage as sentimentalism. Before *The Wild Duck*, Ibsen had written a series of problem plays, dealing with publicly disputed issues like emancipation of women (*A Doll's House*), euthanasia (*Ghosts*) and freedom of speech (*An Enemy of the People*). Apparently, he was considering the possibility of using vivisection as an element in his new play about contemporary life. Eventually, he must have rejected the idea, since the issue of animal experimentation seems completely absent from its final version. Unless – the duck itself can be regarded as an experimental animal. And this is indeed the case. The research animal is still present in the play, but rather than staging a debate *about* animal experimentation, Ibsen allows such an experiment to be actually conducted before our eyes – albeit as a new and somewhat unfamiliar *type* of experiment, less atrocious than vivisection, focusing on problems of animal behaviour (notably adaptation) rather than on animal physiology. Apparently, it must somehow have dawned on Ibsen that, besides the traditional form of experiments with animals (vivisection), a new animal practice was in the process of emerging, one no longer directed at dissecting animals alive, but rather at closely and systematically observing their behaviour under a variety of modifiable conditions. The play describes an experiment in domestication.

Now it suddenly becomes less obscure what father and son Ekdal are doing in their loft. Their apparently futile pastime actually constitutes a quasi-experimental activity. The line quoted above – *He, He! … she's lain down in her basket. He, He!* – is actually an observation. Such observations (made by one observer and reported to the other) are made at regular intervals, in accordance with a quasi-scientific protocol ("Have you looked in there this evening, father?", "Of course I have"). The remark "She is beginning to get used to it" is an interpretation, apparently a confirmation of a hypothesis ("What did I tell you?"). In this manner, they are conducting an experiment in adaptation. The process of domestication, of adjustment to artificial circumstances, is monitored meticulously. Their remarks, their gestures are part of a behavioural pattern, a protocol, and become perfectly meaningful and reasonable, even typical. They are carrying out an experiment, whether they (or, for that matter, the author himself) are conscious of it or not.

As I already indicated in Chapter 5, an experimental design or protocol is basically structured by a simple phrase – *What happens if …?* What happens if a wild duck is confined within a tiny artificial forest? Will she be able to live there? (Greger's question) Will she get used to it? (Old Ekdal's question) The behaviour of father and son Ekdal is guided by questions of this sort. Their time-consuming and apparently futile activities amount to something – they are manipulating the environmental conditions (independent variables) and subsequently observe the behavioural effects (dependent variables).

Older animal practices (such as hunting and husbandry) are also present in the play. The hens seem to be merely "kept", and old Ekdal at times relapses in his

former practice by shooting rabbits, instead of observing them. But amidst these reminiscences, a new phenomenon emerges, a new mode of being for animals: a new type of research animal enters the scene.[2] Father and son Ekdal witness the process of adjustment, the gradual erasure and extinction of natural behavioural patterns. While "fiddling" with and deliberating about contrivances such as a water-trough, for example, they are in fact manipulating independent variables (such as "water"). They are accommodating the environment to the animal's needs, in order to further adaptation. Interestingly, more or less at the same time, professional researchers are beginning to design precisely these kinds of experiments. It is the beginning of an important production line of knowledge claims, generating an increasing number of ethological, biological and psychological publications in the course of the next century. In short, the Ekdals are doing what a small number of professional contemporaries were also engaged in at that time.

In *The Variation of Animals and Plants Under Domestication*, the book that perhaps "inspired" Ibsen to write his play, as we have seen, Darwin had collected a considerable number of observations on animal behaviour. His "successor", George Romanes, continued this work by collecting and systematizing numerous data and stories about animal performances (Boakes 1984). From a methodological point of view, this type of research is often discarded as anecdotal rather than experimental. The first biologists to really submit animal behaviour to systematic observation and experimentation, were Douglas Spalding (1873) and Conwy Lloyd Morgan (1890/1894). In terms of publication dates, their papers are "flanking" as it were Ibsen's play. Before highlighting some other details of the play, therefore, let us have a look at the kind of research reported in these publications.

6.4 The Emergence of a New Research Paradigm: Spalding and Morgan

The animal research described in Chapter 5 was done within university settings such as the *College the France* (Bernard) and the *Imperial Institute of Experimental Medicine* (Pavlov). The first initiatives towards commencing a new kind of animal research, focusing on the ethology of behaviour, were taken *outside* universities. Experiments with animals of this new type were done by amateurs, like the Ekdals, and took place in private settings, within the confines of family life. The new science emerged when, in 1873, Douglas Spalding published the results of his pioneer

[2] When in 1854 Darwin started to collect pigeons and ducks out of scientific interest, Desmond and Moore (1991) tell us, "it was hard to realize the novelty of his move. Most naturalists disdained pigeons and poultry. Science was not done in the farmyard. The gentry might have kept ornamental ducks on shooting estates … but such gamekeeping was a world removed from contemplative philosophy" (p. 426).

trials, conducted in a private environment: the house of the famous Maberley family,[3] where he was appointed as tutor and where children, observers, lovers and research animals mixed (Boakes 1984). In other words, Spalding's "research facilities" constituted a bourgeois version of the Ekdal attic. His research set the model for the new paradigm to be, demonstrating that animal behaviour could be studied and manipulated by isolating and controlling a limited set of conditions. In doing so, he "began an experimental science which was carried forward by … innumerable later investigators" (Gray 1962, p. 303).

In Spalding's time, the "marvellous dexterity" displayed by animals was still generally regarded as an object of wonder (Spalding 1873/1993), but he sets out to subject some of these exceptional feats and "marvellous stories" to "careful experiment and observation".[4] He performed a series of experiments with chicks and ducklings, depriving them of, and then exposing them to, for example, visual stimuli (the famous "Hooding" experiments). He writes: "The conditions under which these little victims of human curiosity were first permitted to see the light were carefully prepared.… [E]very movement, with the date thereof, was put on record. Never in the columns of a Court Journal were the doings of the most royal personage noted with such faithful accuracy" (p. 283). Spalding thus invented a new science, but realized that "to the many who love more to gaze and marvel than to question and reflect, all this will seem miserably inadequate as a clue to one of the mysteries of life" (p. 293) – thereby hinting to the struggle between two ways of viewing animals – the romantic and the scientific view – that we also find fleshed out in Ibsen's play.

Conwry Lloyd Morgan, friend and collaborator of Romanes, was sceptical and critical about the latter's handling of anecdotal evidence and decided (like Spalding) to rely solely on experimentation and observation. He carefully distinguished between actual behaviour and human interpretation and introduced the famous "canon" for animal research,[5] directed against our natural tendency to attribute mysterious faculties to animals (notably the "marvellous" and mystified phenomena of "instinct"). His favourite research subjects were chicks and ducklings. In one of his experiments, he constructed a small pen with newspaper walls, insecurely propped against various objects, and placed a one-week-old duckling in it, to study its efforts to escape (1890). In another series of experiments he tested the responses of research animals to various stimuli – notably the "stimulus of water" (1894/1993, p. 175).[6]

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[3] The house of the Maberley family was the parental residence of the philosopher Bertrand Russell. His mother actually assisted Spalding in some of his research.

[4] The Dutch philosopher J.H. van den Berg (1961) defines modern science as a "struggle against marvellous" – a *lutte contre le merveilleux*.

[5] "In no case may we interpret an action as the outcome of the exercise of a higher psychological faculty, if it can be interpreted as the outcome of the exercise of one which stand lower on the psychological scale" (1894/1993, p. 53).

[6] Nonetheless, "romantic marvel" is not completely absent from his work: "Nothing is more admirable than the skill of animals. One may watch by the hour with ever renewed delight the marvellously delicate adjustments involved in the sailing flight of sea-gulls" (p. 161).

Spalding and Morgan had a predilection for chicks and ducks as animal models. One of the characteristics of the scientific literature that started to emerge at the close of the nineteenth century was that the bulk of it was inhabited by a limited number of favourite species, notably hens, pigeons, rabbits – the very inhabitants of the Ekdal loft. Indeed, more and more details of the play become recognizable all of a sudden, as soon as we read it against the backdrop of the emergence of this new animal practice.

6.5 *The Wild Duck*: Close Reading 2

Like Spalding and Morgan, the "Ekdal team" conducts its experiment not in an academic, but in a private setting. Their small-scaled, time-consuming experiment (N = 1) focuses on domestication and adaptation, while a rival, "romantic" comment on their doings is provided by other characters, notably Hedvig and Gregers, the former is represented as an imaginative girl dwelling in a world of fantasies, the latter, having accused his father of social Darwinism, is characterized by him as being "over-sensitive" and "romantic".

The Wild Duck contains a meticulous record of an animal trial which we will now analyse in more detail. Besides the emergence of a new scientific *practice*, the play faithfully documents the emergence of a new way of looking at animals, a new scientific *gaze*. Moreover, the new science not only transforms the *object* (the animal) into a particular type of research animal, but also calls for a drastic transformation on the part of the *subject* (the scientist) himself, affecting both his repertoire of behaviour and his modes of perception. The animal's *world* is reduced to an experimental *environment* (i.e. a setting composed of a limited number of stimuli or conditions), and this applies to the human world (the family home) as well. Finally, Ibsen's play stages an important cultural struggle, between the scientific and the romantic understanding of animals.

6.5.1 A New Scientific Practice

Father and son Ekdal have entered a new and as yet unfamiliar scientific scene. From an outsider or common sense perspective, they simply seem to indulge in "keeping" animals. Comparison with the writings of Spalding, Morgan and others, however, allows us to recognize the specific nature of their doings. Their pattern of action contains typical gestures and techniques that are part of a coherent protocol. As we already noticed, the fact that the duck has "gone into the basket" is *observed* by Ekdal, *reported* to his son and *interpreted* in terms of adaptation – that is, regarded as a confirmation of a hypothesis. The many improvements made by them, notably concerning the water-trough, can be regarded as introducing, modifying and manipu-

lating certain stimuli or controlling environmental factors (independent variables). Thus, the mysterious loft is actually transformed into an artificial *Umwelt*, an impoverished world, reduced to a limited number of basic constituents that can be isolated and controlled independently from one another – notably water, lighting,[7] time[8] and a number of spatial conditions (such as "high" versus "low"[9]). Thus, with the help of a series of "contraptions", "contrivances", "gadgets" and "improvements", an experimental set-up is created that allows the research animal to develop certain behavioural patterns, and the observer to closely observe the animal's responses to his interventions. In short, a new scientific practice is staged in Ibsen's play *in statu nascendi*. The Ekdals have initiated a new science, apparently without realising what it is they are doing, still feeling rather embarrassed about it. The new and time-consuming behavioural pattern has not yet established itself as a *legitimate* practice in its own right. We may say that, in the Ekdal loft, *praxis* precedes *consciousness*.

The duck is subjected to an experiment in deprivation. She is deprived of her natural surroundings, in order to observe whether she will manage to adapt to the new circumstances or not, whether and to what extent she will produce her usual behavioural repertoire, or rather a reduced and simplified version of it. Thus we find it reported that she (the research animal) is doing "extraordinarily well", that she is nestling, growing fat, and so on. In this manner, the Ekdal experiment, as a follow-up of observations reported by Darwin, not only coincides with the work of Spalding and Morgan, but anticipates the research on domestication done by Lorenz and other researchers of the twentieth century (Lorenz 1940; Eibl-Eibesfeldt 1975).

6.5.2 The Scientific Gaze

The transition from a photographer's studio, with its apparatus and instruments, to a scientist's laboratory is not a difficult one to make. From the beginning, Hjalmar is obsessed with the idea of turning his work as a photographer into a science by making a "grand invention". Yet, although his *actions* are already those of a scientist, his *mind* remains that of a romantic. More precisely, his image of what is involved in making scientific discoveries is of a rather romantic sort. The projected invention is described as a heroic feat, as the outcome of a sudden "intuition" or "inspiration". In order to bring this miraculous feat about, Hjalmar relies on introspection and contemplation. This prevents him from short-circuiting the invention he is dreaming of with the simple, but nonetheless effective contraptions and con-

[7] In his casting instructions, Ibsen placed particular emphasis on lighting and it is different in every act. The aspect of lighting is "far more subtly worked out than in any of the earlier Ibsen dramas" (Beyer 1978, p. 138). The light is brilliant (Act 1), dimmed (Act 2), bright (Act 3), declining (Act 4) and grey (Act 5).

[8] "Time has stopped in there with the wild duck", Gregers notices (p. 162), a fact that can be interpreted both in romantic terms (adding to the mystic stillness of the loft) and in scientific terms (ordinary time is suspended, congealed, controlled).

[9] It is observed that pigeons nestle in high, chickens in low places.

trivances he is already introducing in the loft. His romanticism prevents him from apprehending that he already *is* an inventor, more or less, and that a real scientific practice might be something less spectacular that his romantic views suggest. At a certain point, for instance, he exclaims: "good heavens, you can't expect me to work to a schedule. An invention is something that even the inventor himself isn't completely master of" (p. 168). Apparently it escapes him that working to a schedule is a crucial constituent of the *organon* of modern empirical science, Apollonian rather than Dionysian, requiring working methodically and punctually rather than intuitively. It is a science that involves active manipulation, rather than peaceful meditation. For example, Hjalmar could easily have short-circuited his dreams about "revolutionizing photography" with his daily fiddlings in the loft by taking pictures of the domestication process. Morgan, for example, used an innovative high-speed photography technique for producing a series of photographs with which he intended to prove that the transmission of nervous impulse takes time (Morgan 1894/1993; Boakes 1984). Hjalmar could have made himself into an *experimental* photographer.

In *Beyond Good and Evil*, Nietzsche distinguishes between truths that are best recognized by "mediocre spirits" and those that appeal to "spirits of a higher type", who do things in a "grand style". Indeed, "for scientific discoveries of the type of Darwin's a certain narrowness, aridity and industrious diligence… may not be a bad disposition", Nietzsche argues (1966, § 253). This is a typical example of the romantic view on science. Neither Hjalmar nor Nietzsche seem to appreciate the fact that the new protocols of science, emerging in the second half of the nineteenth century, not only transform the animal into a research animal, but have important consequences for the researchers themselves as well. The researcher has to become self-disciplined, has to become a certain type of human being. Not only the animal, also the human being has to change, both poles of the knowledge production process are affected by this transformation. Without being aware of it, Father and son Ekdal are inaugurating a new type of science. The experiment not only affects the behavioural repertoire of the animal subject, but that of its conductors as well. A typical form of communication arises (a rather awkward one at first), in connection with this type of research. To give just one example: When Gregers says that he can hear the wild duck *crying* (interpretation), Hjalmar immediately corrects him by saying that she is *quacking* (observation), thus restricting himself to reporting what is audible. By behaving thus, the animal is bound to emerge in a certain manner, namely as a research animal, producing behavioural sequences rather than meaningful messages.

Hjalmar's fantasy of becoming an inventor is not all that ridiculous if we closely watch what he is actually doing. Indeed, "the loft … is the only thing that can extract any kind of constructive activity from the fundamentally lazy Hjalmar. Here, rather than in the world of photography, he is the inventor he images himself to be" (Støvegrud, p. 111). Had he submitted a report of his contrivances and findings to a scientific magazine, his name might have been recorded in the annals of science. From a romantic point of view, the new scientific practice is far too "mediocre", no doubt, too laborious, too practical and down-to-earth to be recognized as such. His inability to grasp that he, by entering this new scientific practice, already made his

grand invention, constitutes his "fatal flaw" so to speak. In *Act Four* he announces that "Tomorrow I intend to start working in real earnest.… From now on I shall never set foot in that loft again". Apparently he fails to realize that his activities in the loft, not his "meditations" on the sofa, may actually be seen as scientific work. Father and son Ekdal engage in a novel animal practice, allowing an animal to emerge as a research animal of a new kind, but nobody really *sees* it. The research animal remains *unseen*. Instead of discerning the research animal, and himself as an experimenter, Hjalmar allows himself to be subjected to someone else's experiment.

6.5.3 The Scientific and the Romantic Gaze

The problem of perception is important in Ibsen's play. Images of sight and blindness occur throughout the text (Reinert, p. 458) and Gregers Werle explicitly states that he sees it as his mission "to open Hjalmar Ekdal's eyes". How can someone be a photographer and still be closing his eyes to what is happening right in front of him?

What is staged in *The Wild Duck* is basically the struggle between the scientific and the romantic perception of animal (as well as human) behaviour. It is, indeed, an exercise in comparative epistemology. The reduction of the animal's *Umwelt* to a limited set of controllable factors clears the ground for the emergence of the scientific gaze, while the scientific gaze in turn reduces the animal's world to a limited number of stimuli (such as "water"), and the animal's behaviour to a limited number of behavioural units (such as "swimming"). That is, a marvellous and fascinating world becomes disenchanted, neutralized. The enigmatic is reduced to something controllable, a natural world is decomposed and transformed into a scientific "environment". Moreover, while the animal's world is reduced to a limited number of environmental constituents (producing a limited number of behavioural options), the *human world* (i.e. the modest Ekdal family home) gradually becomes transformed into a laboratory where experimental protocols are implemented. Indeed, the duck mirrors the fate of the human inhabitants. In the end, Hedvig herself becomes the "little victim" (as Spalding calls it) of Greger's effort to transform the world into an experimental environment. A life-world becomes a manageable *environment* that makes behaviour more or less predictable and modifiable.

The romantic mode of seeing, however, constitutes the antipode of the scientific one. In Ibsen's play the romantic view is most apparent in the speech acts of Gregers and Hedvig. In their perception, water is not a stimulus, but a grand and mysterious force of life, referred to as "the sea", "the vasty deep", and so on. The Christmas tree is not a stimulus, allowing the animal to display certain patterns of behaviour (such as nestling or looking for shelter), but a miserable substitute for a grand and mysterious life force referred to as "the forest", "the wide open spaces",

and so on. The loft itself is a strange, mysterious, altogether different world, and the wild duck its *most eminent* inhabitant.[10] Indeed, the romantic gaze allows the animal to emerge as enigmatic and awe-inspiring, because of its silence, its wisdom, its intimacy with the basic forces of life. The wild duck is the "most eminent" inhabitant because she is still wild. "There's so much that's strange about the wild duck. No one knows her", Hedvig tells us. And elsewhere she says that "If I suddenly – without thinking – remember what's in there, I always think of it as being 'the vasty deep'" (p. 163).

Spalding concedes that, from a romantic perspective, a truly scientific account of animal life must seem miserably inadequate. At the same time, he stresses that a "most royal personage" is not observed so meticulously as is the modern research animal, thus suggesting that the gaze of science adorns the animal with a new kind of splendour, rather than erasing its significance altogether.

On having seen the duck, Gregers makes the following (cynical) comment: "Just make sure she never gets a glimpse of the sky or the sea" (p. 152). Experimentally speaking, Gregers seems to hint at introducing a new variable: full exposure to the stimuli of light and water. His remark could thus easily be transcribed in accordance with the basic formula of science, *What happens if …?* What happens if a semi-domesticated bird suddenly finds herself exposed to her natural state of life? Will the original repertoire of natural responses immediately release itself? From a romantic perspective, however, the sky and the sea are not seen as "stimuli", but rather as basic forces of life, bound to reveal the superficial nature of domestication. Rather that exposing the research animal to an additional condition, Greger's intervention would entail the abolition of all limitations, of all "conditions". It would constitute something of an experiment indeed, but of a romantic type, an anti-experiment so to speak, introducing the one "condition" (i.e. "nature", "the elementary forces of life", φύσις) that puts an end to the logic, the methodology of scientific conditioning. It is the type of experiment that is conducted and documented in London's Klondike novels discussed in Chapter 5. Strictly speaking, romantic experimentation goes beyond the confines of the scientific approach. Whereas scientific experimentation is basically directed at introducing limitations and disruptions, or at replacing natural conditions by artificial ones, romantic experimentation is basically directed at transcending all artificial limits, and at replacing an impoverished environment by a free and natural world.

In an entry entitled *Anti-Darwin*, dating from 1888, Nietzsche articulates such a romantic-experimental point of view by contending that, at least in the case of human beings, domestication is bound to remain superficial – one cannot *dénaturer la nature* (1980, p. 315) – and history is like a series of experiments that verify this claim. Or, to use Jack London's term (an avid reader of Nietzsche), if exposed to the proper circumstances, human beings (or at leas a certain class of human beings), although they *seem* to have adapted themselves to a life as domesticated animal, may still respond to the call of nature, the "call of the wild". This is the type of experiment described in London's most

[10] [*F*]*or vildanden er vel den aller fornemste derinde* (Ibsen 1908, p. 268), the duck is without doubt the loft's *most eminent* inhabitant.

"Nietzschean" novel, *The Sea Wolf* [1904], where an apparently civilised human being is transformed into a "blond beast", a more or less Nietzschean hero through exposure to nature as φυσις.

This romantic ideal is present in Ibsen's play as well. The animal research, conducted by the Ekdals, is paralleled by an experiment with a human subject conducted by Gregers. What happens if a human being suddenly finds himself deprived of his illusions and is exposed to the truth? Gregers is convinced of the fact that the person involved will become free and happy (much like the duck would be happy if she would somehow manage to escape). Sadly enough, however, he will find his romantic hypothesis refuted. Hedvig, his favourite research subject, will not survive his hazardous endeavour.

6.6 Ethical Dimension

The Wild Duck stages a struggle between two modes of perception, two important speech genres, two incommensurable types of knowledge claims, namely science and romanticism. The new science did not yet manage to establish itself as a legitimate practice. The basic import of Ibsen's play resides in the fact that it allows us to discern important aspects of the ethical dimension of this animal science to be *in statu nascendi*. Three aspects can be distinguished, namely: the well-being of the research animal, its integrity and finally the fact that as a rule, an experiment inevitably leads to the death of the research animal.

6.6.1 Well-being of the Research Animal

When Gregers asks Hedvig what her father and grandfather are doing with the duck, she answers that they care for it and build things for it. Apparently, the new science, emerging at the close of the nineteenth century, *cares* for its animals. In this respect, it constitutes a rupture with the traditional scientific practice of dissecting animal – an atrocious practice marked by an astonishing disregard for the animal's well-being. Laboratory ethology is the scientific discipline devoted to safeguarding or even improving the well-being of laboratory animals, reducing animal suffering and the side-effects of "laboratorification" (Fox 1986). A much more "humane" animal science, continuously on the alert as to whether the animal subject is doing well, gradually replaced vivisection – although acute forms of experimentation continued to exist – even today. On the other hand, whereas vivisection only affected the final hours of a research animal's life, the "humanization" of animal research allowed experimental research to affect the animal's complete life span. As the "acute" method of Bernard was replaced by the "chronic" method of Pavlov, long-term monitoring of animals replaced the nasty but short techniques of former times.

As was indicated in the previous chapter, the transition from vivisection to more humane forms of systematic observation can perhaps be compared to the transition, described by Foucault (1975), from the gruesome penal practices of the early modern period to the more humane penal practices of modern time, with its elaborate techniques for closely observing and monitoring human subjects. The duck is a prisoner, and her prison a *panopticon*. Every aspect of her behaviour is subject to observation and modification. Thus, the new animal practice not only produces new forms of knowledge, it is also the emergence of a new form of power. Finally, it allows the human subject to constitute himself in a certain manner, namely as a researcher, involving new forms of responsibility, by allowing his behaviour to be guided by a protocol – by living (acting, perceiving) methodically. The experiment introduces new and carefully designed uses of space and time.

6.6.2 Integrity of the Research Animal

Even if physical well-being is secured, the animal may still be harmed in its integrity. From the scientific point of view, it will be difficult to see how integrity can be something else than well-being. The romantic position, however, insists. Even if the wild duck is reported to be doing "extraordinarily well", the separation from its natural environment, from "all her family" as Hedvig phrases it, poses a violent intrusion upon the animal's way-of-being. The romantic view stresses that the animal suffers from loss of dignity and grace, as mystery gives way to docility. By impoverishing the animal's environment, by drastically reducing its behavioural repertoire to a limited set of basic constituents, the new science reveals that it is still a *violent* practice, although brute and physical violence has indeed been replaced by other, more refined forms of violence, such as separation, deprivation, domestication, and so on – that is, by a violence more humane, but more far-reaching and subtle as well. The animal subjects are still "victims" (Spalding). Whereas the scientific gaze aims at transforming the animal into a research animal, the romantic gaze tries to restore and recover its status as an awe-inspiring, mysterious being, at one with its natural world.[11]

[11] It would be a mistake, however, to think that sensitivity to mystery and marvel would be completely absent from the scientific research world. Cf., for example, this quote by Lorenz: "No man … could physically bring himself to stare at fishes, birds or mammals as persistently as is necessary in order to take stock of the behavioural patterns of a species unless his eyes were bound to the object of his observation in that spell-bound gaze which is not motivated by any conscious effort to gain knowledge but by that mysterious charm that the beauty of living creatures works on some of us" (Ewer 1968, p. 2).

6.6.3 The Death of the Research Animal

In *The Wild Duck*, the inevitable death of the research animal is alluded to at several occasions. Sacrificing the animal constitutes the final act of the standard protocol of animal research, an indispensable element of its inherent logic. "I'd like to wring the neck of that damned wild duck", Hjalmar tells us in *Act Five*, for this would indeed have put an end to the experiment. From the scientific point of view, it is something which defies further explanation.[12] From a romantic point of view, however, the inevitability of death has a more tragic import. It is the final consequence of the ontological violence inherent in the experimental approach *as such*. When Hedvig dies in the final act, this demonstrates that she really had become an "experimental animal", subjected to a trial without her consent.

6.6.4 From Awe-inspiring Nature to Managed Environment

Rather than merely affecting the research animal *as such*, the experimental gaze affects its way-of-being-in-the-world. Out there, in the wild, the duck had been at one with nature. But now the duck's life is reduced to a limited number of typical, predictable behaviours, while the natural world *at large* is being reduced to a limited number of manageable conditions or stimuli, all of them replaceable by artificial set-ups and contrivances (such as Ekdal's water-trough, replacing the original lake). The well-being of the animal itself is not necessarily affected by these procedures. The romantic view, however, will never accept such a conclusion. Nature is more than simply an enumeration of spatio-physical conditions, and the wild duck in captivity is bound to degenerate, whatever researchers do or devise in order to prevent it. On the other hand, notwithstanding the sultry atmosphere inside the loft, the radiance of life, the "eminence" of being the wildest inhabitant of the loft, the aura of having once been at-one-with-nature never leaves the duck completely. Rather, it remains sensible throughout the play, reminding visitors of the fact that the inconspicuous animal really belongs to another world, to a more natural environment. The sense that something is disturbed or disrupted is never extinguished completely. In short, whereas the scientific perception stresses the importance of the research animal's well-being, the romantic view rather points to the "ontological" violence at work in this research practice, affecting the research animal's integrity rather than its well-being.

[12] Among the strange, unusual objects in the loft there is a book containing the picture of death with an hour-glass – perhaps an allusion to the inevitable death of the research animal.

So far, we have been addressing important scientific animal practices of the nineteenth century (such as classification, vivisection and ethology) in terms of their epistemological profile, and in the context of a comparative epistemological approach. In Part III, the focus will shift from animals to plants and from individual animals to environments.

Part III
Plants, Landscapes and Environments

Chapter 7
Aquaphobia, Tulipmania, Biophilia: A Moral Geography of the Dutch Landscape

7.1 Introduction

In Genesis (1:9–10) it is stated that God gathered the waters into one place, in order to let the dry land appear, which He called earth, while the waters were called seas. In the Netherlands, this process took more than a single day, and it was the work of man. Gradually, a cultivated landscape emerged out of diffuse nature. In the course of centuries, the Dutch were increasingly effective in determining the conditions that allowed coastal and wetland nature to present itself in a more domesticated version. In this chapter, I will assess this process in terms of a moral geography. Different types of landscapes are read as manifestations (or materializations) of different moral attitudes towards nature, while concrete landscape interventions are interpreted as instances of moral criticism directed towards the activities and values of previous generations. In order to flesh out such a "moral geography", a comparative epistemological approach is taken. The moral profile of particular landscapes or of particular landscape interventions will be determined by means of a systematic confrontation of a variety of sources, notably scientific and literary ones. For it is in the instances of conflict and convergence of these various sources that the moral profile of a landscape emerges.

The idea of a "moral geography" is adopted from the famous German geographer and naturalist Alexander von Humboldt (1808/1975). According to Von Humboldt, nature first of all manifests itself as *landscapes*. All landscapes convey a sense of nature as such, but they all do so in their own particular manner. In *Ansichten der Natur* ("Views of Nature") he points out that every landscape has a distinctive character of its own. A peculiar "physiognomy" belongs to every region on earth, from the polar to the tropical zone. It impresses the visitor in a certain manner, conveys a certain *Totaleindruck*, calls forth a certain basic mood. According to Von Humboldt, the physiognomy of a landscape is determined by climatologic and geographical features of the area involved, but attaches itself to a typical plant form that gives the landscape at hand its identity, its *face*. The palm form, the banana form, the cactus form and the grass form are among Von Humboldt's examples. In fact, sixteen different landscapes or regional types, associated with (and represented by) typical plant forms are distinguished, but Von Humboldt points out that other forms may be added to the list.

H. Zwart, *Understanding Nature*

At first glance it seems questionable whether Von Humboldt's idea still applies to our present world. We are still inhabiting landscapes, of course, but many of them are (or have been) subject to drastic modifications. My own landscape, that of the Netherlands, may stand as an example. It is not *one* landscape, but rather an amalgam of landscape fragments that emerged during different historical periods – and they are all more or less man-made. Such a landscape is actually a *mnemoscape*, retaining the traces of human–nature interactions in various episodes. Yet, even in the case of cultural landscapes, covered with the footprints of cultural epochs, it can make sense to follow Von Humboldt's suggestion. First of all, landscapes are never purely artificial of course. They still evolve within certain geographical and climatologic constraints. Furthermore, also cultural landscape may have a particular physiognomy and they also may be associated with certain typical plant forms. Whereas Von Humboldt (a Romanticist) preferably studied landscapes in their pristine state, unspoiled by human influence, the Dutch landscape must be studied from an historical perspective that emphatically includes the effects of human activity. The landscape of the Netherlands is the outcome of a long history – a *moral* history in fact, as the physiognomies of man-made landscapes reflect the moral attitudes of their creators towards nature.

The basic idea behind this chapter is that landscape types may be read as materializations of the moral ideas and values that guided their creation. I will regard the Dutch landscape as the outcome of a series of dramatic reversals in the interaction between man and nature. As I said, a "moral geography" of a landscape will interpret landscape modifications as forms of moral criticism directed towards the values, choices and achievements of *previous* generations. In this chapter, I will focus on the decisive highlights, the most dramatic shifts that gave the Dutch landscape its present appearance. Notably, I will reflect on the transitions that occurred during two decisive turning points in the history of the Netherlands, two "Golden Ages". The first Golden Age was the classical or early modern period, notably the seventeenth century. It will be discussed in Sections 7.3 and 7.4. This episode gave birth to the two most outstanding and enduring icons of the Dutch landscape: the windmill and the tulip. The second Golden Age roughly covers the period between 1880 and 1920. Like the first Golden Age, this episode produced a relatively large number of scientists and artists of renown. While the domestication of coastal and fluvial nature was more or less completed, a new and more "romantic" vision of nature emerged as a competing ideological force. This episode will be discussed in Sections 7.5–7.7. Finally, I will indicate how the new vision just mentioned resulted in the remarkable landscape modifications that are taking place now, at this very moment, and that seem to *invert* the changes that were brought about during the early modern period or "classical age" (Section 7.8). As was already indicated, these developments will be studied from the point of view of a comparative epistemology, that is, a synchronic analysis of scientific and literary sources on coastal and fluvial landscapes. But in order to set the stage and define the proper context for such a comparative approach, I will summarize (in Section 7.2) the history of the landscape in broad outline and in a more diachronic manner.

7.2 An Elementary History

The history of the Dutch landscape is first of all a prehuman, *elementary* history. Glaciers shaped its geological matrix, glacial winds and wandering rivers left their deposits, and sea-level fluctuations determined its coast line. But the most significant "element" that effectively shaped the Dutch landscape was neither wind nor water, but mankind as an almost "elementary" force. We seem to be without a habitat of our own. We *create* our habitat and for that reason we are able to live almost anywhere, from the polar to the tropical regions – even in the Netherlands, a densely populated area, 60% of which is actually situated below sea level. According to strict geological determinism, one would expect to find there nothing but wetlands and lagoons, sluggish streams and stagnant or brackish waters, the undisputed domain of sea fowl and migratory birds – not a very hospitable place for humans (Wagret 1960/1968, p. vi). The Dutch landscape had to be *created* by its inhabitants and in this chapter I will indicate how its polymorphous *physiognomy* reflects their basic moral attitudes, and how these attitudes can be associated with a number of typical plant forms, serving as basic markers for a moral geography.

The geographical backdrop of the Dutch landscape is the elementary struggle between land, wind and water. Geographically speaking, the western and northern (or Holocene) parts of the Netherlands are slowly subsiding. The lateral moraine that once transected the area from east to west is still clearly visible in the East (near Nijmegen), where it forms a series of steep hills, but they gradually diminish in size towards the West and by the time Amsterdam is reached the sandy peaks have already disappeared 15 m below sea-level. Until recently, this process of subsidence was counteracted by periodical floods, covering the area with deposits. Since the Middle Ages, however, anthropogenic factors have undermined this balance of elementary powers. In the absence of intensive water management, the greater part of what is now called the Netherlands would be flooded and lost to the sea.

About twenty-three centuries ago the post-glacial rise of sea-level halted more or less and the present Dutch coast line emerged. It basically consisted of sand dunes, with extended mud-flats and tidal salt marsh areas (exposed to the sea by tidal inlets) right behind them, and intersected by the branches and estuaries of large rivers: Rhine, Meuse and Scheldt. Pliny (1945/1960) informs us that in Roman times, the northern and western parts of the country were regularly flooded. In some areas the sea was allowed to enter twice a day. In the eyes of Roman visitors, it was difficult to tell whether this bleak, appalling, boundless, treeless landscape of coastal marshes, alternately flooded and exposed by the tides, should be called land or sea. Forest vegetation was nowhere to be found (p. 387/389). Pliny also noticed that the pitiful inhabitants sought their retreat on small artificial hummocks of earth (the famous *terps*), where they warmed their limbs, numbed by the shivering North wind, at peat fires. The policy of building terps lasted until the eleventh century AD. It constituted a "passive" form of sea defence. The terp materialized a moral attitude of *Gelassenheit* so to speak. The inhabitants, whose deities were actually weather gods, simply waited until the overwhelming, demonic forces

of nature retreated of their own accord. Nature simply was beyond human control. Primal nature – φύσις – was still part of daily life and experience.

Around the year AD 800, the landscape of the Netherlands was still hardly influenced by man. In the centuries to come, however, human inhabitants became the decisive factor in the formation and deformation of the land (Van de Ven 1993, p. 33; IDG-Bulletin 1996). Slowly but unrelentingly a major transition occurred. Building terps gradually gave way to a new and more active form of water management. The Dutch started to dig ditches and to construct small dikes. From around AD 800 onwards they began to drain the vast peat-bogs to open them up for cultivation. Large peat areas were reclaimed and as a result, these lowlands became more vulnerable to flooding, by sea – as well as by river water. Man was not only a disturbing, but also a consolidating factor, however, notably by building dikes. The first dikes were erected during the eighth century AD, although these two forms of water management, terp-building and dike-building, coexisted for some time. Eventually, however, the new, more active regime was to have dramatic ecological consequences. Between the late tenth and the early fourteenth century, Tebrake (1985) tells us, the face of the Dutch landscape was drastically transformed. A wide expanse of wilderness, with small scattered patches of settlement and agricultural activity, was changed into a more or less continuous agrarian landscape. The greater part of the Netherlands was brought into the world of human affairs during that period. Huge quantities of previously unused lands were incorporated into the realm of culture. In the former peat-bog wilderness villages were founded and farms were built on parcels of standardized size and shape. The reclamation, by means of dikes and ditches, of formerly remote, impassable, soggy and swampy areas, where the imprint of human presence had been absent or slight, irrevocably altered the physical appearance of the Netherlands. The landscape was thoroughly humanized.

Until this time, human presence had merely produced patches of dry, arable land within a matrix of humid wilderness. But after AD 1000, a geometrization of the landscape took place at an increasing pace and the natural matrix was increasingly fragmented until only a few marginal leftovers remained. Gradually, through diligent and skilful manual labour by generations of anonymous farmers, a diffuse, ambiguous, soggy and brackish landscape, in which clear boundaries between land and water (as well as between fresh and saline water) were absent, was replaced by a discrete, highly compartmentalized landscape. For indeed, whereas vague and gradual transitions are characteristic of natural landscapes, human influences tend to produce abrupt, discrete boundaries (Forman and Godron 1986). Yet, traces and patches of primal nature can still be found in the remoter areas, as marginalized remainders, such as the Wadden Sea in the North. As was already pointed out above, the reclamation activities had averse consequences, even from a purely anthropocentric viewpoint. Human cultivation was the main cause of the loss of large areas in the north and in the southwest to the sea, notably because of accelerated subsidence.

From the perspective of *moral* geography it is important to note that these transitions on the level of water management coincided with a transition on the spiritual

or ideological level, namely the Christianization of the northern and western parts of the Netherlands, that is, of the area beyond what once had been the border of the Roman Empire – the Rhine. After the collapse of the Roman Empire, only a few Christian enclaves survived in the South, notably in the Maastricht region. And when in the early Middle Ages the Franks were converted to Christianity, the Frisians, who inhabited the lower, Holocene parts of the Netherlands held to their pagan convictions. Shortly before AD 700, Anglosaxon missionaries began to arrive, but the conversion of the Frisians would prove a time-consuming process. Saint Boniface was killed by pagans defending their faith in 754. The conversion of the pagan elite during the eighth century AD did not imply that paganism was eradicated completely and immediately. Pagan ideas and attitudes lingered on for quite some time. A certain affinity may be discerned between the conversion to Christianity on the one hand and the transition from terp-building to dike-building on the other. Christianity entailed a more active stance towards nature. Christians regarded themselves as stewards appointed by God, as co-creators, taking active part in the management and restitution of fallen nature. Monasteries played a prominent role in the medieval transformation of soggy wilderness into a place more pleasing to man and God. They played a large part in reclamation projects, just as they did in forest clearance elsewhere in Europe (Wagret 1960/1968, p. 62). Only monastic orders were able to recruit and organize a sufficient number of "hands" in those days (Terra et Aqua 2001).[1] It was in a charter of the Cistercian abbey of Middelburg dated 1219 that the word *polder* first appeared. The great abundance of Dutch villages created during this period with names ending in *-kerke* ("church") or *-kapelle* ("chappel") likewise testifies to prominent monastic and ecclesiastical involvement.

Christianity, as an ideology, rendered the erection of dikes and the reclamation of wetlands morally legitimate, or even obligatory. A demarcation was introduced between the "baptized" and humanized areas on this side of the dikes, and the diffuse and unreliable realms beyond. The dike materialized a form of moral criticism, directed at previous generations of pagans who, faced with natural phenomena, had been overwhelmed by a mixture of fear and awe. They had regarded uncultivated nature as the abode of their gods and had settled for a more passive attitude. Time had come for the demystification of nature.

The diffuse, fluid, ever-changing boundaries between land and water, as they had existed since time immemorial, began to give way to more discrete and

[1] Elsewhere in Europe, major marshland reclamations were executed by the abbeys of Fulda (Germany), Saint Rémy (Reims), Saint Panthaleon (Cologne), Saint Armand (Tournai) and Saint Baafs (Ghent), while the Flemish Cistercian monks of Ter doest and Ter Duinen became famous for their hydraulic engineering in the Dutch province of Zeeland. Among the earliest recorded reclamations was that of the Bishop of Bremen who in 1103 had a huge marsh area east of the River Elbe drained and cultivated. And Finally, in draining activities by experienced Dutch colonists in the North of Germany, the church played a similar, no less decisive role (Wagret 1960/1968, p. 86).

semi-permanent demarcations, while pre-Christian awe gave way to *aquaphobia*, to a long-term policy of building, maintaining and strengthening dikes. The construction of dikes and ditches, however, was not the end but rather the beginning of a chronic combat. Christian reclaimers began to disturb a natural equilibrium between the elements that had developed over a long period of time. Their activities, directed at draining and reclaiming peat-bog marshes resulted in a substantial lowering of the ground level. The cultivation of the peat-bog wilderness initiated a process that would make the Dutch increasingly dependent on their hydraulic devices. Moreover, during the medieval period the sea level had started to rise again and this combination of anthropogenic and natural factors resulted in a late medieval atmosphere of crisis. A series of dramatic floodings, known as the late-medieval transgressions, created a sea (the *Zuyderzee*) in the very heart of the country. The element of water literally gained ground. The sea advanced from the North as well as from the Southwest, while right behind the dune "line of defence" a series of pools, ponds and marshes gradually formed huge lakes (such as the *Haarlemmermeer*) that continued to expand. The increasing use of peat for fuel aggravated the situation even more. Gravity-flow drainage was no longer adequate. A still more active, more drastic form of water management became necessary. But this also called for a more active, more offensive ideology than traditional Christianity had provided.

7.3 Simultaneous Reformations: Shifting Physiognomies

The technical device that would make a more active, offensive and large-scale form of water management possible was the windmill. The first known use of a windmill to displace water was recorded in 1408 (Tebrake 1985; Van de Ven 1993). But this contrivance would evolve during the centuries to come into a very powerful device. The erection of batteries of windmills for the purpose of draining water proved very effective and allowed the Dutch to build polders of a much larger size during the Dutch classical (or "Golden") age – the seventeenth century. In order for a polder to be created, lakes, marshes or coastal areas were encircled by dikes, while impressive rows of windmills were constructed to pump the water out. These tools became the typical artefacts, the icons of a new Dutch landscape. Artificial canals, controlled by sluices, transported the water to the sea. Dams and sluices were built to close off sea entries and to control the movements or rivers. But the impoldered areas subsided even more and this made the Dutch polder-dwellers even more dependent on their new technologies.

These new forms of water management were accompanied and stimulated by changes in other realms of culture. To begin with, practical expertise began to be written down and printed rather than transmitted orally. Practical hydraulic knowledge began to migrate from the unwritten spheres of life to that of published scholarly discourse. During this period, science flourished in the Netherlands. Simon Stevin (1548–1620) and his followers introduced the paradigm of the Dutch mathematician-engineer. Stevin not only stimulated the rise of modern mathematics

in the Netherlands, but also successfully applied this new type of knowledge in the context of building dikes and sluices, designing wind-mills for land reclamation and other hydrological practices (Struik 1958/1979). Although Stevin is primarily known as a "pure" mathematician, he also took an interest in technical (notably hydraulic) problems. His many applications for patents testify to his hydraulic involvement. As early as 1584 he was granted a number of patents by the Dutch authorities on various inventions, most of them having to do with drainage (Struik 1970, p. 5). He worked on mills, sluices and canals and with the help of extensive calculations he was able to improve the windmill, while his son Hendrik (a mathematician in his own right) in 1667 devised a bold plan for the reclamation of the *Zuyderzee*. From 1588 onwards Simon Stevin, together with Johan Cornets (the father of Hugo) de Groot, built and improved a number of windmills, using a scoop wheel. But the windmill would be subject to further significant improvements during the decades to come. In 1634 Symon Hulsebosch introduced the Archimedes screw, a device that replaced the scoop wheel and by means of which water could be lifted up to 4 m. From the late sixteenth century onwards, extensive reclamation projects were realized, such as the draining of the Beemster (1607–1612), the Purmer (1617–1622), the Wormer (1624–1626) and the Schermer (1631–1635). The drained areas were carefully parcelled out in a strictly geometrical pattern. Whereas Renaissance engineers such as Andries Vierlingh (1570/1920), dike master to William the Silent, had opted for "persuasion" rather than force in dealing with aquatic nature, the new engineers of the classical age displayed a much stauncher attitude (Lambert 1971). One of them was Jan Adriaanszoon, a self-made man, born in De Rijp, a notorious waterland area, who nicknamed himself Leeghwater ("Empty-Water" in English) and who claimed involvement in all the important reclamation projects of his era (1641, p. 15), although in critical studies it is said that his contributions may have been overestimated (Struik 1958/1981). In 1641 he published his *Haarlemmermeerboek* which contained detailed plans for the reclamation of Harlem Lake, some 4 m deep, covering an area of 18,000 ha of fertile land, threatening agricultural areas as well as major towns (even Amsterdam itself). Leeghwater described it as "a huge, harmful, pernicious water" and as "a wolf that eats away land" (1641/1764, p. 7). He had wanted to deploy no less than 160 windmills in order to achieve his goal, but the reclamation of this lake would have to wait until the nineteenth century, when steam engines replaced the picturesque, emblematic windmills of the classical era.

In this same landscape, other scientific practices emerged, notably in the area of the life sciences, but again in close connection with water. Jan Swammerdam (1637–1680) and Anthonie van Leeuwenhoek (1632–1723) are the two most famous representatives of this movement. A booklet by the Dutch ecologist Jac. P. Thijsse (whose work will be discussed later on) contains a beautiful story concerning the birth of natural history in the Netherlands. In this booklet, entitled *In Sloot en Plas* ("In Ditch and Pool", 1895/1898) it is narrated how early in the seventeenth century an apothecary from Amsterdam decided to place an aquarium in his shop window, filled with various life forms collected in local wetland areas – a gesture that was to have a stimulating effect on two youngsters, Swammerdam

and Van Leeuwenhoek, who eventually became the two most outstanding Dutch naturalists of the century, focusing attention of scientific communities worldwide to minuscule aquatic life forms. Whereas Van Leeuwenhoek's fame rests on his extensive observations of bacteria, using self-built microscopes, Swammerdam's renown is predominantly connected with his work on insects (his *Bible of Nature* was published posthumously by the famous physiologist Boerhave). The Dutch landscape as it emerged in the seventeenth century formed the "context of discovery" for their work.

A no less dramatic transition occurred on the ideological level, namely the rise of Protestantism. There is an evident affinity between polderlands and Calvinism. In his book on the birth of capitalism and protestant ethics, Max Weber (1965) points out how Calvinistic Protestants excelled and took pride in maintaining themselves in a hostile natural environment. Nature was fundamentally distrusted. Indeed, the Dutch Calvinists put their trust solely in God. The goal of leading a Christian life in threatening surroundings called for a methodical and disciplined way of existence, based on diligence, technology and labour. Traditional Christian constraints on the accumulation of capital were removed and since according to protestant ethics the profits of labour had to be reinvested rather than spent, huge sums became available for financing ambitious and expensive reclamation projects. The classical windmill alone represented an enormous investment in those days. A new type of human being emerged, the protestant self-made man, dwelling in a self-made environment. The natural world, the inhospitable semi-maritime realms of old, were now radically disenchanted and *Kreaturvergötterung* (deification of nature) was vehemently rejected. The late medieval transgressions, such as the notorious St. Elizabeth's Day Flood (November 18, 1421) that created a huge wetland area called the *Biesbosch* as well as the flood of 1570 that created the wetland area of *Saeftinghe* in the province of Zeeland, were reinterpreted as the Great Deluge of the Dutch nation, a calamity that signified the downfall of a morally deficient, medieval world, a "winnowing of souls", as Schama (1987/1991, p. 38) calls it. It ended one world, while a new and cleaner world was reborn, sealed by a new covenant with God. Political geography (the emergence of the Netherlands as an independent nation) and environmental geography (land reclamation by means of polders and windmills) were all part of one complex, one *Gesamtbild* so to speak. The old water-devil, the demon of the floods, commemorated in many coastal names, had been intimidating previous generations long enough and was now finally driven out, together with the Spanish forces and Catholicism. Political borders and geographical demarcations were established simultaneously. The word *reclamation* itself is not a neutral term, but has evident moral connotations. The protestant reclaimer takes back what is his: the land that had been expropriated from the human sphere during the far too reluctant late medieval period. Nature had to be controlled and disciplined with the help of science-based practices (creating polders, canals, sluices and dikes) and, above all, with the help of a new ideology.

So far, a series of landscapes has been described in historical succession: the *terp*-landscape, the *dike*-landscape, the *polder*-landscape. The question now is: what kind of impression or *Totaleindruck* (Von Humboldt) did these landscapes

evoke? What kind of view or *Ansicht* did they offer? And, finally, what were the typical plant forms, the vegetal icons that gave them their identity, their face?

Pliny's contemporaries who visited the landscape of the terps were overwhelmed by its desolateness, its emptiness, its shapelessness. In the lower, slowly subsiding and periodically flooded areas, sphagnum peat and other forms of marshland vegetation must have been omnipresent, but Roman visitors were most of all struck by the formlessness of this damp and dreary world, by the lack of clear distinctions between land and water, and by the *absence* of discrete and recognizable vegetable forms. This diffuse landscape could hardly be called a *land*-scape at all, as a substantial part of it was covered by brackish, semi-stagnant water. Pliny inserted his description of the Netherlands right at the beginning of his book on forest trees. Before turning to genuine forest areas, such as the woodlands of interior Germany, he speaks about a country *without trees* where the sea sweeps in a flood twice a day "over a measureless expanse" (p. 389). It was an environment *deprived* of a typical plant form, a landscape *without* a face.

The introduction of dikes and polders effected a "greening" of the Dutch landscape. The bleakness of its semi-stagnant waterlands gradually gave way to a completely different type of surface, dominated by grass forms. Primal nature or φύσις ("oernatuur" in Dutch) gradually gave way to agricultural nature ("boerennatuur"), where the imprints of human intervention and rectification were omnipresent. The large-scale reclamation projects of the Protestant era produced huge stretches of fertile soil. Notably in areas on the boundaries of dunes and polders, the soil proved favourable for growing bulbs and colourful flowers. Wealthy Calvinists were not allowed to spend their money on a grand scale, but there were no moral objections to decorating one's garden. Thus, besides the windmill, the reclamation era (the Dutch "classical age") also produced the second landscape icon that still gives the Netherlands its face: the bulbous plant, notably the tulip. Tulipmania raged in Holland in the 1630s and reached its peak in 1636–1637. Astonishing amounts were paid for the most colourful varieties. It was the first "hype" in history. And when the government finally intervened to end the trade, many were ruined in what was the first example of a stock-market crash. What is the significance of this episode from the point of view of moral geography?

7.4 Tulipmania, or the Beautiful and the Sublime

As an artificial, highly cultivated plant, the tulip was perfectly suitable for representing an artificial, highly cultivated landscape. The first tulips were imported into Holland in 1571 from Turkey, probably by the well-known horticulturist Carolus Clusius, professor of botany at Leyden university, who planted them in the newly established *Hortus Botanicus* where he started a series of experiments in cultivation (Lambert 1971). The easily modifiable Dutch soil (a balanced mixture of sand, clay and manure) readily allowed for the production of new varieties. Horticulture became a fashionable way of spending one's time and money, notably in the gardens

of the country manors and residences of the Protestant rich. Professional botanists experimented in a systematic manner with colour, size and shape. Catalogues were published and tulip bulbs became the object of financial speculations. In 1623 a single bulb of *Semper Augustus* (red flames on white) was selling for thousands of florins. The tulip was a flower devoid of instrumental value. It was not grown because of its nutritional ingredients, nor put to use in any other manner. Rather, it was grown for its own sake, for aesthetic reasons only. It had, so to speak, *intrinsic value*. It was simply a feast for the eye and symbolized the Sunday of life.

According to Schama (1987/1991), what was so astonishing about the Dutch tulipmania was "the apparent incongruousness between the banality of the flower and the extravagance of its treatment" (p. 350). Yet, although a tulip may seem humble *to us*, in those days it was an exotic, distinguished and alluring novelty. Initially the growing of tulips had been a leisure time occupation of the elite, but around the beginning of the 1630s a popularization of the tulip set in. A new generation of horticulturists entered the scene and started to produce a series of bizarre and expensive specimen. A national, no longer class-linked cliché was invented.

Alexander Dumas, who visited the Netherlands in 1848, published his novel *The Black Tulip* in 1850. It is set against the backdrop of land reclamation and horticulture in a landscape of windmills and canals. Its main character, Cornelius van Baerle, is a fancier, a connoisseur, solely obsessed by tulips. The wealthy Van Baerle, being at a loss what to do with his time and with his money, becomes engaged in a practice both elegant and expensive. He looks after his tulips with the utmost care and patience, in a methodical and systematic manner, indeed: in a *scientific* manner, keeping exact records and creating the most perfect conditions for his bulbs in terms of temperature, sunshine, soil and wind and thus producing new varieties. He invests all his intellectual and financial resources in growing bulbs. One day, the Horticultural Society of Haarlem offers a prize of a hundred thousand guilders for the production of a black tulip. By means of careful and minute manipulations, Van Baerle succeeds in this laborious task. An envious neighbour, likewise a tulip-fancier, tries to ruin him, but while in prison, the jailor's daughter comes to Van Baerle's aid and, by closely following his instructions, she manages to produce the tulip. In those days, tulip growers really went to elaborate lengths to produce new varieties and to protect their precious artefacts from envious neighbours – the novel, notwithstanding some extravagancies, was true to life.

From the point of view of moral geography, the Dutch preoccupation with the tulip, transforming it into a national cliché, is quite understandable. As a highly artificial and modifiable plant form it exemplifies and represents a highly artificial landscape. The windmill (the symbol of intelligence and labour) produced it, the tulip adorned it. Kant's distinction between the "beautiful" and the "sublime" may help us to further clarify its meaning. According to Kant (1788/1975), there are two ways in which nature appeals to us. Nature can either be beautiful ("schön") or sublime ("erhaben"). In its formless, overwhelming and "measureless" immensity, nature (notably maritime or mountainous nature) is not beautiful, but sublime. Flowers, on the other hand, are beautiful, precisely because of their marked and pleasing form. A crystal is beautiful, a mountain sublime. The aesthetic significance of the sublime

was discovered by romantic poets and scholars of the eighteenth century, such as Alexander von Humboldt and Jean-Jacques Rousseau. During his walks along the shores of *Lac de Bienne*, now a wetland restoration reserve, Rousseau found them wilder and more romantic ("plus sauvages et romantiques") than those of Lake Geneva – thus using the word "romantic" for the first time (1782/1965, p. 89).[2] During the classical age, however, the romantic appreciation of the sublime and overwhelming aspect of nature was more or less absent. The diffuse and formless immensities of maritime or semi-maritime nature beyond the dikes were emphatically ignored, but the beauty of delicate *forms* was valued to the extreme. Dutch painters not only immortalized a highly cultivated landscape, but also the flower that gave it a face. The tulip exemplified the beautiful *par excellence*. Calvinism did not entail a rejection of nature as such, but it did reject the diffuse, unstable, unreliable aspect of nature, while valuing nature in its pleasing forms, exemplified by the tulip.

Speaking of the Dutch, Kant noticed that they appreciated order, utility and gracefulness. Hegel, who (unlike Kant) actually visited The Netherlands himself, carefully analyzed the paintings of the Dutch classical era. In the landscapes of the Dutch masters of the (first) Golden Age, he tells us, we see a flat and low terrain, with a foggy horizon and the sea always nearby. Because of the grey and dreary aspect of their *natural* environment, the Dutch painters became obsessed with light and colours. In their still-lives, the tulip played a decisive part. They painted, as Hegel puts it, the Sundays of their life, spent in a landscape completely reshaped by the human hand and mind. The explanation for this art form, according to Hegel, is to be found solely in Dutch history. The Dutch produced the soil on which they dwelled themselves – *Der Holländer hat sich zum größten Teil den Boden, darauf er wohnt und lebt, selber gemacht* (1970/1986, I, p. 222). That is, the Dutch appreciated and immortalized the products of their own making in their still-lives and their landscape paintings. Of all flowers, the tulip aroused the greatest interest. In the floral paintings of Jacob de Gheyn, Ambrosius Bosschaert, Balthasar van der Ast, Christoffel van den Berghe and many others, the tulip always is the dominant flower (Haak 1984/1996).

7.5 Growing Tensions

The policy of land reclamation continued during the eighteenth and early nineteenth centuries. In 1798, under the French occupation, water management in the Netherlands became centralized and professionalized (Bosch 2000). The centralizing spirit of Enlightenment encouraged coordinated management and administration in all spheres

[2] "Les rives du Lac de Bienne sont plus sauvages et plus romantiques que celles du lac de Genève … Le pays est peu fréquenté par les voyageurs; mais il est intéressant pour des contemplatifs solitaires qui aiment à s'enivrer à loisir des charmes de la nature, et à se recueillir dans un silence qui ne trouble aucune bruit que le cri des aigles …" (1782/1965, p. 89)

of public life. As far as water management was concerned, this was well in time, because the "Little Ice Age" of the early modern period, with its slightly lowered sea level, had ended. Still, this episode in Dutch (water) history is generally regarded as one of stagnation. The Dutch leisure class preferred income and ease to enterprise and exertion. In rural and urban areas, poverty and social malaise increased. Due to extensive peat-cuttings, new water areas and interior lakes started to undo what previous generations had achieved. The plans for reclaiming the Haarlemmermeer and the Zuyderzee, put forward by engineers like Leeghwater and Hendrik Stevin, were not realized. It is interesting to note that the self-content and relative passivity of this era, compared with the frantic industriousness of the classical or Golden Age, was expressed by nicknaming it after a plant. In 1841 the Dutch poet E.J. Potgieter published one of his most famous stories, whose main character *Jan Salie* ("John Sage") exemplified the general loss of élan. Tulips no longer expressed the Dutch morale and were replaced by this humble plant form, appreciated for its instrumental (herbal) rather than for its esthetical or intrinsic value.

Yet underneath the quiet façade of the leisure class, the struggle continued. This is emphasized by a literary document written in 1888, but describing an event that took place in the middle of the eighteenth century, namely Theodor Storm's novel *Der Schimmelreiter* ("The Grey Rider"). The novel's setting is the coastal zone of the eastern (i.e. German) part of Friesland. A huge dike divided the human world from a dark, grey, cold, coastal immenseness, the realm of strange apparitions and frightening birds: the Wadden Sea. Storm's novel tells the story of a talented dike master who, as a boy, came across a Dutch translation of Euclid's *Elements* – a clear reference to the significance of mathematics in early modern Dutch water management. He further expanded his autodidactic knowledge by means of clay models and as an adult he tried to apply his rationalistic and methodical approach to improving the art of dike management, facing obstinate resistance from his superstitious, less-enlightened social environment. The novel describes the clash between, on the one hand, the demonic immensities of the Wadden Sea, forever defying human control and, on the other hand, the mathematical tools and calculative efforts human beings may rely on to warrant their safety. The ancient clash between φύσις and τέχνη, between the (fluid) Id and the (solid) rational Self was reframed in terms of a clash between Rationalism and Romanticism. On the ideological level, it describes the clash between a Christian, enlightened world, on the safe side of the dike, and an older demonic world filled with pagan, Wotanesque reminiscences beyond it. In the novel, these two basic attitudes towards nature are exposed to and played out against one another. The author refuses to take sides. He is fascinated by both perspectives, by science-based efforts to domesticate nature as well as by the alluring aspects of untamed φύσις.

As an account of a struggle, it is a retrospective novel, reflecting on reminiscences of the past, because in real life, the rationalistic, calculative approach was quickly making progress. In 1852 the *Haarlemmermeer* was finally drained with the help of steam engines (in the twentieth-century Schiphol Airport would be built there). Tidal inlets were closed by dikes and other projects, such as the draining in 1874 of the Prince Alexander Polder (21 feet below sea-level) followed. But the

Zuyderzee still offered resistance. In 1859 the island of Schokland had to be abandoned. It still can be seen today: a small hill with a lighthouse and a harbour in the middle of a polder landscape. Yet, in 1891, Cornelis Lely presented his plans for turning the Zuyderzee into a lake. Work did not begin until 1919, but in 1932 the dike that changed the sea into the man-made lake, separating it from the Wadden Sea in the north, was closed. Polders were created and mud became soil, while brackish and saline water was gradually replaced by fresh water. Common reed, *phragmites vulgaris*, was sown from helicopters, later to be replaced by grass. What once had been bleak and diffuse, became distinct and discrete. Primal nature ("oernatuur") was converted into agricultural nature ("boerennatuur"). New settlements received the names of old ones that had long ago been surrendered to the sea. This ambitious and successful project again expressed a sense of moral criticism, directed towards the older generations of the *John Sage* era. The decisions to carry out the huge project was made almost unanimously (Van de Ven 1993, p. 237). Lely's plan, presented during the second Golden Age, was in all respects the modern equivalent of the grand impolderisation projects of the classical era. The famous Dutch physicist Lorentz (a Nobel Prize winner) was asked to predict the tidal effects caused by the closure of the Zuyderzee (Bijker 1995). The extensive calculations this involved took him 8 years (Wagret 1960/1968). From the engineer's point of view, the project was an astonishing success. Through the partial reclamation of the Zuyderzee, 166,000 ha of new land was gained.

When Sigmund Freud visited the Netherlands in 1920 he was deeply impressed by what he saw happening there. In a famous passage he compared psychoanalysis to the *Trockenlegung* ("impolderment") of the Zuyderzee (Freud 1932). It inspired him to frame his famous maxim, the metaphor that indicated to aims of psychoanalysis: "Where Id was, the Ego should become ("Wo Es war soll Ich werden"). According to Freud, the basic objective of psychoanalysis is to allow the *Ego* to reclaim ("aneignen") parts of the *Id*. His metaphor emphasized the synchronicity between changes in water management on the one hand and ideological transitions on the other, between *Kulturarbeit* on the hydro-technical and on the psycho-technical level. In *Das Unbehagen in der Kultur* ("Civilization and its discontents") Freud had already indicated that "culture" literally means cultivating the earth, and defending cultivated earth against the forces of nature. Ideally, according to Freud, culture is a landscape in which optimal use is made of resources and space, where rivers are regulated and excess water is drained off by canals (1930, p. 451). Moreover, Freud points out that such a "polderisation" of nature is often supplemented by the careful treatment of beautiful things, such as flowers on windowsills (p. 452). It is quite clear that in this beautiful picture of a cultivated landscape *par excellence*, Freud is actually thinking of the Dutch landscape that he had visited himself.

Indeed, Paul-Laurent Assoun (1987) has emphasized that for Freud the Dutch polder landscape served as an image of culture *as such*. Freud visited the Netherlands three times, in 1908, 1910 and 1920. During the first two visits, he went to see the cities, such as The Hague, Delft and Leyden, in whose museums he studied the works of the Dutch painters of the seventeenth century. In 1920,

however, he visited the Dutch *landscape*. This time he saw the polders and the canals with his own eyes, travelling by rowing boats, carriages and on foot. Due to these experiences, the impolderisation of Dutch nature (not merely pictorial and historical this time, but *real*) became a metaphor for culture as such. Indeed, he came to regard Holland as the "prototype" of culture (Assoun 1987, p. 223).

The great project whose realization Freud actually witnessed was the reclamation of the Zuyderzee. Huge dikes and powerful hydraulic devices were used to reclaim significant amounts of land at the expense of sea. A clear demarcation was introduced between culture and nature, at the latter's expense. Paul-Laurent Assoun stresses the remarkable synchronicity between the history of this astonishing project and that of psychoanalysis itself. In 1891, when Freud (together with Breuer) became involved in the therapeutic efforts that would eventually be published as the *Studien über Hysterie* (1895/1940), Cornelius Lely actually presented his famous plan for the closing of the Zuyderzee. The first polder was finished in 1929, the same year in which *Civilisation and its discontents* was written. And in 1932, when the huge dike that closed off IJssel Lake from the Wadden Sea was finished, Freud's *New Lectures on Psychoanalysis* were published – the third of which contains his famous maxim (cited above), his tribute to the epic of impolderisation as a remarkable feat of ethical significance. Indeed, by comparing the creation of polders with the practice of psychoanalysis, the analogy between psychological and geographical cultivation is emphasized. Both efforts had one and the same objective, they represented the internal (individual) and external (collective) impact of one and the same *Zeitgeist*. The building of dikes and the draining of polders exemplified a process of much broader significance, moreover. They constituted a work of culture. There was a clear affinity between the "gospel" of psychoanalysis and modern water policies (Assoun 1987, p. 232). The modern subject constituted himself *through* impolderment. In a reclaimed environment he established his modern Self.

There is a price to every form of progress, however. According to the German painter Joseph Beuys, who postulated this theory in the late 1970s, the price of reclamation was difficult to notice but rather dramatic: the light in the Netherlands had changed. The light for which Holland had been famous, notably through its landscape painters, had lost its unique radiance, due to reclamation of the Zuyderzee. Moreover, he maintained, the reclamation marked the end of a visual culture, a style of perception dating back to the seventeenth century. The Zuyderzee had functioned as a vast mirror of light. By draining it to create polders, the Dutch had actually blinded themselves.[3]

Freud visited the Netherlands at a time when the *Trockenlegung* of primal coastal nature was *almost* brought to a completion, but he explicitly pointed out that reclamation efforts (the process of demarcation between Ego and the Id) could never be regarded as really completed. Rather, it would involve ongoing psychic efforts, and this

[3] http://www.hollandslicht.nl/www/html/eng/film/synop_01.html.

applied to moral geography as well. Diffuse remainders, such as the Wadden Sea, a bleak and more or less "primal" zone beyond the new dike, was allowed to remain what it had been since time immemorial – a tidal area more or less untouched by *Kulturarbeit*. This does not imply of course that the Wadden Sea is "natural" or "primal" in an absolute sense. Landscapes and seascapes cannot be categorized as *either* artificial *or* wild. They vary along a continuum (Cole-King 1994). Even the Wadden Sea and other leftovers are, in their present form, the results of human choices, policies and modifications. And yet, there is a striking and undeniable contrast between the grey, φύσις-like Wadden Sea beyond the dike and the green, domesticated polders, separated from the water by a straight line, a demarcation of mathematical precision.

In the era of Freud, this process of ongoing reclamation *nearly* reached its completion. It is remarkable that precisely at that moment, a competing attitude towards coastal nature began to emerge, a cultural undercurrent, so to speak, adhering to a rather different view. Already in the nineteenth century, but even more so during the twentieth century, the reclamation campaign had to compete with a movement that, psychoanalytically speaking, could be regarded as a "return of the repressed". Around 1880, a small but influential group of poets, painters and naturalists began to discover and appreciate the charms and qualities of what was still left of the ancient bogs, swamps, dunes and marches. Anton Mauve's sublime painting *The Marsh* (1885) may stand as a telling example of this new awareness, this love of pristine nature – *biophilia*. His most famous pupil, Vincent van Gogh, further disseminated the ideal. The movement not only produced an impressive series of poems, paintings and educational booklets on nature, but scored its first major political success when Jac. P. Thijsse, a primary school teacher and ecologist *avant la lettre*, managed to arrest the plans, put forward by the city council of Amsterdam, to turn the nearby Naardermeer ("Lake Naarden") into a refuse dump.

The *Naardermeer* was a natural wetland area of glacial origins that had been part of the Vecht basin, one of the branches of the Rhine River, from which it was separated by a dam in the fourteenth century (Van Zinderen Bakker 1942, p. 42). Between 1623 and 1629, a first serious attempt had been made to turn the area into a polder, but on this occasion the Dutch engineers had lost their pernicious battle. Pieter Cornelis Hooft, one of the most important poets of the Dutch Golden Age, but also bailiff at the nearby coastal town of Muiden, was responsible for the area. He not only had to deal with various illegal attempts at peat digging, but he also documented the abortive reclamation efforts (Thijsse 1912, p. 11; Van Zinderen Bakker 1942, p. 53). Finally, the authorities decided to give the area back to nature, so to speak, albeit for strategic reasons: as a watery obstacle assisting them in warding off the advancing Spanish forces.[4] In 1906, this wetland area became the first official Dutch *Nature Monument*, a model for the future. A major shift had occurred on the Dutch attitude to coastal and wetland nature.

[4] A second major attempt was made in the period 1883–1886, this time relying on the use of steam power. But once again, the engineers failed to overcome the problem of seepage water emerging from the primeval boggy soil.

7.6 Poetry as the Art of Remembrance

In 1932 (as was indicated above) the IJsselmeerdam was closed and the great project of impoldering the Zuydersee was brought to an end. A whole coastal landscape had been domesticated, so it seemed. A few years later, however, in 1936, the Dutch poet Hendrik Marsman (1899–1940) wrote the following poem (here translated into English):

Reminiscence of Holland
Thinking of Holland
I see broad rivers
Moving slowly through
Endless lowlands.
Rows of unthinkably
Thin poplars
Standing as high plumes
On the horizon;
And sunken within
Wonderful space
Farm houses,
Scattered throughout the land.
Clusters of trees, villages,
Cropped towers,
Churches and elms
In one great association.
The air hangs low
And the sun is slowly
Muffled in a grey
Mottled fog.
And in all the provinces
The voice of the water
With its eternal calamities
Is feared and heard.

On January 27, 2000, during the "Night of Dutch Poetry", this poem was elected as the best Dutch poem of the twentieth century. What does it tell us about the Dutch landscape and its inhabitants, from the perspective of a moral geography?

In this poem a particular experience of nature is articulated, namely nature as φύσις – all-encompassing, immense, powerful, diffused. Sunken within this immense natural landscape we find small human enclaves, unassuming human footprints so to speak, such as farm houses and church towers. In other words, human beings are present, as inhabitants of nature, but they inhabit it in a peaceful, silent and retained manner, living their quiet lives as they had done for centuries. Nature invokes in them a sense of awe (a mixture of fear and respect). They are respectful and fearful of nature, and dependent on nature – they are part of nature. Natural time flows slowly, and natural space is apparently endless. Within this landscape, there are no clear boundaries or demarcations. The elements (air, water, land, light) are blended. Daylight is dim, the atmosphere foggy, the horizon hardly noticable, the demarcation between land and water unclear.

This ideal is in contrast with those of the engineers of the classical era (such as Leeghwater) and their descendants who, in the twentieth century, had apparently managed to pacify the element of water and to reclaim the Zuyderzee. Clear demarcations had been introduced by them into the diffuse natural landscapes, the broad rivers had been contained by dikes, and behind these man-made structures the time-old menacing voice of water had become more or less inaudible. Marsman's poem is therefore an exercise in remembrance. In reality, rivers had been straitjacketed and wetlands and marshes transformed into humanized space. Fresh and saline waters had been ruthlessly segregated and the horizon had become a distinct straight line. For indeed, the engineer's landscape is a compartmentalized landscape, anthropogenic and man-made. Human beings are emphatically present. They dominate it. They are in control. Space is differentiated into separate compartments, each with a more or less clear function. Time moves faster in such a landscape, as we ourselves will travel through it much more easily and at a much higher speed. Long before Marsman wrote his panegyric on the Dutch riverscape, Dutch engineers had already started to transform this area in a rather drastic manner. And by the time Marsman conceived his poem, this process was more or less completed. In other words, his poem conveys nostalgic desire. It longs for a return of the repressed. Up to a certain extent, and notably under certain metereological conditions, the natural, as elsewhere φύσις-like aspect of the Dutch landscape is still discernable, but on closer inspection a new and drastically anthropogenic landscape has more or less taken its place. The poet finds himself on the boundary, so to speak, of both landscapes, experiencing the basic tension that exists between them. His poem gives voice to a more or less romantic attitude towards nature, a yearning for nature as elsewhere φύσις, but under rather modern (and therefore unnatural) conditions. Romanticism presupposes the very technologies it deplores so much.

In the seventeenth century, Dutch river poetry had played a rather different role. Poets of the Golden Age, such as Pieter Cornelis Hooft (1581–1647) had *reshaped* the Dutch language, similar to the way in which the early modern engineers had reshaped the Dutch landscape. Hooft's poetry, however, was inspired by Renaissance (Italian) and classical (Roman) sources rather than by personal experiences and observations of Dutch nature. When it came to describing the Dutch landscape, his most important source of inspiration was not the landscape itself, but Tacitus, author of a number of influential documents concerning the Netherlands and its early inhabitants. Hooft regarded himself as a second Tacitus, so to speak, and he saw the seventeenth century as the beginning of a new era. Indeed, he aspired to be its chronicler. Some of his works are clearly modeled after Tacitus' examples. In his poetry, nature provides sceneries for Arcadian fantasies, but nature as a *real landscape* is hardly present in his work.

The same predilection for literary sources over first-hand observation of nature characterizes the work of the greatest Dutch poet of the ("first") Golden Age, Joost van den Vondel (1587–1679) – although he was fascinated more by biblical and theological than by classical themes. It is remarkable that although the first Golden Age produced a number of very important scholars of nature (Swammerdam, Van Leeuwenhoek and others) as well as important landscape painters (such as Salomon

van Ruysdael 1600–1670), but also Rembrandt van Rijn, who created a famous set of etchings of the river Amstel), the period was less prolific in terms of its landscape *poetry*. Vondel's long poem on the Rhine River (1986, pp. 777–778), for example, strikes modern readers as remarkably lifeless, bookish and boring. The poem contains several references to Tacitus, as well as an enumeration of the Rhine's principal tributaries, and various praises of its historical and economic significance, but nothing in it suggests that the Rhine as a natural entity, as a riverscape, ever made much of an impression on Vondel.

This is clearly in contrast with the poetry of the "second" Golden Age (1880–1920), an episode which, like the first one, produced a relatively large number of outstanding artists and scientists in the Netherlands. From the 1880s onwards, after an extended period of cultural malaise, the Netherlands suddenly experienced a period of reawakening. In a relatively short time, the country not only counted five Nobel Prize winning scientists (Van't Hoff 1901; Lorentz and Zeeman 1902; Van der Waals 1910; Kamerlingh Onnes 1913) but also a series of outstanding painters and poets (of which Vincent van Gogh is no doubt the most famous example). Notably the work of the *Tachtigers*, a generation of poets who became famous during the 1880s, is important in this respect. The indisputable highlight of the epoch was the poem *Mei* ("May") written by Herman Gorter (1864–1927). This brilliant and compelling poem published in 1889 (and containing no less than 5,000 lines), was a fascinating panegyric on the Dutch coastal landscape, but difficult to translate. Let me insert just a few lines, more or less arbitrarily chosen:

> From the pond a rivulet fled away,
> Water of jewel-like light. With heavy leaves
> Young plants were standing on the earthy banks
> Listening to the soft flourish of the water …
> Her foot in the white soft sand, her ankles dragged
> The water through the stream, erasing her trail.
> The clear surface seemed to enjoy her presence,
> Its spirals continued to play in the shade (Gorter 1889/1948, p. 27)

In his poem, the author describes how everything in nature is touched and awakened by an enchanting young girl, the personification of the month of May. It conveys the impression, moreover, that it is possible for human beings to be present in nature in an unobtrusive manner, joyfully sharing in the seasonal euphoria. Gorter's poetry is full of close observations and detailed descriptions of nature in general and of plant forms in particular. He was an important source of inspiration for later generations of poets, such as Marsman.

Another important reader of Gorter's poem was Jac. P. Thijsse, who clearly shared the enthusiasm and fascination with nature so characteristic of the work of the poets and painters of the "second" Golden Age. There are remarkable similarities in style between Gorter's poetry and Thijsse's prose. In fact, Thijsse's booklets were originally published by W. Versluys (Amsterdam), who also published Herman Gorter's *Mei* as well as the poetry of most of the poets of the 1880s. I will come back to his work in Section 7.7.

The second Golden Age was also remarkable in the domain of the life sciences. In the 1890s, the attention of the experimental botanist Hugo de Vries was drawn by

the Evening Primrose (Oenothera Lamarckiana), a plant that grew in masses in meadows in the neighbourhood of Amsterdam. He observed how varieties of this species disintegrated spontaneously into a number of new forms and concluded that evolution proceeds by distinct changes which he called "mutations". Because of its experimental employability, he elected the Evening Primrose as his model species and soon it became an experimental flower *par excellence*. It stimulated a new scientific practice and made the introduction of "mutation" as a key concept in genetics possible. As a wild but charming flower, adorning the polder landscape in the immediate vicinity of extending cities, it was the tulip, so to speak, of the second Golden Age. It is a natural flower, representing the new appreciation of naturalness, but still within a broader context of policies of impolderisation, whose technologies had become extremely powerful. Its remarkable plasticity was natural rather than artificial. Moreover, the presence of a university professor, an experimental botanist, in a picturesque polder landscape indicates that scientists has left their laboratories, more or less as impressionistic and expressionistic artists had left their urban studios to wander about in rural picturesque sceneries in order to produce their paintings on site – like Van Gogh. But it also indicates the extent to which urban extension began to enter the polder areas. Interestingly enough, the rediscovery of nature more or less coincided with industrialization and urbanization in the Netherlands. The increased sensibility towards the intense beauty of typical, semi-natural Dutch landscapes took place at a time when industrial activity was growing and major urban centres, notably in coastal regions, such as Amsterdam and Rotterdam, were quickly extending, at the expense of coastal nature. How were the Dutch to harmonise this new appreciation of nature with these competing interests and claims?

7.7 Romanticism and the Emergence of a More "Natural" Natural Science

In order to understand this question, a short historical detour must be inserted at this point. Looking back upon the geographical history of the Netherlands, two competing views on nature have emerged: on the one hand the science-based view of the engineer (as the dominant perspective), on the other hand the artistic view of the poet (as its "recessive" counterpart so to speak) – ego and alter ego. However, the engineer-poet dichotomy or, more broadly speaking, the "Two Cultures"-paradigm, fails to appreciate the ways in which poetry and Romanticism actually inspired scientific research efforts and vice versa. Notably, it would be a mistake to identify the romantic view with *art*, and the engineer's view with *science*. Romanticism as a cultural movement, as a style of thought, gave rise to important forms of scientific activity, notably in the life sciences. Albrecht von Haller (1708–1777), for example, who, as was already mentioned in Chapter 5, meticulously described the plant forms of the Alpine landscape (his famous flora listed no less than 2,490 Swiss plants), was a romantic scholar – and a romantic poet as well.

Another outstanding representative of Romanticism, indulging in similar scientific activities, was Jean-Jacques Rousseau (1712–1778) who, as we have seen, discovered the romantic landscape during his promenades on Ile Saint-Pierre in Lac du Bienne, where he developed a passion for collecting and identifying flowers ("herboriser" in French).This was his way of re-establishing a form of contact, a *rapport* with nature. He set out to write a *Flora Petrinsularis*, a systematic description of all the plant forms he encountered on the islet. Whereas he regarded – or rather: discarded – research with animals as a violent research practice, herborisation was a peaceful and innocent endeavour, a gentle way of getting in touch once again with nature, a form of research devoted to studying life forms in their natural environment. At the same time it was a form of leisure, of *far niente*. And Rousseau was, of course, an educator. Herborisation was a cultural remedy, a pastime he emphatically recommended to his readers. Johann Wolfgang von Goethe (1749–1832) was among those who followed his example. He too became devoted to botany and became addicted, so to speak, to studying, collecting and carefully drawing the wild plant forms he encountered during his wanderings with romantic zeal.[5] He regarded it as an activity on the borderline between art and science.

Another interesting protagonist of the romantic movement in botany was Franz Bratranek (1815–1884), a Goethe scholar, but also a fellow-friar of Gregor Mendel at the famous Augustinian monastery at Brno.[6] Both friars were devoted to botany, but Bratranek's style of research was apparently quite different from that of his colleague Mendel. Like Von Humboldt, Bratranek claims that nature presents itself to us primarily as a landscape, and that every landscape expresses itself in typical plant forms that determine its character, its identity so to speak. At the same time, a landscape evokes in us a particular mood. And this explains the experience of rapport between subjectivity ("Stimmung", mood) and objectivity (the landscape, notably the typical plant forms we encounter in it) that so often befalls us when wandering through charming natural surroundings.[7] It explains why certain plant forms will strike us as particularly beautiful and valuable. And this concordance, this empathy between subject and object, between man and nature, between wanderer and plant form, arouses in us a sense of profound happiness.

Initially, the great romantic movement that spread across Europe during the eighteenth and nineteenth century more or less by-passed the Netherlands – until the 1880s. All of a sudden, a new generation of poets and painters stepped forward

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[5] Wer wollte nicht dem in höchsten Sinne verehrten Johann Jakob Rousseau auf seinen einsamen Wanderungen folgen, wo er, mit dem Menschengeschlecht verfeindet, seine Aufmerksamkeit der Pflanzen- und Blumenwelt zuwendet und in echter, gradsinniger Geisteskraft sich mit den stillreizenden Naturkindern vertraut macht (1910, p. 59).

[6] Bratranek's work will be discussed more fully in Chapter 9.

[7] "Die Stimmung des Menschen [wird] durch den Vegetationscharakter der Landschaft geleitet, und andererseits spiegelt die Innigkeit selbst ihre Gestaltung in der Wahl von Pflanzen und in solcher Umgestaltung der Landschaft ab" (p. 23).

who endorsed romantic techniques and ideas and who emphatically discovered and affirmed the beauty of the natural Dutch landscape, of coastal areas, dunes and wetlands, of ponds, river beds and marshes. And in the wake of this movement, a number of influential authors tried to combine an artistic with a scientific view on nature. By describing the Dutch landscape in a way that was both artistically convincing and scientifically informed, they tried to educate the public, notably the working-classes and other inhabitants of the emerging industrial cities, allowing and inciting them to rediscover nature.

The most important representative of this movement was already mentioned above: Jac. P. Thijsse, a prolific author of booklets on Dutch landscapes, or rather: mnemoscapes, and the life forms they contained, with a special focus on rivers, wetlands and coastal regions. Famous titles are, among others: *In Sloot en Plas* ("In Ditch and Pool", 1895), *Blonde Duinen* ("Blond Dunes", 1910), *Het Naardermeer* ("Naarden Lake", 1912), *Langs de Zuiderzee* ("Along the Zuyderzee", 1914), *De Vecht* ("The Vecht River", 1915), *De IJssel* ("The IJssel River", 1916), *Texel* ("The Isle of Texel", 1927) and *Onze Groote Rivieren* ("Our Great Rivers", 1938). These booklets were not only famous because of the charming and poetic vein in which they were written, but also because of the beautiful pictures of plants, animals and sites they contained. Thijsse was an educator who believed that knowledge of animal and plant forms would further our respect for nature. Although the larger part of the Netherlands had been compartmentalized and made functional by generations of engineers, there were still valuable enclaves and remainders of the natural and the picturesque waiting to be discovered and preserved.

In the opening lines of *Our Great Rivers* ("Onze Groote Rivieren"), one of his most important works, Thijsse explains that the basic mood from which his book was written was a sense of "welbehagen" – feeling at home in one's own landscape. Thijsse clearly acknowledges, moreover, that the Dutch landscape results from an ongoing interaction between human activity and natural processes. The Dutch landscape is natural (in the sense that it is a manifestation of the creative forces of nature), but at the same time it is thoroughly man-made. For example, several pages are devoted to praising the exceptionally rich and beautiful vegetation one is likely to encounter along man-made dikes. Moreover, there is, to use the words of Bratranek, a happy concordance between the mood the Dutch landscape tends to evoke in us, and the typical plant forms one is likely to encounter in it. Thijsse sees the Dutch landscape predominantly as a *river* landscape – formed and dominated by rivers, and certain typical plant forms feel quite at home in such a riverscape: they give it a "face". The typical Dutch riverscape is exemplified by a typical plant form, the *Gevlekte Dovenetel* (Lamium maculatum), in which all the conditions of this ecosystem come together, become visible so to speak. Thijsse does not want to remove the dikes from the Dutch landscape. On the contrary, even the countless chimneys of brickworks one encounters along Dutch river-sites are a beautiful and inevitable part of the river as a *comprehensive* landscape, the outcome of a joint activity, so to speak, a co-evolution of human and natural forces. Indeed, a remarkably natural site, consisting of endless rows of dunes and marshes, can be found in the immediate vicinity of Rotterdam harbour, the largest harbour complex worldwide.

We have to care for our landscape in a prudent manner and this implies that we must carefully mediate the (sometimes conflicting) claims, desires and tendencies of man and nature.

According to Thijsse, the Dutch riverscape encourages two different forms of scientific research that often tend to be seen as antagonistic, namely the knowledge of the engineer and that of the "friend of nature" ("natuurvriend"). The engineer is someone who uses his mathematical and physical expertise and tools to make the dynamic and ever-changing Dutch landscape not only inhabitable but even more or less stable and safe. Without the research and interventions of the engineer, cities like Amsterdam and Rotterdam would inevitably disappear. In other words, the Dutch landscape literally *calls for* this kind of scientific activity. At the same time, however, a completely different form of knowledge is stimulated and evoked by the Dutch landscape as well, a form of research that resembles "romantic botany" already described above. The landscape literally invites us to study the life forms that inhabit it very closely and intimately, from a basic attitude of empathy. Both forms of knowledge are important, when it comes to managing and developing riverscapes in a responsible manner. Thijsse clearly believes that somehow the concerns of the engineer and those of the friends of nature, however contradictory they may seem at first glance, may eventually be brought together in a comprehensive view on landscape management. Both the engineer (Stevin c.s.) and the naturalist (Leeuwenhoek c.s.) are, after all, the product of the first Golden Age. They constitute complementary forms of expertise.

Thijsse's work contains a simple moral message for the "ordinary reader", of all walks of life, namely: *visit nature*. He urges his readers to expose themselves to nature as a kind of cultural remedy, a form of public education. "Ins Freie!", as Bratranek had phrased it: expose yourself to landscapes and get to learn the plant forms that inhabit them and represent them. This is important, not only for our personal development, but also for our rapport with nature. It was this powerful, research-based message, in combination with political skills, that eventually allowed Thijsse to become a decisive factor in the preservation of the Naardermeer ("Lake Naarden") as the first Dutch Natural Monument. The creation of the Naardermeer as a natural monument became a turning point in the history of Dutch water management. It was no coincidence of course that the wetland reserve was situated in the middle of a beautiful area called *het Gooi*, not very far from Amsterdam, where a significant number of the poets and artists involved in the second Golden Age had taken up their residences. The plea for the conservation and rehabilitation of wetland nature, at the expense of both urban expansion and rural cultivation, was an expression of moral criticism directed towards the ethos of mastery, the engineering mentality of previous generations. It was the beginning of a very successful pursuit. The *Vereniging tot Behoud van Natuurmonumenten in Nederland* ["Dutch Association for Nature Conservation"], established by Thijsse and others in 1905, now owns over 80,000 ha of natural areas. In short, the century-old tendency towards pacifying nature was finally counter-pointed by a movement in the opposite direction. It was the beginning of a significant change in the Dutch attitude towards the element of water. The "softer" approach of the "friends of

nature" gained in strength, while the "tougher" approach of the traditional engineer seemed to have reached its limits.

According to Thijsse, the *Naardermeer* was not simply a remainder from the past, to be preserved for nostalgic reasons, as an open-air museum for natural history. Rather, it would open-up possibilities for scientific research and serious biological inquiry into wetland ecology. Relatively undisturbed by anthropogenic influences, under conditions that could be regarded as being "as natural as possible", scientists would be able to study how a dynamic natural area would gradually change from open water into boggy wilderness. In other words, the *Naardermeer* as a natural monument was an object of scientific inquiry that would yield important information on the history – and future – of the Dutch landscape. In 1953, however, a unexpected disaster occurred that temporarily halted the "friend of nature" perspective and greatly reinforced the traditional engineering view.

7.8 Challenged Ideals

In the night of February 1, 1953, a major flood claimed 1,836 human victims (besides over 200,000 farm animals) and inundated 165,000 ha of arable land in the Dutch river deltas.[8] The "voice of the water", with its "eternal calamities", was heard again. A Delta Commission was established and its members quickly decided to close all sea entries. The Delta Works were developed to address the fact that the southwest of the country, where Scheldt, Meuse and Rhine enter the North Sea, was still dangerously exposed to uncontrollable, maritime nature. The Delta Act was passed in 1958, with almost unanimous support. The Delta Works were to reduce the chances of a future flood disaster to virtually zero. Other, more or less similar projects were executed as well. In 1969, for example, a unique ecosystem called *Lauwers Zee* was closed by a concrete dike, some 13 km long.

Gradually, however, the dramatic ecological consequences of this uncompromising hydrotechnical agenda became increasingly clear. The public image of the engineer began to change. In the years following 1953 he had been a hero of safety, but in the 1970s he became something of an ecological threat. The Delta Plan implied that unique and complicated ecosystems would be destroyed as tidal activity and the regular inflow of saline water (as well as marine organisms) would come to a halt (Nienhuis and Smaal 1994). One by one, they were to be transformed into stagnant lakes, most of them filling up with polluted river water. Initially, the ecological aspects did not receive much attention, as water policies were primarily directed towards the final realization of the old aquaphobic dream of establishing a

[8] Nowadays, the claim that this flooding should be regarded as a "natural disaster" is highly disputed. On closer inspection, it was a disaster that resulted from the failure of authorities to take proper action, before and during the event. We live in a world where disasters are at least as much the result of policy decisions as they are "natural".

permanent demarcation between land and water, fresh and saline water, tidal and non-tidal systems. Hydrotechnical policies had but one unequivocal objective, namely safety, and initially they met with unanimous support. During the 1960s and early 1970s, however, the environmentalist movement made the public more aware of the need to protect these unique tidal habitats. Ecology became an issue and the ecosystems involved began to be closely monitored.

This called for a "new" Jac. P. Thijsse and he was found in the person the Dutch ecologist Victor Westhoff who, in 1970, published a highly influential, three-volume encyclopaedia of Dutch landscapes entitled *Wilde Planten: Flora en Vegetatie in onze Natuurgebieden* ("Wild Plants: Flora and Vegetation in our Natural Areas"). These impressive volumes were based on scientific research and expertise, but written in an accessible style and illustrated with beautiful pictures. Not surprisingly, they were published by the *Nederlandse Vereniging tot Behoud van Natuurmonumenten*, the Dutch Society for the Preservation of Natural Monuments that had been established by Thijsse in 1905. The authors explicitly wanted to work along the lines Thijsse had set out (Westhoff et al. 1971, p. 6). Knowledge of plant forms was necessary to improve our understanding of natural landscapes. This new way of looking at nature, as a follow-up of the romantic tradition, quickly gained ground and incited a more critical stance towards the Delta Project.

Because of this, a considerable number of corrections drastically changed the original Delta Plan. Notably, in 1974, the Dutch government decided to alter its plans for the most ambitious of all projects, the Easter Scheldt Dam. The original design was replaced by a complex and hydrotechnologically unique compromise: a storm surge barrier that allowed tidal movements to enter the estuary freely, but guaranteed safety whenever a storm flood threatened the area. This massive concrete construction became a new landscape icon, a materialization of moral criticism directed towards the values and decisions of previous generations. It became a model project, as similar plans, costly but eco-friendly, were developed for other parts of the Delta area. One by one the stagnant lakes are now again transformed into tidal, dynamic systems. The *Veerse Meer* for example was closed by two dams in 1960 and 1961. Water quality rapidly deteriorated, notably because of eutrophication, and mass extinction of its fauna was the inevitable consequence. Recently, however, a twenty million Euro plan has been accepted to revitalize the system by creating a connection with the tidal Easter Scheldt.

Towards the end of the millennium, a reliable frontier of dikes, dunes and dams extended from the Swin inlet in the southwest of the Netherlands to the Dollard in the northeast, fencing off immense areas of reclaimed land. Natural defences (beaches and dunes) existed side by side with high hydrotech. Rivers travelled down constricted beds and man-made channels. Only in marginal areas, patches of wetland and coastal leftovers could still be seen. Notably in the Wadden Sea, small islands and sandbanks were still allowed to disappear and resurge, and coastlines were still allowed to migrate. Even "natural" landscape fragments such as dunes and wetlands, however, depended on human interventions and modifications for their survival. A history of two millennia, starting with terp building in the time of Wotan and Pliny and finally resulting in the Easter Scheldt Dam in the 1970s,

seemed to have come to an end. The Dutch landscape seemed to be "finished" more or less. In recent years, however, an unexpected reversal has set in. There is a strong desire, even among policymakers, to allow a more natural landscape to re-emerge once again. What is happening?

7.9 Down with the Dikes

Indeed, in recent decades, a dramatic reversal has set in. Freud's famous maxim, so it seems, has been rephrased: "Wo Ich war, soll Es werden". Instead of planning still higher and safer dams and dikes, a new generation of engineers is aware of the need for collaboration with nature, to preserve wetlands, to make room for water and even to breach some of the dikes (Sellers 2001). Instead of regarding water as an adversary, the new engineers agree that wetland areas have to be restored, not for ecological reasons only, but also because they can absorb huge quantities of excess water in times of crisis.

From the Middle Ages until the middle of the twentieth century, the Dutch have worked hard to replace the diffuse, natural wetlands that still existed during the early medieval period by a highly compartmentalized geography. Now, all of a sudden, the Wadden Sea and other wetland and coastal areas have become issues of public interest, not because new reclamation projects are being planned, but rather because a strong plea is made in favour of their conservation and rehabilitation. Dramatic events such as the death of 14,000 seals in coastal waters in 1988 added to environmental awareness. The beautiful, picturesque, agricultural landscape that had gradually been created in the course of history, with its farms, green meadows, canals and dikes, its colourful flowers and grass form vegetations, is challenged by a significant change on the level of aesthetic appreciation: a rehabilitation of the diffuse, desolate nature as depicted by Mauve and others. Wotan instead of Christ? Not only have the ecological drawbacks of hydrotechnical policies become apparent, even nature itself seemed to protest when in the mid-1990s the huge rivers that transect the Netherlands suddenly started to flood their banks again, as if they refused to accept their straightjackets any longer. A policy was initiated to create natural buffer zones alongside the river beds, as they had existed before the onset of intensive human interventions, that could temporarily absorb the surplus of water during exceptionally wet seasons.

It all started with an accident. When the last of the polders that had been created in the former Zuydersee was drained, a marshy landscape began to evolve in the lowest area, earmarked for industry. Before the planned industrial park could be built, planners were faced with something unexpected: nature. The area involved, called the *Oostvaardersplassen*, soon developed into a perfect habitat for plant forms and migratory birds associated with a more natural landscape. But instead of correcting their negligence, the planners made a remarkable decision. The *Oostvaardersplassen* were to be given back to nature. The area was to be recognized officially as a natural reserve, as a model even for future restoration projects (Vera 2000; Wigbels 2000).

Indeed, this new attitude would give rise to a series of plans for introducing and developing "new nature". This ideological reversal has become a prominent factor in Dutch water policies of today. Rivers are allowed more space, polders are inundated and at certain places even the sea is allowed in again. In 1997, a groove (*kerf* in Dutch) was made in a dune area near the town of Schoorl, called the *Parnassia-Valley*, in order to allow a more natural, more dynamic coastal landscape to develop, where wind and water are allowed to reign. Every now and then, during high tide, the sea may enter the tidal inlet, so that drifting, calcareous sands may change the properties of the soil, allowing unique forms of vegetation, typical for dynamic dune systems, to reappear and flourish. The ecological value of these border-line ecosystems is now emphatically recognized and it is perhaps a telling coincidence that the valley where the *Kerf* is situated is named after the Parnassia flower (Parnassia Palustis, Grass of Parnassus), "one of our most beautiful wild flowers", according to the famous Dutch ecologist Victor Westhoff mentioned above (1970/1972, p. 301). It is a pioneer species found in wet dune valleys and flourishing in this type of soil. By creating a dynamic dune landscape, the conditions are realized that will allow this and other precious flowers to return. The Parnassia therefore functions as a symbol or icon of a particular type of landscape, more natural and diffuse, more fluid and dynamical than the classical, compartmentalized and consolidated coast line. The Parnassia has emerged as the anti-tulip, so to speak. Aquaphobia gave way to "biophilia", not as a genetically based human propensity to affiliate with nature (Kellert and Wilson 1993; Kahn 1999), but rather as a recent chapter in the history of the way we interact with our coastal and wetland environment.

And this is not a temporary craze. Rather, these developments seem to convey a sense of moral criticism directed towards previous generations, much less susceptible to the values of dynamic coastal and wetland nature. The dream of former generations, namely a completely sealed off and standardized landscape, is rejected by the water managers of today. A new chapter in the history of water management is being written in the Netherlands. As I said: the dictum *Where Id* (bogs, fens and other swampy places) *was, ego* (arable land) *should become* is reversed as aquaphobia gives way to biophilia. Patches of arable land are transformed into wetlands, mud flats and salt marshes. The focus is on the rehabilitation of coastal and wetland nature. Still, the precondition for appreciating new nature is a sense of safety and therefore, as Thijsse already noted, the irony is that the engineers of the past have made the present predilection for a more natural landscape possible. New nature is a new synthesis of φύσις and τέχνη. The Dutch landscape of the future will be a hybrid landscape, at combination of diffuse, dynamic nature ("oernatuur") on the one hand and urban expansion at the other, at the expense of agricultural nature ("boerennatuur"). There will, however, remain loci of conflict. The Naardermeer, for example, is under pressure once again because of plans to alleviate Amsterdam's pressing traffic problems by building a new highway right beside it.

The objective to create "new nature" is, of course, a paradoxical one. Pliny's *Totaleindruck* (Humboldt) of the Netherlands as a fluid, bleak and anonymous landscape without a face, and with no particular plant form to represent it, can never return unchanged. After centuries of intensive cultivation, the original vegetation of

the Netherlands has been almost completely destroyed (Arts 1990). The characteristic *continuum* between fens and bogs, for example, has now almost entirely vanished (Lamers 2001, p. 75). Due to processes like desiccation, habitat fragmentation, pollution, eutrophication, alkanisation and acidification, the biochemical and ecological conditions indispensable for the development of natural wetland ecosystems have been irreversibly affected. This excludes the possibility of restoring the natural situation in a truly "pristine" state. Rather, "semi-natural states" are regarded as a reference situation for wetland restoration (Brouwer 2001). Furthermore, restoration is only possible within a strict hydrological and biochemical framework. New nature, in other words, will be the outcome of drastic and scientifically informed human interventions. Careful experiments are conducted to monitor restoration efforts as closely as possible. By modifying the biochemical and hydrological conditions, it is hoped that the desired semi-natural ecosystems will recover. Certain plant species (like the Parnassia) play a significant role in this process. They function as target species or bio-indicators. Their incidence is regarded as a standard by means of which the effectiveness of restoration policies can be measured. The production of new nature is structured more or less like an experimental design. Biochemical and hydrological conditions are established and varied by scientists (or scientifically informed water managers) with the purpose of causing certain ecological effects, or testing the effectiveness of certain strategies. The conditions (the *x*-axis so to speak) are defined in chemical or physical terms, that is, in terms of concentrations of NO_3^-, SO_4^{2-}, PO_4^{3-}, etc. By modifying the chemical composition of the water, and by maintaining a strict water level regime, certain target species or bio-indicators (representing the *y*-axis so to speak) are "invited", so to speak, to take possession of their newly reconstructed, semi-natural habitats. New nature is, in other words, a dialogue between the scientist (who modifies the conditions in a systematic and evidence-based manner) and nature, acting as *natura naturans*, bringing forth the desired plant forms (the *natura naturata*), not completely on its own accord, but in response to human interventions. Scientists (ecologists, biochemists, and others) try to create favourable conditions in order to allow nature to manifest itself in the form of favoured species a return of repressed vegetations. Nature is regarded as a collaborating and enhancing factor in the process of landscape development. The new semi-natural landscape has become a large-scale open-air laboratory and new nature is, quite literally, an experiment.

Chapter 8
Taming Microbes: Ibsen's Dr. Stockmann as a Contemporary of Pasteur and Koch

8.1 Introduction

Ibsen's play *A Public Enemy* is set in a tranquil Norwegian coastal spa and tells the story of a doctor who discovers that the Baths, on which the livelihood of the town depends, are contaminated because the water conduit system has been too economically designed.[1] A brief summary of the play was already given in Chapter 6. Stockmann analyses the bathing and the drinking water, sends samples to university experts who have the right equipment at their disposal, and concludes that the local bath facilities, about to be visited by health-seekers and tourists, are petrified by *animalculae* or *infusoria* – living beings that can only be detected with the help of a microscope. Convinced that he is about to avert a major public disaster he alerts both town officials and journalists (simultaneously). He regards it as his duty to disclose his discovery to the authorities, notably his elderly brother, the conservative Mayor, who had offered him his present position, but also to the latter's opponents: the liberal press. Moreover, he regards himself as somewhat more than simply a medical officer or local physician. He is repeatedly referred to, both by himself as by others, as a "man of science", and devoted to the cause of scientific enlightenment and societal reform. Initially he is praised as a public benefactor who simply wants to avoid illness among tourists, but when the public learns that Stockmann's discovery might irreparably damage the town's reputation while necessary improvements of the Baths will greatly affect their income, they turn against him. The necessary repairs seem far beyond their means. Stockmann calls a public meeting but is prevented from delivering his speech and getting his message to the villagers due to a number of tactical manoeuvers by the more dexterous politicians present. This makes him decide to give a philosophical lecture instead, on the intellectual superiority of the elite in comparison to the unenlightened and prejudiced majority of mankind. As a result of this snobbish tirade by a "man of science" against popular

[1] *A Public Enemy* by the Norwegian playwright Henrik Ibsen (1828–1906) was published and performed for the first time in 1882. All references are to the Penguin edition, easily available in English (Ibsen 1882/1964).

opinion, the audience brands him as an enemy of the people, the target of a *cordon sanitaire* – as if he himself is exposed as an infectious agent. They stone his house and leave him "revelling in his position as a pariah" (Mehra 2001, p. 2).

One could say that Ibsen's play analyses the impact of a number of emerging technologies on the life-world. In the final decades of the nineteenth century, Norway's coastal zones were made more easily assessable, were being opened up for tourism by steam ships (cf. Chapter 10), while public health policies became possible because of the dissemination of the microscope as a general research tool in the biomedical and life sciences. Moreover, the play assesses the impact of the press on politics. As Kierkegaard had argued in *Two Ages* (1846/1978), because of the press, society was no longer in the hands of "men of excellence" (and this is how the mayor sees himself) but rather in the hands of the whimsical "public", described by Kierkegaard as an unreliable artefact, a phantom-like phenomenon called into existence by mass media, something politicians could no longer afford to neglect. Stockmann's attitude towards this new phenomenon, "the public", is rather ambivalent. At first he aspires to become a public hero, but then, all of a sudden, he rather depicts the public in terms of a "phantom", much like Kierkegaard.

Usually, Dr. Stockmann is applauded as a champion of science and enlightenment, who runs into conflict with prejudices, hypocrisy and vested interests. By several authors he is presented as the archetypical literary model of a whistleblower. Examples of such unequivocal, one-dimensional portrayals can be found in the comments on Ibsen's play by left-wing intellectuals such as Bernard Shaw (1891) and Emma Goldmann (1914). According to Shaw, the play is about a an honest doctor who insists on exposing the danger that visitors will be infected, and therefore has to face fierce opposition from people who are pecuniarily interested in concealing the truth. And according to Goldmann, the doctor is a sincere man of high ideals, a conscientious physician who has the courage to stand alone, a herald of reason who is silenced by force and deprived of his right to free expression by conservative forces. Others, however, are more willing to stress the ambiguities of Ibsen's play. They notice for example how Dr. Stockmann's obsessive and self-centered character keeps him from understanding how anyone could possibly disagree with his scientific views (Mehra 2001). He is unable to adequately respond to or interact with his social environment, unable to cooperate with stakeholders in order to find viable solutions for a complicated situation that involves much more that lab results alone. By exposing a potentially malignant public health problem, he is undoubtedly doing the town a service in the long run, and he certainly has the courage to stand fast to his beliefs despite overwhelming criticism, abuse and disciplinary measures (such as dismissal as medical officer to the Baths). At the same time, however, he is "blindly naïve to the implications of his discovery. His slavish devotion to objective truth is so uncompromising that he sees his scientific discovery in a self-absorbed vacuum" (Merha, p. 2). He is not only driven by zealous dedication, Mehra continues, but also by vanity and a desire to be canonized as a kind of public hero. His ideals are virtuous, but his motives partly selfish and narcissistic. And his final pseudo-scientific speech is a disastrous blunder, a desperate overstep from the scientific realm (where he is at home) into the philosophico-

political realm – a move that makes this potentially dangerous antagonist of those in power a very easy target. His scientific discovery becomes mired in (contaminated by) local politics.

Ibsen himself both criticises and espouses his protagonist's attitudes and views. In letters to Georg Brandes and to his publisher, Ibsen makes it clear that Stockman and he have much in common, notably their criticism of both conservative (right-wing) and liberal (left-wing) politicians, and there is ample evidence that Stockmann was (up to a certain extent) a mouthpiece for the playwright himself. But (subtly in the beginning and more emphatically towards the end) Stockmann is also portrayed as a buffoon-like figure. Indeed, many years later Ibsen insisted that he was certainly not responsible for all the philosophical nonsense his Dr. Stockmann proclaimed (Arpe 1972; Beyer 1978).

I have several reasons for submitting Ibsen's drama to a more thorough analysis. First of all, its key issue, the vicissitudes of a wistleblower, is as up-to-date as ever and Ibsen offers his readers a classical case study in which different roles and perspectives are fleshed-out in a convincing manner. Moreover, the scandal which Dr. Stockmann intends to disclose concerns environmental pollution, caused by short-sighted policy decisions, a problem which we are still all too familiar with today. With its lively and far-from-outdated style and atmosphere, the play constitutes rewarding material for educational purposes and is very usable in ethics courses for science students. But the play is of interest for other reasons as well. Underneath the *ethical* issues involved in disclosing touchy information on hazardous situations to a public-at-risk, *epistemological* issues are addressed. Ibsen stages a dramatic confrontation between the scientific way of seeing and understanding the world and common sense. Moreover, a very discrete and particular *form of science* is represented in Ibsen's drama. Dr. Stockmann's discovery of microscopic carriers of infectious diseases in the bathing and drinking water of a Norwegian spa does not stand on its own. He is a contemporary of Louis Pasteur in France and Robert Koch in Germany.[2] His research and public performance bears close affinity to contemporary events in the realm of "real" science. The decade between 1879 and 1889 is generally regarded as the "Golden Era" of (medical) bacteriology and microbiology (Davis et al. 1973, p. 9). In 1882, the very year when *A Public Enemy* was published and performed, Robert Koch published his famous paper on the aetiology of tuberculosis. Subsequently, he and Pasteur (who in 1881 had developed his anthrax vaccine) went to Egypt to hunt the microbes that cause cholera. Moreover, very much like Stockmann, Pasteur and Koch not only had to deal with the scientific and technical difficulties involved in microbe research, but also with the problem of how to communicate their findings to journalists, official authorities and public audiences. Stockmann's performance, both as a researcher and as a

[2] In Ibsen's play Doctor Stockmann is presented as being in his mid-life years, around the age of 40 – that is, he is approximately of the same age as Koch (1843–1910) was (who was close to 40 in 1882).

public figure, reflects (in a compact and concise form) the opportunities and obstacles, the failures and successes that were also experienced by real "microbe hunters". In other words, Ibsen's play constitutes an exercise in comparative epistemology.

What can we learn from Ibsen's play, not only with regard to science communication and professional ethics, but notably in the context of comparative epistemology? What philosophical message does it convey? To answer this question, the play will be analyzed in three successive steps. First of all, the focus will be on the clash between science on the one hand and its social and cultural environment on the other, between the scientific worldview and the common sense (or life-world) view. Subsequently, attention will shift to the ethical and political dimension of the play. In this section I will read Ibsen's text as an effort to show what may happen to more or less "simple" scientific facts regarding environmental pollution when they enter the complex and turbulent social world of interests and values (either moral or economic). I will monitor Dr. Stockmann in his role as a relentless whistleblower who unfortunately lacks the social sensitivity and strategic instincts needed to confront his adversaries successfully, but who suffers a fate that is at times uncannily similar to that of those who nowadays find themselves in similar positions. Finally, I will take a comparative epistemological approach. I will describe in more detail the similarities between Stockmann's and his scientific contemporaries Pasteur and Koch, not only in terms of their scientific performance, but also in terms of the societal import of their scientific discoveries. This will allow me to reflect on the affinity between literary and scientific "microbe hunters" as counterparts. What can we learn from Ibsen's play concerning science, and what can we learn from researchers like Pasteur and Koch to further our understanding of Ibsen's play?

8.2 Stockmann as a *Man of Science*

As was indicated above, Dr. Stockmann regards himself as somewhat more than merely a country doctor. Not only is he repeatedly referred to as a man of science, but he is also a prolific contributor to a liberal (left-wing) local newspaper. In this manner, he became rather notorious for his radical and non-conformist political ideas. Before accepting his present position as medical officer of the Baths, he worked as a physician somewhere in a remote and sparsely inhabited part of Norway ("up north") under difficult financial and climatic circumstances. In his imagination, he developed grand schemes for making a lasting contribution to the cultural and political transformation of his country in general, and of his home town in particular, by means of scientific discoveries. And now it seems he finally made such a discovery. At the same time, he is represented as rather naïve, self-indulgent and as lacking practicality.

Ibsen published his play at a time when the typical literary profile of the physician had changed. For centuries, in the writings of Molière and others, physicians had been staged persistently as buffoons who cared more for grand, obsolete theories and academic disputes than for the well-being of their patients. Their sole

expertise seemed to consist (according to one of Molière's characters) in translating into scholarly Latin what everybody else already knew, namely that the patient was ill. In the nineteenth century novel, however, the physician came to play a much more serious role, observing and discerning facts and details that went unnoticed by others. In Ibsen's drama, we are faced with a serio-comic mixture of these literary stereotypes. On the one hand, the play shares some similarities with the "doctor novel" through whose eyes a somewhat backward community is (both literally and figuratively) enlightened. But he is also a buffoon, with a somewhat pedantic diction and a greater interest in theory than in real life.

The play can be read, to some extent, as a literary experiment – in Zola's sense, with Stockmann (and, indirectly, Ibsen) as its conductor. *What happens if* lay audiences are exposed to an important but distressing scientific truth? Will they respond the way Plato in his famous simile of the cave had already predicted, namely by rejecting the truth and by ridiculing or even killing the messenger? Normally we see but shadows on the wall. In order to discern the truth, we must learn to see things scientifically, that is – with the help of scientific apparatus – and formulate our truth claims in scientific language.

In ACT I, at the beginning of the play, Stockmann is eagerly awaiting a letter from the university. When the document finally arrives, he knows that he is on the right track. His hypothesis is confirmed by the experts. The letter shows, he exclaims, that we think we know everything, while in fact we are completely blind. Stockmann, the man of science, has managed to labour himself out of Plato's cave, so to speak, and now he tells his fellow human beings what he saw out there, a message they do not like to hear. Because the town officials (for financial reasons) refused to construct the conduits in accordance with Stockmann's original directions, the waters are polluted by decaying organic material. Strange cases of illness among visitors gave him the idea that something was wrong, but he wanted to have "absolute proof". He meticulously prepared samples and dutifully sent them to the University for a full analysis:

> I've made the most careful investigations.… I started to analyse the water.… I hadn't the necessary scientific equipment here, so I sent samples of both our drinking water and the sea water to the University for a complete analysis by an expert. (p. 122)

In other words, he obtained a "second opinion" from an expert. And this gave him certainty. Millions of *animalculae* or *infusoria* are present in the water. "Used either internally or externally" (a translation into scientific language of the verbs "to drink" and "to swim"), this water is a positive menace to health.

Let us reflect for a moment on the scientific (or quasi-scientific) terminology that is being used here. *Animalculae* (or animalcules) was the word for microbes or microorganisms that Anthony van Leeuwenhoek from Delft had originally used in the letters he sent to the Royal Society of London – the *Anfang* of microbiology (Dobell 1932). In 1683 he had for the first time observed "little animals" in drops of rainwater through one of his home-made microscopes. *Animalculae* was, of course, a rather vague general term encompassing all sorts of microscopic organisms. Most of Van Leeuwenhoek's little animals would be called bacteria nowadays (although in current literature experts

reject even this term as unsatisfactory), but he also used it to refer to protozoa (which he discovered in canal water) and spermatozoa. *Infusoria* is also used in a rather vague and obsolete way in Ibsen's play. Originally it applied to all microscopic organisms found in water. The term came from the practice of infusing substances such as hay into liquids. Later, "infusoria" was used to specifically refer to ciliated protozoa, but nowadays, like animalculae, it is no longer in use in the academic literature.

Contemporaries of Stockmann, such as Pasteur and Koch, did not use terms like "animalculae" any more. They wrote about bacteria, bacilli (rod-shaped bacteria), and the like. Professor Ferdinand Cohn from Breslau, Robert Koch's mentor at the time of his first discoveries, was an expert on bacteria and he had stated that bacteria are minuscule plants rather than little "animals". In France, lexicologist Emile Littré had coined the word *microbe* in 1878 as an alternative for animalculae (Debré 1994/1998). Around 1880 a new scientific language was emerging and the word microbe began to make "its way around the world" (Debré, p. 364). Thus, in 1882, Ibsen used a scientific idiom that was outdated from a scientific point of view. In the 1880s not only the original terminology (dating from the seventeenth century) had become obsolete, but scientists were also far beyond the sense of horror still experienced by Van Leeuwenhoek's contemporaries when they realized for the first time the presence of little animals in, for example, their oral cavity. The survival of outdated scientific jargon outside academic circles is a very common phenomenon of course. While scientists continuously update their research practices and terminology, the vocabularies and experiences of previous generations of scientists (once they have managed to spread through the public realm) tend to persist among the public at large for quite some time. In 1882, more sophisticated terms like bacteria and bacilli had not yet permeated public consciousness and its idioms – while terms like prokaryotes and eukaryotes had not yet been invented.

In the 1880s, the omnipresence of micro-organisms was still a novelty the general public had to get used to. The presence of microbes in the environment was not a fact that outsiders were very familiar with. On the contrary, evidence concerning the existence and omnipresence of microscopic living beings caused uneasiness, at times even panic among lay audiences. One of the reasons was that after the days of Van Leeuwenhoek and Hooke the interest in microbiology had declined. For many decades only a few persons had studied bacteria (Carpenter 1972, p. 28). Although the dispute over spontaneous generation of micro-organisms (involving Spallanzani, Needham and others) caused a temporary revival, Linnaeus exemplified the general lack of interest among naturalists when he assigned microbes to the class "Chaos". When Louis Pasteur made his first discoveries, interest in and awareness of the importance of microbes had more or less come to a stand still. Microbes were virtually forgotten, even by the scientists themselves, until Pasteur and Koch rediscovered their existence. It took the "crusading spirit of Pasteur, his zeal and skill as a polemicist, to drag the microbes out of the obscurity into which they had passed once more after Spallanzani died" (De Kruif 1927, p. 79). He brought them back to life again, so to speak. By the time Ibsen published his play, microbes were "in the air" again and news about research by *visible scientists* like Pasteur and Koch made the newspaper headlines. Pasteur and Koch initiated

successful research programs to find the causes of various infectious diseases. But Ibsen's play suggests that this information had not reached everyone in Norway yet. Local sceptics did not believe a word of it and regarded it as a cynical joke. They thought that Stockmann used these little animals (that no one could see) on order to play a trick on his powerful but scientifically illiterate brother:

KIIL: I never thought you had it in you to play monkey tricks against your own brother.
DR STOCKMANN: Monkey tricks?
KILL: What was it? Some animals that had got into the water pipes?
DR STOCKMANN: Animalculae, yes. Infusoria.… Hundreds of thousands perhaps.
KILL: But no one can see them! Wasn't that it? Damn, if that isn't the best thing I have heard from you yet! (p. 128)

Not only the objects of Stockmann's research (i.e. the microbes) are looked upon as something odd and strange, also the figure of the scientist as such is something the village people find difficult to comprehend. This notably applies to the scientific ethos, the ideal of disinterested research, for the sake of truth and human well-being alone. From the very onset until the very end, bystanders keep suspecting Stockmann of having personal or financial motives for acting as he does, such as a wish to take his revenge on his hated brother, or simply a desire to achieve a rise in salary. In the end, when Stockmann's shrewd father-in-law goes around the town buying up devalued shares in the Baths, most bystanders are convinced that a prospect of financial gain was behind it all from the very beginning. The disinterested scientist simply did not seem to have a place yet among the stock of Norwegian characters.

Hovstad, the radical editor of the local left-wing newspaper, is driven by political motives, rather than by an interest in science, which he regards as instrumental. He immediately discerns the political significance of Stockmann's discovery.

HOVSTAD: To you, as a doctor and a man of science, this affair of the water supply seems to stand on its own – I mean, you haven't realized that a good many other things are involved.… [But to me] it seems that a journalist incurs a heavy responsibility if he fails to seize any favourable opportunity of emancipating the humble, down-trodden Masses!

As soon as he presents his findings either to the (right-wing) municipal authorities or to the (left-wing) journalists, Stockmann's touchy data enter a complicated political arena. His facts are no longer simple, clear and neutral (as he himself tends to see them). On the contrary, they quickly find their place in political schemes and agendas. Water pollution changes from a scientific observation into a political metaphor. From a left-wing perspective, society as such becomes a polluted swamp that needs to be cleansed. From a right-wing perspective, Stockmann is an educated hooligan who misuses his data and scientific prestige to satisfy his desire for anarchy and turmoil. But even Stockmann himself soon "contaminates" his scientific data by connecting it with political intentions.

As a man of science, Stockmann finds it difficult (if not impossible) to subordinate himself to the authorities. He sees it as his duty towards truth and humanity to make his discoveries widely known. Indeed, he emphatically refers to his findings as a *great discovery*, something like a major scientific breakthrough – I have found

it, Eureka! And he talks about his four-page manuscript as if it is a masterpiece of scholarly writing. Why did he keep it all so secret? Because, as a man of science, he had wanted to be absolutely sure. And now "the public" should hear about it as soon as possible. When it comes to apprehending the impact his news is likely to have, Stockmann plays the role of unworldly scientist:

> DR STOCKMANN: And if the board [of directors of the Baths] should happen to raise my salary, I won't accept it. Oh, it's wonderful for a man to feel that he's done a service to his fellow citizens. (p. 125)

Before long, however, the doctor is made to understand that on the political level a "self-evident" scientific fact can easily become the object of a fierce dispute, of a struggle between interpretations, as different stakeholders are likely to read scientific findings from different perspectives.

8.3 Stockmann as a *Whistleblower*

Dr. Stockmann has dutifully submitted his four-page report to his brother, the Mayor, but also chairman of the board of directors of the Baths. At the beginning of Act II the doctor is eagerly awaiting his response. Meanwhile, however, he has informed his family members and the press as well. Thus, the news immediately starts to leak and seep into the community. In his enthusiasm about his grand discovery, Stockmann neglects the discreteness and confidentiality which no doubt should have been observed by him at this stage. The societal import seems so obvious to him that procedural discretion and constraints can hardly be relevant. In the context of whistle blowing, this course of action (reporting and exposing hazardous situations to different audiences at the same time) is known as the "shotgun approach". Although it increases the likelihood that corrective action will be taken, the whistle blower may well be accused of having failed to use the proper reporting channels (Miethe 1999, p. 218).

All the audiences he addresses respond in their own peculiar manner. His family members, to begin with, support Stockmann's views and strengthen him in his conviction that the course of action he has taken is for the benefit of mankind. Apparently they are accustomed to act in this vein, for Stockmann easily feels offended when he is being criticized in his own house. It happens more often, of course, that personalities who stand up against authorities in public life, act in a somewhat despotic manner themselves within the confines of their own private life – like Proudhon, for instance.

Hovstad, representing the media, has his own agenda. In his eyes, the findings should be exploited politically right away, at the expense of "the bureaucrats that rule us". He insists that the myth of their infallibility must be exploded once and for all. The mayor's gross and inexcusable blunder must be brought home to every voter in the place. Hovstad's professional and political ethos forbids him not to exploit Stockmann's information in a political manner. Together with Aslaksen, the

more moderate and elderly printer, the young and radical editor offers his political assistance, advice and support to Stockmann, but the latter kindly declines:

Dr STOCKMANN: I really can't believe that all these precautions are necessary: it seems to me that the thing would go ahead on its own momentum. (p. 135)

Should the authorities refuse to undertake the necessary changes, however, he generously grants Hovstad and Aslaksen the favour of publishing his report, on the condition that they handle it as if it was "written in gold". The published version must contain no typos or printing errors. This means that Stockmann regards it as something more than just a newspaper article.

Finally, the mayor himself pays the doctor a visit. The formal way in which he addresses him makes it clear right away what course he has decided to take:

THE MAYOR: Last night after office hours, I received a communication from you concerning the condition of the water at the Baths.… Was it necessary to carry out all these inquiries behind my back?
DR STOCKMANN: Well, until I had absolute proof, I –
THE MAYOR: Is it your intention to submit this document to the Directorate of the Baths as some sort of official report?
DR STOCKMANN: Of course. Something must be done about the state of affairs – and quickly, too.
THE MAYOR: As usual, you make use of some very strong expressions in your report. You say, among other things, that what we offer to our visitors at the Baths is consistently poisonous.
DR STOCKMANN: What else can you call it? Just think – water that's poisonous to drink *and* to bathe in?
THE MAYOR: And so you arrive at the conclusion that we must build a sewer to carry off the alleged impurities.… Etc. (p. 138)

Dr. Stockmann pretends to have written a scientific report, leading from hypothesis to observations and from analysis to conclusions. One gets the impression, however, that his style is not as scientific and restrained as ought to be expected. He not only expresses himself in vehement terms at times, but uses a very large number of exclamation marks (and insists that they are to be maintained in the printed version). Perhaps he should also have been more careful in leaping from observations to "measures to be taken". However, as the adjustments he proposes are "exorbitantly" costly, they are out of the question as far as the Mayor is concerned (who consulted the town's engineer on this matter). And he summarizes his conclusion in a beautiful bureaucratic phrase:

THE MAYOR: I have not been able to convince myself, from your report, that the condition of the water at the Baths is as serious as you present. (p. 140)

To Stockmann's astonishment, the facts he reported apparently leave room for interpretation, for political hermeneutics. For the Mayor, the question now simply is: how do I silence the medical officer or – should that prove impossible – how do I eliminate him? In any event, the report must be withheld. The matter is to be dealt with "discretely" (p. 141). Upon being told that Stockmann already informed the press, he insists that Stockmann agrees to sign a proclamation to contradict his own findings:

THE MAYOR: You have been so indiscreet as to chatter to outsiders about this delicate matter, which should have been treated as an official secret.… It will be necessary for you to contradict such rumours, publicly.… We expect that, after further investigations, you will come to the conclusion that matters are not nearly so seriously or so urgent as you had imagined at first sight.… You will publicly proclaim your confidence in the Board of Governors and in the thorough and conscientious steps which they will take to remedy any possible shortcomings. (p. 144)

Moreover, he denies his brother the right to form, let alone to disseminate, personal opinions on the matter. Of course he has freedom to speak, but only as long as it does not concern the Baths, since his senior director forbids it. According to the mayor, Stockmann's say is limited to ascertaining the scientific data as such. When it comes to pointing out their significance, or proposing measures and policies, town officials are better equipped:

DR STOCKMANN: This is too much! I'm a doctor – a man of science …
THE MAYOR: The point at issue is not a purely scientific one; it is a complex question, with both technical and economic aspects. (p. 144)

Stockmann refuses to give in, of course, but the Mayor quickly alters the terms of the debate. Instead of discussing the facts as presented to him, he decides to focus on the author of the report. He resorts to *ad hominem* arguments in order to discredit him (describing the doctor as a quarrelsome, turbulent, intractable person whom it is impossible to work with) but soon he threatens him with instant dismissal. Stockmann, convinced that his political friends will back him up, decides to allow the press to publish his paper.

Act III, therefore, takes us to the editor's office. Here, revolution seems about to break out, until the Mayor is allowed to display his tactical dexterity and political intelligence. What happens? Initially, Stockmann's discovery seems to fit in extremely well with stereotypical political fantasies of Hovstad and his colleagues to get rid of "those in power" – a scenario that inevitably culminates in a beheading ("heads will fall"). Stockmann imagines himself as the leader of a popular uprising against the stodgy forces of aristocracy. The manuscript, apparently a pamphlet rather than a sober report, is to be printed ("Don't cut out any of the exclamation marks!", p. 155), but this will only be the beginning. Although Stockmann pretends to have written a formal report, to be submitted to the board of directors, it now becomes quite clear that he actually produced a text that belongs to a somewhat different genre and addresses a much broader audience:

Dr STOCKMANN: Well, Mr Hovstad, what do you think of my article?
HOVSTAD: I think it's an absolute masterpiece.
Dr STOCKMANN: It is, isn't it? I'm delighted you should think so – delighted.
HOVSTAD: It's clear and to the point – no need to be an expert to follow it. Take my word for it, you'll have every thinking man on your side. (p. 153)

He has written his report in such a way that it can appear in the newspaper just as it is, without any editorial adjustments. He has taken care not to write formally or expertly, but in an accessible manner. The more easily will it achieve political significance. The doctor will use the newspaper as his headquarters from now on and he will bombard those in power with one explosive article after another. The whole community will be

cleaned and disinfected. The lower classes will take control of all the important posts, and a Revolution will be staged in the name of science and conscience:

DR STOCKMANN: Such endless vistas have opened out before me today. I haven't got it quite clear yet, but I'll soon put that right. (p. 154)

After Stockmann's departure, however, it is the Mayor's turn to pay a visit to the editor's office. He arrives with his hat and staff, the symbols of his official status, but uses the back door so that his unusual visit will pass unnoticed. He does not need as many words as his brother to explain his position, and he expresses himself in courteous, formal language. When he indicates the kind of money the Norwegian village will have to raise in order to cover the expenses, his left-wing interlocutors agree that Stockmann's data suddenly appear "in a different light" (162). The mayor himself has prepared "a short statement" on the situation as it would appear "from a more reasonable point of view" and Hovstad and Aslaksen agree to print it. Then all of a sudden the doctor reappears. He cannot wait to have a glance at the proofs of his article, and he wants to discuss with Hovstad and Aslaksen what he should do if the village people should decide to organize a torchlight procession in his honour. The Mayor is forced to take cover, but forgets to take his hat and staff with him, and when Stockmann notices them, he forces his brother to come out from his hiding place. Stockmann makes fun of him, puts on his official hat ("the pinnacle of authority"!), and in a playful manner dismisses him from his post, until it suddenly dawns on him that the situation has changed drastically. It will be his brother's statement, not his own article, that will appear in tomorrow's newspaper. Aslaksen even refuses to print it as a pamphlet at the Doctor's own expense. Finally, cut off from these channels of dissemination, Stockmann decides to organize a meeting in order to read his paper to the public.

In ACT IV, the meeting takes place and villagers "from all walks of life" have convened to listen to Stockmann's speech, but the politicians (The Mayor, Hovstad and Aslaksen), relying on a series of procedural tricks, manage to prevent Stockmann from presenting his paper. At a certain point, he decides to give a speech on another important discovery of his – or rather, a revelation – something that had been on his mind for quite some time. His great discovery is that the true obstacle to progress and enlightenment is the stupidity of the uneducated masses, the mob, common man. "Now you know"! It is a lie to say, as democrats do, that the majority is always right. The minority is right, the intellectual elite, those who stand at the outposts, far in advance of others:

DR STOCKMANN: As a general rule, an ordinary … truth lives – let's say – seventeen or eighteen years … twenty at the outside. Rarely longer. But … it isn't till then that the majority takes them up and recommends them to society as wholesome spiritual food. There isn't much nourishment in that sort of diet, I can assure you – and I'm speaking as a doctor. (p. 186)

This is the proposition that he intends to prove to his audience "scientifically". He does so by explaining that the relationship between common people and men of science can be compared to that between ordinary mongrels and poodle's of pedigree stock.

> Think of an ordinary, plebeian mongrel.… Then put that mongrel beside a poodle with a pedigree going back through generations of famous ancestors – who's been properly reared, and brought up among soft voices and music. D'you really think the poodle's brain won't have developed quite differently from the mongrel's? [They can be trained] to do things that an ordinary mongrel could never learn. (p. 189)

He accuses his public of agreeing with him when it comes to dogs, but not daring to apply this train of thought to humans, thereby following the idea to its logical conclusion. And he ends by attributing the intellectual depravity of common people to shortage of oxygen in ordinary houses.

In ACT V, Stockmann has been dismissed, and the same has happened to his daughter, a teacher. His window panes are broken and his sarcastic father-in-law remarks that now at least he has enough oxygen in his house. By buying up huge amounts of inexpensive shares in the Baths, the latter makes Stockmann's project seem like a concerted plan. Apparently, it was the Doctor's secret design to create confusion on order to take over the Baths. Indeed, it is the villagers' guess that his scientific expertise will allow him to find some antidote or disinfectant. But Stockmann has the final say and announces another great discovery of his: the strongest man in the world is he who "stands most alone".

To a certain extent, the sympathy for Stockmann that is voiced almost unanimously in ethical and political comments on Ibsen's play is justified. Here we have a physician who has discovered a serious case of environmental pollution. Public health issues are at stake and sanitary measures are to be taken. Unlike the town's engineer, who is consulted by the Mayor and who limits the scope of his attention to the technical and economical side of things, Stockmann acutely senses his professional responsibility. Furthermore, the mayor's response is typical for those in power who find their position suddenly undermined by a (potential) whistle blower. The Mayor tries to cover up the contamination and when his brother refuses to go along with his scheme, because of his conviction that such a dishonesty would be a crime to society, the Mayor typically resorts to ad hominem arguments and force. All this is typical of the whistle-blowing complex too. As a rule, whistleblowers are supported (for a certain period of time) by the press, but eventually they are likely to lose their job and to find their possessions vandalized (Miethe, p. 220). As an employee who reveals dangerous pollution, he soon finds out that his own career is at stake. Indeed, Stockmann is a typical whistle blower in his acceptance of the fact that (because of his loyalty to lofty goals) his personal life is threatened with disintegration. But, like all true whistleblowers, he seems willing to sacrifice his personal well-being as well as his social position to his cause. A marital crisis also belongs to the aftermath of whistle blowing, but we do not know what will happen to Stockmann's marriage after the event.

We should not close our eyes, however, to a number of mistakes the doctor makes. Upon receiving the decisive letter from the university, he immediately informs the press. In view of his position and professional ethic he should have acted more carefully and discretely. He vehemently takes sides in a conflict between two ethical styles: the (old-fashioned) ethics of discretion and the (progressive) ethics of openness. He sees his brother as his enemy, rather than as a

stakeholder whom he has to come to terms with in order to find a viable solution. It is as if he experiences great relief at finally discovering a way to injure him. But the most important thing is that there is some truth in the mayor's remark that the issue at hand is not a purely scientific one, that it is a *complex* issue, involving technical and economic aspects, besides ethical ones. What the community needs is a comprehensive account, addressing and weighing all the relevant aspects. There is still some time left to consider carefully what measures are to be taken. In other words, Stockmann's view is one-sided. He leaps from fact to conclusion and leaves no room for reflection. Dr. Stockmann is not merely a scientist, moreover. He too instrumentalises science. In his view, scientific data are powerful tools in a relentless struggle to reform society. A will to power is behind his will to know. The facts he discovered become "contaminated" by politics, as we have seen. In Stockmann's eyes, they acquire their true meaning when they are set against the backdrop of his ideological vision.

If we follow Sissela Bok (1981) in her assessment of whistle blowing, Stockmann's line of action must be regarded as adequate in some respects, but as inadequate in others. According to Bok, whistleblowers should assure themselves of the accuracy of their reports, checking and rechecking the facts before they speak out – and this is what Stockmann does. He fails, however, to explore and use what she refers to as "the existing avenues for change within the organization" (p. 211). Whistle blowing, she argues, has to remain a last alternative because of its destructive side effects, for the person himself as well as for others; it must be chosen only when other alternatives have been considered and rejected. Stockmann, because of his eagerness to communicate his findings to the press, fails to observe Bok's basic recommendation to those who find themselves in his position: "Try the regular channels first" (p. 211). Moreover, she argues that whistle blowers should be scrupulously aware of any motive that might skew their message. The whistleblower's motives ought to be above suspicion. But in Ibsen's play this is clearly not the case. Stockmann is partly driven by personal motives – such as his extreme desire for recognition and his feelings (markedly unfriendly) towards his brother. Finally, she stresses that whistle blowers should seek advice before going public. But Stockmann acts on his own accord, without informing or consulting anybody beforehand, and he clearly takes delight in the effect of general astonishment and surprise his unexpected message evokes. Yet, this ethical dimension, the one that is usually emphasised in comments on the play, is merely one layer. Beneath the ethical quandaries of whistle blowing, another type of problem emerges, of an epistemological kind.

8.4 Stockmann as a *Microbe Hunter*

The plot of Ibsen's play had its origin in a number of actual incidents (Meyer 1967/1985, p. 523; Watts 1964, p. 13). To begin with, Ibsen had heard a story about a medical officer at a spa who, when an outbreak of cholera occurred, felt it his duty

to make it known publicly. The season was ruined and therefore his house was stoned. And in 1881 a Norwegian chemist had tried to read a paper disclosing shortcomings of Steam Kitchens for the poor. He was prevented from speaking and forced to withdraw. Moreover, Ibsen had responded with indignation at the reception of *Ghosts*, his previous play that caused a scandal because it publicly addressed issues like euthanasia and venereal disease, and there are hints that Ibsen transferred some of his personal anger to Stockmann. More interesting from an epistemological point of view, however, is the apparent concurrence of Ibsen's play with crucial events in the history of science. Stockmann is the literary equivalent, the literary counterpart of outstanding experimentalists and "microbe hunters" (De Kruif 1927), of champions of hygiene and public health like Pasteur and Koch.

To compare theatre with scientific research is not as far-fetched as it may seem at first glance. In comparison to other forms of scholarly activity (such as making calculations or reading books), experimentation constitutes a *dramatic* form of research, a dramatic "art" (Crease 1993).[3] An experiment is basically a performance. The emphasis is on *doing*, on *acting*, sometimes hidden from view, but often before an audience (of students, colleagues or readers). It is a performance moreover that involves rehearsals, repetitions and practice. Especially experiments with human subjects, such as performed by social psychologists for example, can be reminiscent of drama in the eyes of those who witness them. But basically the theatrical analogy applies to all forms of experimental research (although sometimes the performance is actually executed with the help of instruments and equipment while the experimenters are more like producers or directors).[4] The affinity between the *literary* drama of the playwright and the *scientific* drama of the experimental researcher will be of help when it comes to comparing literary figures like Stockmann with real "men of science" like Pasteur and Koch. As I explained in Chapter 1, moreover, it is my conviction that contemporary events share a certain basic mood or *Zeitgeist* – that they tend to mirror one another. This means that Ibsen's play may allow us to further our understanding of what goes on in the life sciences during the 1880s, while the experiences of the "real" scientists during that period may deepen our understanding of what happens to Stockmann on stage. The element of drama is what both events (the discovery of animalculae by Stockmann and of the tuberculosis bacillus, for instance, by Koch) have in common.

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[3] Another example of science theatre is, of course, the lecture. As a student, Pasteur was fascinated by such a "spectacle", namely the courses that chemist Jean-Baptiste Dumas gave at the Sorbonne. His lectures attracted a considerable audience. In one of his letters Pasteur describes the scene as follows: "The lecture hall is huge, and always filled. One has to be there a half hour early in order to get a good seat, just like in the theatre. Here too there is a lot of applause.…" Pasteur was struck by the attentive silence of the audience, interrupted by passionate exclamations (Debré 1994/1998, p. 23).

[4] A beautiful example of science-as-theatre can be found in *The Double Helix* by James Watson where Linus Pauling, when presenting a protein structure, keeps his model behind a curtain, unveiling it only at the very end of his talk, leading Watson to comment that it was "as if he had been in show business all his life" (Crease 1993, p. 98; Watson 1968/1980, p. 25).

This is also the reason why I will use one particular monograph on the history of microbiology as my starting point, namely Paul de Kruif's best-seller *The Microbe Hunters* published in 1927.[5] It presents a rather supportive and protagonist portrayal of scientists as heroes, but with its lively style it emphatically emphasizes the *dramatic* element inherent in experimental inquiry. Therefore, although it is perhaps not always the most reliable source when it comes to historical detail (from a professional historical point of view), is does present the achievements of "microbe hunters" like Pasteur and Koch as if we witness their performances life on stage, as if we (the audience) are allowed to enter for a moment their laboratories and studies in order to shed a glance on their dramatic performances. In fact, the case of Louis Pasteur is hardly in need of any dramatization. He is unanimously described as an "actor" and a "showman" by his biographers, as someone who regarded the disclosure of nature as a "spectacle" (Davis et al. 1973, p. 4).

As I already pointed out, after Van Leeuwenhoek and Spallanzani interest in microbes had eclipsed in favour of other branches of research. According to De Kruif, it took a "propagandist", a "missionary", a "showman" like Louis Pasteur to change the situation. He started a campaign, "part science, part drama" (p. 84), to put microbes on the map again. He had a strong desire to involve larges audiences in his discoveries and he enjoyed to "spout" his results to the public (p. 95). At Paris he staged a "scientific vaudeville" to make Emperor Napoleon III, Alexandre Dumas and other contemporaries more aware of the omnipresence of microscopic species in the environment. Besides that, he loved to fight with colleagues who had attained the status of authorities. His campaign created a storm in the republic of science and got him into dramatic conflicts with Liebig and other powerful men. During a meeting of the Academy of Science in Paris he shouted scandalous remarks and got into a fight with an elderly colleague. He was notorious for transgressing every now and then the limits of scientific discretion by using provocative language and "unseeming remarks". Furthermore, according to De Kruif, his head was incessantly inventing new theories and wild guesses and he often jumped to conclusions. In short, Pasteur and Stockmann share the same character, to some extent, especially if we study Pasteur through the lens of Paul de Kruif.

One of the highlights of Pasteur's career was the discovery of the anthrax vaccine. It culminated in a dramatic public experiment at Pouilly-le-Fort in 1881 that was broadcasted by newspapers all over the Western World, such as the London *Times*. Pasteur accepted the invitation to come to Pouilly-le-Fort, a small provincial town, in order to personally lead the battle against local rural scepticism and prejudices

[5] Paul de Kruif was "America's first great science writer" (Henig 2002). Born in 1890, he was trained as a bacteriologist. He published on streptococci and worked at the Rockefeller Institute, where he was fired after publishing an anonymous, critical review of contemporary medical research. He was co-author of Sinclair Lewis' novel *Arrowsmith*, published in 1925, about a research institute modeled after the Rockefeller Institute. Critics often content that De Kruif relied too much on his imagination, but two successful Hollywood movies and one successful Broadway play were based on *Microbe Hunters*, his most famous book.

that hindered the emerging scientific view on the aetiology of disease. With his Stockmann-like character he eagerly accepted the challenge.[6] This event was an experiment and a public performance at the same time, an experimental "show" (Debré 1994/1998, p. 397). Actually, it was intended as a plot by enemies to lure Pasteur into a dangerous situation, but he succeeded. Pasteur, the "scientific showman", the "actor", the maker of "theatrical gestures" (De Kruif, p. 234) was inspired (in his own words) by "a passion for progress and truth" (p. 219). He marched into the arena "like a matador", facing dignitaries, farmers and other visitors of all walks of life – a typical stage-setting for an experimental drama (p. 214). Spectators formed a large crowd and it took some time for the noise to die down. The atmosphere was that of a country fair rather than a laboratory (Debré 1994/1998).

Bruno Latour describes Pasteur's dramatic public experiment at Pouilly-le-fort in similar terms, namely as a "theatre of proof" (1984/1988, p. 85). Pasteur performed his experiments not only live, before a large audience, but also in front of the assembled media who followed and reported his operations meticulously (p. 87). Thus, he was able to interest a large educated public in the "daily drama" of his trials. The experiment was a grand success and the sceptics were converted.[7] In this manner he set a model for what Stockmann (albeit unsuccessfully) tried to achieve in Norway.

Robert Koch, secluded and austere, was the reverse image of his much more passionate French contemporary. Like Stockmann – so to speak – he started as a lone doctor, living and working in almost complete scientific isolation (Brock 1988). He performed his researches in silence, spending his days as a country doctor in villages in Eastern Prussia (notably in Wollstein). Like Stockmann during his early years "up north", he was virtually cut off from the world of science, from libraries and contact with other scientific workers. "Never could a man have found himself in a position less favourable for scientific research – poor, humble, unknown, isolated from the scientific appliances which are the necessary tools of the investigator" (Brock, p. 27). From 1876 onwards, however, Koch managed to rise above his environment and to become a major medical and public figure – a

[6] "Pasteur's reports on preventing sheep anthrax were so unbelievable to some, that he was challenged by the well-known veterinarian Rossignol to conduct a carefully controlled public test of his anthrax vaccine. This was to take place at Pouilly-le-Fort, a farm in the town of Melun south of Paris. Twenty-five sheep were to be controls, the other twenty-five were to be vaccinated by Pasteur and then all animals would receive a lethal dose of anthrax. All of the control sheep must die and the vaccinated sheep must live.… The publicity was intense. A reporter from the London *Times* sent back daily dispatches. Newspapers in France followed the events with daily bulletins. There were crowds of onlookers, farmers, engineers, veterinarians, physicians, scientists and a carnivalesque atmosphere.… Happily, the trial was a complete success – indeed, a triumph! Two days after the final inoculation (May 5, 1882), every one of 25 control sheep was dead and every one of the 25 vaccinated sheep was alive and healthy. The fame of Pasteur and these experiments spread throughout France, Europe and beyond. It was … the anthrax vaccine that spread through the public mind faith in the science of microbes". (Cohn 1996)

[7] Unfortunately, however, it was a temporary success. Before long, disturbing comments began to arrive, notably a scientific report, signed by Robert Koch from Berlin.

visible scientist. With the help of his microscope, he designed careful and accurate experiments to discover the causes of diseases afflicting farm animals (e.g. anthrax) and patients (e.g. tuberculosis and cholera). Thus, he has had a tremendous impact on hygiene and public health. As a self-made scientist working in a home-made laboratory, he made his first great discovery – he discovered the microbe that caused anthrax, prevalent among farm animals in the Wollstein district. By means of careful painstaking experimentations he proved scientifically that the bacillus was really what caused the disease. Upon writing a courteous letter to Professor Ferdinand Cohn at Breslau, he presented his results in 1876 by performing a number of experiments before an academic audience. Unlike Stockmann, he was extremely hesitant when it came to publishing his results, but Cohn took care of it. Due to this publication, he immediately soared out of the ranks of anonymous physicians and found himself among the most original researchers (De Kruif, p. 155).

Public interest in and enthusiasm over his results was strong. Subsequently, he developed ingenious methods for fixing, staining and photographing bacteria. After he had moved to Berlin in 1880 he decided to investigate the microbe that caused tuberculosis. He patiently and silently performed a great number of experiments in a relatively short time and then he was ready to give his news to the world: the bacillus was discovered. Once again, the scientific proof was presented in a dramatic, performative fashion. On the March 24, 1882 he presented his findings to a meeting of the Physiological Society in Berlin. He *showed* his audience a summary of the experiments he had performed in his own laboratory. The meeting was, so to speak, the absolute opposite of the fourth act of Ibsen's play. When he finished his lecture, there was silence. No applause, no questions, no debate – the audience was simply stunned with admiration. This is how De Kruif describes it:

> He told the plain story with no oratorical raising of his voice.… At last Koch sat down, to wait for the discussion, the inevitable arguments and objections that greet the finish of revolutionary papers. But no man rose to his feet, no word was spoken, and finally eyes began to turn toward Virchow, the oracle, the Tsar of German science, the thunderer whose mere frown had ruined great theories of disease. All eyes looked at him, but Virchow got up, put on his hat, and left the room – he had no word to say.… In 1882 the news that Robert Koch had found the microbe of tuberculosis trickled out of the little room of the Physiological Society the same evening, sang to Kamchatka and to San Fransisco on the cable wires that night, and exploded on the front pages of the newspapers in the morning. (p. 182)

Yet the publication of his paper 3 weeks later created a sensation throughout the world (in the Kruif's words: "The world went wild over Koch"). On April 22, 1882 the news was brought by the London *Times*, and on May 3 by the *New York Times*. At least an echo of the stir must have reached fervent newspaper readers like Ibsen.[8] A few months later, at the *German Exposition of Hygiene and Public Health*,

[8] Robert Koch was not the only man of science involved in this kind of research. Paul von Baumgarten had reported the discovery of the tuberculosis bacillus a few days earlier, but his thesis was less well-founded that Koch's. It shows, however, that this type of research was really up to date.

a replica of Robert Koch's laboratory was shown to the public, with the latest equipment for studying infectious diseases. It made his name even more familiar to the general public. Together with Pasteur, Koch initiated microbiology as an experimental science. He was responsible for developing and refining the logical structure of microbiological experiments. But perhaps it would be more accurate to say that his chief interest was in applied ecology: he was interested in the way bacteria maintain themselves in different environments and spread from host to host (Brock, p. 290).

The life histories of Stockmann, Pasteur and Koch confront us with three more or less contemporary events, situated on the borderline between theatre and science. In 1881, Pasteur performs his dramatic public experiment at Pouilly-le-Fort. The atmosphere is tense and Ibsen-like, but unlike Stockmann, Pasteur is eventually heralded as a public benefactor, rather than as a public enemy – for the time being at least. Subsequently, in March 1882, Robert Koch gives his lecture and performs his famous experiments before a scholarly audience in Berlin. The atmosphere is quite unlike the tumultuous scenes of Ibsen's fourth act, but as the news spreads round, he too is heralded as a public benefactor. Finally, later that same year, Ibsen's play is performed for the first time. Stockmann, intent on lecturing on microbes and infectious diseases and hoping to be heralded as a public benefactor too, meets with a completely different, more unfortunate fate. Nevertheless, he too is a microbe hunter interested in improving the hygienic conditions of his fellow human beings by using microscopic data, hoping to prevent the spread of infectious diseases by taking sanitary measures.[9]

A few years later, when Hamburg was struck by a cholera epidemic, the similarity between Stockmann and Koch became closer even.[10] Koch went over to Hamburg in order to investigate the local hygienic conditions. Contrary to some of his colleagues, he insisted that cholera was due to an infectious agent and saw water as the primary mode of transmission. The Hamburg epidemic permitted Koch to *prove* the relationship between the purity of water and the incidence of infectious diseases. Both Hamburg and the nearby city of Altona obtained their water from the Elbe, but while Hamburg obtained it unfiltered from apparently unpolluted surface water, Altona derived it from the water that had flowed through Hamburg, picking

[9] Besides Pasteur and Koch, Ignaz Semmelweis (1818–1865) and Joseph Lister (1827–1912) deserve to be mentioned as microbe fighters. Semmelweis was persecuted for saying that physicians should wash their hands before doing any procedures on patients, and when Joseph Lister actually saw microbes in a microscope he knew that Semmelweis was right. Inspired by the work of Pasteur he became the pioneer of antisceptic surgery. Also in this case, biomedical history has a literary counterpart. The Norwegian playwright Jens Bjørneboe (1920–1976) wrote a play about Semmelwies's struggle against childbed fever, with strong political overtones (Bjørneboe 1998). For obvious reasons, it is often compared to Ibsen's *A Public Enemy*. Finally, in 1924, the famous French novelist Celine – a physician – published his thesis on Semmelweis.

[10] One could say that Stockmann is more similar to Pasteur in terms of temperament, to Koch in terms of biography.

up sewage water on the way (Brock 1988, p. 32). Yet, while Hamburg was visited heavily with cholera, Altona was nearly free of the disease, due to the fact that it filtered its water supply by means of sand. Koch provided solid bacteriological evidence for the efficacy of sand filtration by counting bacteria before and after filtration. Thus, he showed engineers the most effective (albeit costly) way to attack the problem, thereby placing sanitary engineering on a firm footing. His work became the basis for government regulations requiring bacteriological examination of public water supplies. In short, Koch set a model for physicians interested in public health like Stockmann. He managed to do what Stockmann failed to achieve, not only by assembling convincing scientific evidence, but also by communicating his conclusions and recommendations to politicians, officials and policymakers in an effective manner.[11] In other words, he not only proved that cholera was transmitted by microbic agents, but he also demonstrated the pivotal importance for scientists involved in ecological research to develop communicative and socio-political insights and skills.

Bruno Latour (1984/1988) describes the work of Pasteur and other "microbe hunters" against the backdrop of the much broader hygienist movement of his days. The hygienists' aim was to make the environment (notably the urban environment) healthier for humans. Costly municipal investments (to improve the water supply for example) had already been promoted by them, but microbiology finally offered a *scientific guarantee* that these investments would really proof effective and indispensable. Thus, the microbiologists *displaced* the traditional engineers who had forgotten the microbes in their plans. By making the microbes visible they were able to translate laboratory data into concrete plans and policies. This pattern is clearly recognizable in Ibsen's drama as well: Stockmann tries to overrule the municipal engineer who, by supporting the "economical" solution, failed to taken the animalculae into account. Unlike other microbe hunters, however, he was unsuccessful – and I tried to point out why.

Two basic scripts or typical scenarios are embedded in these biographical stories. The first script concerns the isolated, invisible scientist, working quietly in his home-made laboratory, whose only contact with the world of science consists of an occasional letter to a university expert, but who suddenly experiences his *Eureka!*, his breakthrough, the decisive event that puts him on one line with the other famous "heroes" of science. The contours of this script can be discerned in Koch's biography as well as in Ibsen's play, but while it works out extremely well in the case of Koch, it completely miscarries in the case of Stockmann. The second script concerns a dramatic public event during which a scientific proof of great import is presented by a scientific hero to a mixed audience. Once again, this scenario is present

[11] Koch's life was not always a success story, however. His claim that he had discovered a *remedy* for tuberculosis proved a disapppointment and his decision to devorce his wife and remarry a much younger woman caused a scandal. Whereas Stockmann considered emigrating to America, Koch went off to Africa to escape public criticism – and to do research on malaria and other infectuous diseases.

both in the case of a real scientist (Pasteur) and in the case of Stockmann, but whereas it works out quite successfully in the case of Pasteur, Stockmann faces a dramatic failure. In his play, Ibsen makes full use of the contrast between the quiet, secluded atmosphere of the first script and the tumultuous and dramatic nature of the second. Indeed, they are like two *Acts* in a play.

A major reason for Stockmann's failure, his *tragic flaw* so to speak, is his unwise and sudden decision to change genres and to leap from science to philosophy without preparing himself properly. Instead of discussing environmental pollution and issues of public health, he enters upon one of the typical themes of nineteenth century philosophical discourse, namely "mass phobia", or the anxiety (articulated by Le Bon, Mill, Nietzsche, Kierkegaard and others) over the fact that the intellectual, the autonomous individual, the free-thinker is likely to be outnumbered, in a democratic era, by a prejudiced and backward "majority". After failing to see the anonymous masses for centuries and consciously focussing on the elite, when finally philosophers become aware of the majority of mankind, their first image of their societal environment is that of a "swarm" of microbe-like entities.

Besides being "politically incorrect", Stockmann's ideas on this subject are rather confused and his discourse is anything but carefully composed. It reads, rather, like a desperate improvisation. The argument that the environment has been polluted due to mistakes made by blundering and short-sighted politicians is based on a completely different kind of "scientific proof" than Stockmann's revelation that the majority of people is unable to think rationally and consistently. There is no attempt at careful analysis, for instance in terms of styles of thinking. He eagerly extrapolates Darwinism and pseudo-genetics to human society without giving it much thought. Therefore, his address is the outcome of imagination, rather than of reasoning. It is an intuition, rather than an argument. That is, Stockmann articulates an archetype, the archetypical image of sociology, the sociological equivalent of the monster-archetype of biology: the image of the (amorphous, violent, irrational etc.) monstrous masses, a promising and fascinating prospect for some, a terrible idea for others. His radical aristocratic conceptions conflict with the views of both the "right" and the "left". Indeed, the apparent ease with which Stockmann shifts from discerning the *fascinating* aspect of the mass phenomenon (in the beginning of the play) while highlighting its terrible and δεῖνος aspect towards the end, is a symptom of the fact that we are indeed confronted with an archetype.

8.5 Taming the Micro- and the Macro-monster

What can we learn from Ibsen's play, what is its "message"? As we have seen, Dr. Stockmann belonged to a whole generation of microbe hunters who directed public attention to the presence of microbes in the environment (be it as our benefactors or as our enemies). From a purely scientific point of view Stockmann is of course far from being Koch's equal. While the latter assembled and handled his own equipment for example (indeed: technical dexterity in using delicate tools was part of his

genius), Stockmann remained heavily dependent on the tools and expertise of others. But what is important is that none of these researchers were *pure* scientists. They were all very much involved in the process of making research more relevant for society: Pasteur as a champion of vaccination, Koch as an influential and internationally acknowledged hygiene expert and Stockmann – if only he had succeeded – as a public health expert who could have been involved in revealing and addressing instances of environmental pollution. The dispute over spontaneous generation that had obsessed previous microbe experts had been purely theoretical. The new microbiology had an immediate and highly significant impact on human existence.

Indeed, the inquiries made by Pasteur, Koch and their followers (such as Roux, Behring, and Ehrlich who became famous in their own right) had an outspoken societal *relevance*. Their research had an obvious link with environmental concerns and public health issues. And therefore, sooner or later, the researchers involved were called upon to go beyond their small subculture of scientific experts and to address broader non-expert audiences: the press, the authorities, the public at large. In others words, these researchers were not only involved in internal communication among fellow scientists, but (because of the nature of their discoveries) they also took part in the intricate dialogue between science and societal stakeholders. At first, they would present their findings to small assemblies of scientific experts, as Koch did in Breslau and Berlin. But sooner or later, they would be facing much broader publics (or their political and journalistic representatives). And in order to be successful in reaching this broader audience, the microbe hunters had to switch genres, they had to develop new forms of communication, more dramatic even than traditional experimental demonstrations. They began to use more theatrical forms of presentation, such as public speeches or scientific demonstrations before audiences "of all walks of life". Like experimentation, the public dissemination of research findings presupposes a considerable amount of skill and exercise as well. Only if the "theatrical" component is professionally done can researchers hope to convey their information on microbes – information that lay persons may find very difficult to comprehend at first – and prepare the ground for preventive measures.

Although Stockmann on previous occasions had shown himself a prolific contributor to Aslaksen's newspaper, that is, as someone who successfully popularized the scientific point of view, on the crucial moment (which could have been his "finest hour") he completely failed to communicate his research findings to the public. This was not completely his fault of course. His four-paged manuscript might have had a tremendous impact on the public had he been allowed to read it, but his adversaries successfully prevented him from disseminating his views. Relying on their political techniques, they managed to transform Stockmann's audience into a fearful, archetypical "mob" – an image that incited Stockmann to launch his desperate assault. What we may learn from Ibsen's play, in short, is that scientific "heroes" – visible scientists – had not only developed their talents and dexterity for handling microscopes, or for collecting and analysing water samples. They also excelled in the more theatrical dimensions of their work, notably when it came to addressing broader audiences and discerning the societal and communicative dimensions of their work.

These communicative talents and skills were especially important when it came to dealing with the two most important intermediaries that had positioned themselves between scientists and the public at large, namely politicians and journalists. The histories of Pasteur and Koch are interesting because, notwithstanding their striking differences in terms of strategy and style, they constituted role models that could (and to a certain extent still can) be copied by others, not only in order to become successful experimentalists, but also in order to become successful communicators. Stockmann, on the other hand, is interesting precisely because, as an anti-hero, his story more or less constitutes the reverse image of the performances of these real microbe hunters. From Ibsen's play we may distil a list of possible mistakes to be avoided. We may read *A Public Enemy* in order to understand what may go wrong, and what kind of pitfalls are to be avoided, whenever a scientist feels the need (often for very good reasons) to address a larger public, first through its intermediaries (notably journalists and politicians), but eventually face-to-face. The most basic skill of all is the ability to tame, to domesticate – rather than to infuriate – the monster. This is what Pasteur and Koch manage to do. And this applies both to the monster of microbiology (the *swarm* of microbes) and to the societal monster (the anonymous masses). Pasteur not only handled microbes quite effectively, he could also work with large lay audiences. Notably the domestication of the latter involves a gift for theatre. *This* – rather than the ethics of whistle-blowing – is Ibsen's basic message.

Chapter 9
Pea Stories. Why was Mendel's Research Ignored in 1866 and Rediscovered in 1900?

9.1 Introduction

The story of Mendel's research is one of the highlights in the history of the life sciences. It has become a scientific legend. In 1865, after 8 long years of careful, time-consuming and laborious experiments with *Pisum Sativum* (the common garden pea), father Gregor Mendel (1822–1884) of the Augustinian monastery of Brünn (now: Brno) recorded and analysed his findings in a two-part lecture before the Brünn Society for Natural History. Subsequently, he published, in the society's proceedings, a forty four-page article on which his fame still rests (Mendel 1866/1913). He dispatched several copies of it to leading experts in biology and botany but apparently, hardly anyone took notice of it. He did receive an answer from Professor Carl Nägeli of the University of Munich, but even he took 2 months to reply. And instead of becoming interested in Mendel's work, Nägeli tried to persuade him to participate in a research programme of his own. And indeed, in the correspondence that subsequently evolved, Mendel offered his services as an unpaid research assistant, more or less. Mendel had hoped that Nägeli would assess, and even repeat, his experiments on *Pisum Sativum*, but instead the latter urged him to join his experiments on *Hieracium* (hawkweed). Their correspondence lingered on for some years (they continued to exchange letter until 1873), centring around Mendel's discouraging problems with his Hawkweed-trials, but eventually it ended in silence. For years to come, Mendel's masterpiece was virtually ignored. Although his article was cited every now and then,[1] it failed to really impress his contemporaries. Then, all of a sudden, in the spring of 1900, his paper was unearthed and rediscovered, posthumously, by three different scholars, simultaneously but independently from one another. They were all active in what was about to become the field of genetics. All of a sudden, Mendel's paper became a scientific classic, the starting

[1] As pointed out by Orel (1996), we must not exaggerate his contemporaries' lack of appreciation. Orel lists a number of authors referring to Mendel. One of these sources (Focke 1881) even refers to him fifteen times. Notwithstanding the existence of citations predating the year of his rediscovery, the difference in impact of Mendel's work before and after 1900 remains considerable.

point of a new style of research, and its impact was enormous. It was the beginning of a dramatic transition of biology as a field. As a result, researchers suddenly became interested in this enigmatic author, who was almost totally unknown among professionals. But even today, Mendel remains a surprisingly obscure figure. After decades of historical research, data on Mendel's life and work are remarkably sparse, compared to what we know about some of his contemporaries such as, for example, Charles Darwin (1809–1882) or Louis Pasteur (1822–1895).

Mendel's story has raised (and will no doubt continue to raise) a host of questions of various kinds: historical, philosophical and scientific. The most tenacious one, I think, is how we are to explain the tremendous difference between the impact his article had when it was originally published and its eventual impact after its rediscovery. All of a sudden, an obscure and more or less forgotten publication was celebrated as a scientific highlight. What had happened, between 1866 and 1900? Various explanations have been given. First of all, Mendel's paper contains a relatively large amount of mathematics, and in the 1860s his readership, the natural historians (both professional and amateur) were not yet very fluent when it came to mastery of numbers. Many of them were still suffering from what we nowadays refer to as "innumeracy".[2] His subtle mathematical reasoning was apparently wasted on them.[3] Mendel was, moreover, an exceptionally shy person, an introvert, and rather hesitant when it came to disseminating his data. He allowed his masterpiece to appear in an obscure source, hardly accessible to the scientific avant-garde of the day. And although he did send copies to a number of acknowledged experts, he undertook no further action. Perhaps Mendel should have given it more effort. Eventually, he even allowed his correspondence with Nägeli to die out. In other words, it was Mendel himself, up to a certain extent, who was to blame for his lack of recognition. His biographer Orel (1996) is rather outspoken on this issue. He points out that, although Mendel did draw attention to his paper immediately after it was published, he did little to promote his ideas in later years:

> We may well ask why he did not publish the results of experiments with other plant species [besides peas], about which he reported in detail in his correspondence with Nägeli. In effect each of his letters was a scientific communication which might have been published after slight editing. … Mendel must have had every reason to publish the results of further experiments, and prove the wider validity of his theory. … But he was silent. (p. 290/291)

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[2] According to Simon Mawer (1998) innumeracy was among the reasons why the event of Mendel reading his first paper, "one of the most momentous scientific events of the nineteenth century … a moment like few others in the history of science", failed to have much of an impact: "Can you wonder that a great silence fell in the room, the silence of incomprehension, of indifference, of boredom? Can you wonder that the applause in the end was thin? … There was a vague sense of embarrassment, a feeling that they had been called out in the cold evening on a fool's errand. They had come to see about plants and hybrids; they had got mathematics" (p. 194).

[3] His audience "listened uncomprehendingly as he plunged into the mathematics of hybridization. By training and inclination a physicist rather than a botanist, Mendel preferred to express his ideas in mathematical terms wherever possible. … He was completely unaware that he had left his audience behind" (Sottin 1959, p. 152). "Mendel flooded his audience with statistics, numbers and ratios. … He did not begin by declaring 'I have found the secret of heredity'" (Shreeve 2004, p. 29).

Another explanation sometimes given is that, as a priest, he may have felt reluctant to publish data that could have brought him into conflict with religious authorities. Of all possible explanations, this is surely the least convincing one. Mendel never seems to have experienced any conflict between his scientific research and his religious convictions, or between theology and science. He seems never to have felt "any basic differences between science and religion. He functioned both as a scientist and as a priest without conflict" (Sottin 1959). He belonged to an order that regarded scholarly and experimental research as a perfectly legitimate vocation.

Although Mendel's reluctant style of communication is no doubt a relevant factor in itself, it does not tell us the whole story. In this chapter I will focus on another possible explanation, mentioned in various sources, but usually in a rather vague manner, the idea namely that somehow, Mendel's time was not yet "ripe" for his findings and his approach, that somehow his paper was "ahead of its time", that it failed to concord with the "spirit of the time" – the *Zeitgeist*.[4] It is the objective of this chapter to critically assess this line of reasoning and to make it more precise. What exactly do we mean with phrases such as "the spirit of the time", and in what way *exactly* did Mendel fail to concur with it? Why were contemporaries interested in the natural sciences ready for Darwin's discoveries, for example, but not for his?

This is, of course, an epistemological question, rather than a historical one. It is not the objective of this chapter to add new historical or biographical data to what others have already uncovered and assembled. As far as biographical details are concerned, I will rely on the research that already has been done by various authors. My basic objective is to try to understand the intellectual content of Mendel's work from an epistemological perspective. Why did he initially fail to impress his readers, and why were his ideas suddenly embraced with such enthusiasm 34 years later? How did Mendel's work relate to his cultural environment, to the *Zeitgeist* of his own era and to that of the next generation? It is the type of question that should be addressed by a *comparative* epistemological approach. As was explained in Chapter 1, the focus of comparative epistemology is on synchronicities, on affinities between intellectual events in various domains of culture, notably science and literature. Mendel's ideas somehow must have belonged to his time, but in what manner? And why did his ideas, "recessive" at first, all of a sudden become so "dominant"?

I will start with a concise account of Mendel's life and work, a summary of the case study so to speak, before moving on to the comparative epistemological analysis.

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[4] Iltis (1924) speaks about the lack of concurrency, on Mendel's part, with the "Bewuβtsein der Zeit" ("the Consciousness of the Time"). Posthumously, his nephews Alois and Ferdinand Schindler reported that, later in life, Mendel repeatedly said, referring to the future impact of his work, that "his time would come" ("Meine Zeit wird schon kommen"); also quoted in Henig (pp. 160, 171). Simon Mawer (1998) writes: "It is rare that a man is genuinly ahead of his time. Even the greatest discoveries in science [he mentions Darwin and Watson & Crick] are made in their appropriate time. … Few are ahead of their time – but Gregor Mendel was. He was so far ahead … that even when he spelled it out and people read the argument … they still couldn't grasp the importance" (p. 257). Henig (2000) likewise states that Mendel was born a generation too soon.

Notably, I will focus on the way Mendel communicated his findings, for although it is true that as a researcher he was a rather timid, modest and introvert person, he was nevertheless more active in terms of scholarly communication than is sometimes thought. Basically, however, I am interested in his *style* of working and thinking, in the *epistemological profile* of his experiments. What did he try to prove? What was his conceptual framework? How did he interact with his model species? And most of all, why were his readers in 1900 much more willing to accept this style of reasoning than those of 1866? Why were his ideas about what would become genetics more or less lost on his own generation?

This question will be addressed in the form of a case study in comparative epistemology. I will point out that, in important respects, the basic logic of Mendel's ideas was quite out of tune with the scientific discourses that constituted the mainstreams of his disciplines (notably botany and, more generally, natural history) as they were evolving in this period (the 1850s and 1860s). Yet, they were remarkably congenial to the ways of thinking displayed in a number of literary sources of this epoch. The latter retained conceptual elements that were more or less "repressed" in dominant scientific discourse. The rediscovery of Mendel signifies the moment when these repressed ideas, through an epistemological reversal as it were, returned to the surface and became dominant once again.

9.2 The Imperfection of the Biographical Record

We still do not know very much about Mendel. Notwithstanding the fact that careful biographical research has been done, by scholars like Iltis (1924), Olby (1966) and Orel (1996), there remain deplorable gaps. Indeed, biographical data on Mendel are unsatisfactory to this day (Orel 1996, p. 1). He kept no diary and no research notebooks from his experiments survived. Despite all that has been discovered, we are not very well informed about his sources of inspiration (Olby 1966, p. 104). One gets the impression that in later years, he was not a very likable person. He died without leaving many friends. This may explain the deplorable fact that apparently, shortly after his death, Abbot Rambousek (Mendel's successor) ordered his papers to be burned. Throughout his life he was a modest, introvert personality who performed his research in the seclusion of a monastery on the edge of a provincial town. It is not at all surprising, therefore, that time and again so many of his biographers rely on their imagination to a considerable extent when it comes to describing his life and work in more detail. And this not only goes for more popular biographies such as Sottin's (1959). Recently, Robin Marantz Henig (2000) published a biography that contains beautiful novel-like sections and Simon Mawer (1998) even wrote a novel that is in part a biography of Mendel. In terms of genre, Mawer's document is a perfect hybrid: a dialectical interplay of fact and fiction. Time and again biographers have reverted to more or less narrative styles of writing. Due to the scantiness of data, we have to rely on our imagination when it comes to entering Mendel's world and to familiarise ourselves with the details of his performance. These hybrid

sources, recasting biographical data in a narrative manner, blurring the boundaries between scholarly monographs and belles-lettres, will also prove valuable sources for an epistemological analysis, especially if we want to situate Mendel's work in the context of his world, his cultural environment.

The scantiness of data not only affects our biographical knowledge. It also affects our knowledge of his research as such. His paper raises a whole set of questions. Indeed, for those who read it carefully, it is likely to raise more questions than it answers. First of all there are questions about the technical and methodological details of his work. In a famous article Fischer (1936) tried to reconstruct the experiments and came to the conclusion that Mendel cannot possibly have performed them as they were reported, while DiTrocchi (1991) even concluded that most of the experiments described in his article are fictitious in the sense that they were performed *on paper*, in retrospect as it were, by disaggregating the data from various trials.[5] Others have criticised these findings,[6] quite convincingly in my view, but the debate over the issue still continues. Even less transparent, even more opaque are the ideas and concepts that led him to his experimental design. What precisely did he want to show? What where the theoretical conceptions that were guiding him? What was the epistemological profile of his reasoning? This type of questions is especially important if we want to address the issue of Mendel's apparent lack of congruency with the "spirit" of his era.

Notwithstanding these difficulties, resulting from "the imperfection of the biographical record", I believe it is possible and legitimate to ask ourselves in what way the epistemological profile of Mendel's work conflicted with the spirit of the age in 1866, while suddenly being in agreement with the spirit of the age at the turn of the century, when they were much more favourably considered. I will formulate an answer to this question in three successive steps. First of all, I will look at Mendel's scientific sources: his predecessors in the field of experimental botany. Notably, I will draw attention to the writings of Joseph Gottlieb Kölreuter, whose work contains some theoretical ideas that may also have guided Gregor Mendel. This will provide us with the beginning of an answer to the question in what way and to what extent Mendel fell out of tune with his intellectual environment.

Subsequently, I will turn attention to Mendel's own time, his cultural world. It is notably in this section of the chapter that a comparative epistemological approach will be fleshed out. I will start by pointing out that, on the cultural level, there are remarkable similarities between Mendel's work and a number of literary documents that were written in this same epoch. These literary documents may help us to elucidate Mendel's research practice and style of reasoning. Indeed, Mendel's paper is not the only remarkable "pea story" written in the nineteenth century. This exercise will indicate that, apparently, the manner in which Mendel interacted with

[5] DiTrocchi does not deny that Mendel actually performed a great number of experiments, but he claims that the logical schema Mendel used to interpret his data were developed in retrospect.

[6] Lamprecht (1968), Pilgrim (1986), Joyce (1987), Valen (1987), Weiling (1989).

his peas, as well as with other model species, was somewhat out of tune with mainstream biology of his lifetime, but not at all out of tune with other dimension of his cultural milieu, notably belles-lettres.

Finally, I will turn attention to Mendel's *scientific* contemporaries. Notably, I will compare Mendel's view with those of his contemporary Charles Darwin who became immediately famous when in 1859 *The Origin of Species* was published. In various respects, Darwin was Mendel's perfect counterpart. I will argue that Mendel's work, up to a certain extent, can be regarded as a polemical dialogue with Darwin. Initially, the focus will be on their strategies for communication and dissemination, on their tactics as authors. But eventually I will argue that these differences in strategy cannot suffice to explain the difference in impact between Darwin's best-seller and Mendel's obscure paper. Somehow, time was ready for Darwin, and not for Mendel – but in what sense? What can be meant by the claim that in 1866 the world was ready for evolution, but not quite ready for genetics? What was, on the epistemological level, the basic difference between the theoretical views of Darwin and those of Mendel? A comparative epistemological approach will allow us to address this issue.

9.3 Mendel: A Case Study

Gregor Mendel was born in 1822 in Heinzendorf in Northern Moravia.[7] He came from a rural (agricultural and horticultural) background. Three out of four of his forefathers were of German origin, one out of four was Czech. Thus, his genealogy already displayed the famous ratio he was to discover later on (Orel 1996). In biographies, young Mendel is depicted as a withdrawn, but sympathetic person who tended to respond to the more serious existential challenges and difficulties in his life by falling ill and hiding in his bed for extended periods of time (weeks or even months). He had a lively interest in the natural sciences, but his parents were unable to financially support an intellectual career. After years of hardship and poverty he decided to enter the Augustinian monastery at Brno (Brünn).[8] He was admitted there as a novice in 1843 at the age of 21. Four years later he became a priest. His priesthood activities, notably caring for the ill and dying, soon resulted in a severe psychic and physical crisis, and his considerate abbot decided that Mendel should become a priestly intellectual instead. The monastery was a centre of learning, an intellectual oasis, an outstanding scholarly institution. Mendel joined a brotherhood

[7] He was in other words a Sudeten-German (Mawer 1998). He was actually born as Johann, but received the name Gregor upon entering the Augustinian monastery.

[8] "It was the only route available for the son of a destitute peasant in search of an education. … [The Augustinian monastery] was an ideal haven for a young man with an interest in natural science and little forward momentum in life" (Shreeve 2004, p. 28).

of scholars devoted to a broad range of scientific pursuits – although horticulture seemed to be something of a common ground. Scientific investigation and experimentation was greatly encouraged among the friars dwelling in these medieval living quarters. By entering the Augustinian order, he was not at all cutting himself off from the world of cultural and scientific developments, rather the reverse was true (Olby 1966, p. 107). Virtually every single member of this cloistered community was a learned man (Henig 2000, p. 151).

Mendel's colleagues included several outstanding scholars such as Matthew Klacel (1808–1882), a well-known botanist[9] and Hegel expert; Pavel Krizkovsky (1820–1885), musician, composer and an expert on church music; and Franz Thomas Bratranek (1815–1884), whose work I already briefly discussed in Chapter 7. The latter was a Goethe scholar who edited Goethe's correspondence with natural scientists such as Alexander von Humboldt. In 1853 he published a remarkable book, *Ästhetik der Pflanzen* ("The Aesthetics of Plants") in which he developed a rather Romantic view on plant life and its impact on human beings. I will come back to it in more detail below. Besides gardening, Mendel engaged in various other scientific activities. Throughout his life he was interested in weather-forecasting and beekeeping. In fact, the majority of his publications are about meteorology. He was the official weather watcher of Brno, taking meteorological observations daily and sending them to the Vienna Meteorological Institute. Accurate observation and mathematical treatment of data is characteristic of his work in this area as well.

On two occasions, namely in 1850 and in 1856, he failed the examination that was supposed to bring him his teaching certificate as well as a permanent appointment – and on both occasions he fell ill. After the first failure, his superiors made it possible for him to study at the University of Vienna (1851–1853), where he received a thorough training in physics (with Doppler), mathematics (with Ettinghausen) and botany (with Unger) and acquainted himself with the logic of experimental research. Upon his return from Vienna to Brno, he started working with peas and in 1856, after his second failure, his seminal pea experiments in the monastery garden really began. He wanted to apply the standards of the "hard" sciences (notably physics) to biology, at a time when this was still a much "softer" science (Henig 2000).[10] His abbot, running his monastery like a university department, encouraged him to do so.[11] Rather than questioning nature in an aggressive

[9] He had been in charge of the experimental garden before Mendel and grew alpine plants in it to test whether changes in the environment led to changes in the plants themselves.

[10] Cf. The famous saying by Ernst Rutherford that science is either physics or stamp collecting. In the days of Mendel biology was still to a large extent "natural history", a scientific practice still centred around the art of collecting and classifying specimens.

[11] Initially, Mendel had worked with mice, but a bishop who came to visit the establishment found it improper that a priest who had taken vows of chastity and celibacy should be watching and studying rodent sex. Therefore, but perhaps also for hygienic reasons, Mendel turned from animal to plant breeding. In those days not everybody realised that plants were sexual entities as well.

manner, Mendel applied softer skills, such as painstaking brushwork. His work implied caressing rather than torturing nature, carefully moving his paintbrush among the delicate petals in order to fertilize his plants. Whereas Bacon said that nature reveals her secrets when put to torture, Mendel proved that nature reveals her secrets when she is *stroked* (Mawer 1998, p. 61). Nonetheless, his method came down to "castrating", "de-sexing", "emasculating" or "feminizing" his plants. Even in Mendel's experiments there was an element of violence.

As is argued convincingly by Orel (1996), the *Pisum*-experiments were part of a larger, long-term research programme of which the work with peas formed only the first stage. After 8 years of experimentation he published his results and this brought him in contact with Nägeli, an expert in the field of hybridisation. The latter managed to convince him that he should try his hand at *Hieracium* – a real challenge. Due to technical problems as well as to the fact that reproduction in *Hieracium* usually takes place through apomixis, his results were not very impressive. Although he published his data, the *Hieracium*-paper remained obscure until today (unfortunately, the rediscovery of Mendel's work only concerned his *Pisum*-paper, not his work *as such*). Besides *Pisum* (the garden pea) and *Hieracium* (hawkweed), Mendel worked with various other species as well, such as mice (already mentioned), beans, fuchsias and bees.[12] After he was elected abbot, however, administrative duties increasingly interfered with his research work. Besides that, his health gradually deteriorated, notably due to stress, obesity (due to his excessive fondness for good food) and heavy smoking (recommended as a remedy to counter overweight). His administrative position brought him into a chronic conflict, first with the Austrian authorities, but eventually with more or less everyone around him. At the time of his death, his life must have seemed more or less a failure.

This is the basic outline of the story. The question to be addressed now is: what precisely was Mendel doing in his garden? What were the ideas he was putting to the test? To answer this question, we will first of all look at the ideas of his predecessors, his sources of inspiration.

9.4 Mendel's Predecessors

The monastery which Gregor Mendel entered was a centre of research and learning, an intellectual stronghold of considerable import. The combination of monasticism and research was less remarkable than stereotypical conceptions of monasticism may suggest.[13] The study of natural science itself had originated

[12] Fragments by Mendel in which he analyses data on beans and some other species were published by Olby (1966).

[13] William Whewell, author of an influential book entitled *History of the Inductive* Sciences (1837/1967), is usually held responsible for disseminating the belief that medieval times were scientifically speaking a dark and barren episode of stagnation.

in monasteries in the Middle Ages. In recent years historians of science have successfully demolished the pernicious myth that experimental research only became possible after Enlightenment had put an end to the "dark", monastic and gothic medieval style of thought.[14] We now know that the experimental method, the *scientia experimentalis*, emerged in a monastic context. It was developed by outstanding medieval scholars such as Albert the Great, Peter Peregrinus, Duns Scotus and Cusanus (Grant 1974). These "gothic" experimenters were especially interested in physics (notably statics and dynamics), but some of them, such as Albertus Magnus (and presumably even his pupil Thomas Aquinas), had a lively interest in alchemy (or proto-chemistry) as well. These men were, one could say, the "gothic" predecessors of the "neo-gothic" biologist Gregor Mendel.

Modern experimental botany started with the discovery of sexuality in plants by Rudolf Jacob Camerer in 1694. Due to this discovery, hybridisation became an important method of investigation (Morton 1981). Mendel's experiments were part of a flourishing research tradition and in his famous paper he mentions five predecessors by name: Kölreuter, Gärtner, Herbert, Lecocq and Wichura. The first one, Joseph Gottlieb Kölreuter (1733–1806) deserves our special attention. Starting from Camerer's discovery of sexuality in plants, he argued that a demonstration of the existence of hybrids would be the strongest proof of sexual reproduction. He undertook a large number of controlled experiments, notably with *Nicotiniana Rustica*, and studied, for example, the re-conversion of hybrids to parental forms (Morton 1981). One of his greatest achievements was the discovery of the importance of insect pollination.[15]

His work is also interesting in terms of the theoretical framing of his experiments. Kölreuter was especially interested in the possibility of *Transmutation* (in German: *Verwandlung*) of one species into another, that is, in the possibility of creating new species. Transmutation refers to a sudden rather than a gradual change. The word transmutation, moreover, has strong historical connotations – of an alchemical nature to be precise. Alchemists believed in the possibility of transmutation, notably in chemistry. They tried to produce sudden, leap-like changes of one metal or mineral into another (e.g. the transformation of lead into gold). Now the interesting thing is that, in Kölreuter's case, the alchemical connotation of the word "transmutation" must be taken quite literally. He explicitly tells his readers that it is his objective to achieve in the field of botany what the alchemists had tried to achieve in the field of chemistry. He consciously compares the transformation of one plant form into another with the alchemical

[14] One of the first to challenge the traditional image of medieval intellectual life was Oswald Spengler (1918/1923).

[15] During the eighteenth and nineteenth centuries there were two types of naturalists: travellers who collected large numbers of specimen and data, and experimentalists who stayed at home. Kölreuter and Mendel belonged to the latter, less prestigious category (Olby 1966, p. 22).

transformation of lead into gold.[16] The alchemists believed that it was possible to improve or refine (literally: to ennoble) metals or minerals, Kölreuter argues, but for some reason or other they did not try their ideas on plants. Here, however, in the vegetable sphere or kingdom, the "miracle" can be successfully performed. We can really change certain characteristics of a plant form effectively.[17] Due to this process, an original feature of a plant (e.g. a particular colour) is "repressed" ("Verdrungen", p. 88) by the new feature (the colour of the new variety), artificially induced by the experimenter. He regards his results as "strikingly" similar to what the alchemists had in mind. And he states that the alchemists would have achieved their goal, had they applied their ideas to vegetable species rather than to metals. The comparison of botany with alchemy is less awkward than the contemporary reader may be inclined to think if we realize, for example, that the symbols for male (♂) and female (♀) used by Kölreuter, and still in use in biology today, were borrowed from the alchemical tradition, where they referred not only to male and female, but also to the plants, minerals and planets (Mars and Venus) associated with them.

We do not know whether or to what extent Kölreuter's alchemical analogies were also guiding ideas for Mendel. Nonetheless, it is clear that Mendel was also involved in "creating a new kind of pea, a hybrid", in order to find out "how new and better types of plants could be created" (Henig, p. 70/71). Like Kölreuter, he was interested in the question whether and how "man can create new species" (p. 74). How plausible then is the idea, articulated by Ernst Peter Fischer (2004), that Mendel could indeed be placed in a more or less alchemically minded botanical tradition? Whether scientists like it or not, the alchemical body of thought has had a tremendous influence on a large number of heroes of modern science such as Kepler, Newton and Boyle. Indeed, it is "an unmistakable part of modern science" (Fischer 2004, p. 1). Although in the eighteenth century alchemy was pushed away into the shadowlands of science, some fundamental ideas continued to be effective (p. 4). According to Fischer, alchemists' ideas did have a considerable effect on Mendel. Like Kölreuter he studied and described the transformation of plants. He

[16] "Ich glaube durch [die Verwandlung einer Pflanze in die andere] eben so viel geleistet zu haben, als wenn ich Bley in Gold, oder Gold in Bley verwandelt hätte. Man hat die Verwandlung der Metalle von uralten Zeiten her für möglich gehalten; es ist aber noch niemand eingefallen, dass es möglich wäre, eine Pflanze in die andere, oder ein Tier in das andere zu verwandeln. Vielleicht erweckt es bey einigen meiner Leser ein vergnügen, wenn ich ihnen zeige, dass die Theorie der Alchymisten von dem Wachstum und der Veredlung der Metalle mit derjenigen, die ich von der. … Verwandlung einer Pflanze in die andere gegeben, sehr viel übereinkommt" (Kölreuter 1764, p. 88). I am indebted to Professor Ernst Peter Fischer (University of Berlin) for drawing my attention to this passage. The analogy with alchemy is briefly mentioned by Olby (1966, p. 29).

[17] What changes abruptly in an experimental setting is not the plant form as such, of course, but rather certain definite characteristics. Nonetheless, an accumulation of such discrete changes may lead "nach und nach" (Kölreuter 1764, p. 88), but still relatively fast, to an alteration of the plant form as such.

thought about the question how colour and shape of pea varieties could be changed and he was intrigued by the fact that sooner or later original forms (carrying "repressed" traits) were bound to recur.[18]

Although Mendel had studied Kölreuter carefully and highly regarded him, one might nonetheless argue for the possibility that he only used his botanical data and ignored Kölreuter's "out-dated" theoretical framing. But on further consideration it is not that easy to separate the two completely. What Kölreuter and the alchemists had in common was the idea that sudden changes (transmutations) are possible, and this basic idea appealed to Mendel as well. His research also focused on the sudden disappearance or reappearance of particular characteristics in subsequent generations. There is a certain attractiveness to the possibility that the neo-gothic experimentalist Mendel was, up to a certain extent, inspired by concepts that had flourished in gothic monasteries of medieval times, where outstanding monastic scholars had been involved in alchemical experiments. The decisive question is not, however, whether Mendel really believed in or was inspired by alchemy. What is important is that Mendel – and in *this* respect at least he agrees with the alchemical tradition – subscribed to the idea that more or less abrupt changes are possible in nature – *natura facit saltus*. Mendel proved that it is perfectly possible for a strain of garden peas to yield yellow and round peas in one generation, but green and wrinkled ones in the next.[19]

But perhaps this is all a bit far-fetched? Indeed, it may be somewhat hazardous, when it comes to making a connection between Mendel and alchemy, to rely on just one source, namely Kölreuter. I therefore want to follow this line of thinking a bit further. During the last decades of his life, Carl Gustav Jung (1875–1961) was intrigued by the extent to which alchemical schemas and ideas influenced modern science. Together with Nobel Prize winner Wolfgang Pauli (1900–1958), for example, he explored the similarities between on the one hand some basic concepts of alchemy and on the other hand the epistemological profile of the new physics that originated in 1900, starting with Planck's introduction of the photon-concept (Jung 1952).[20] After summarizing Jung's findings I will once again raise the question to what extent Mendel's basic views, his basic design, his *style of thought*, concurred with the epistemological profile of the alchemical tradition. What is at stake is not the question whether Mendel was an "alchemist", or was "influenced" by alchemy.

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[18] And it was perhaps more than just a coincidence that in 1865, in the very year Mendel presented his data, Friedrich August Kekulé von Stradonitz had his famous dream about a snake that bit his own tail – the ancient alchemical symbol of Ourobos that revealed to him the structure of benzene.

[19] According to alchemists, circularity (e.g. in round peas) is dominant because it is more perfect.

[20] A famous example of the reappearance of "repressed" alchemical conceptions in modern science is the dream (mentioned earlier) of Mendel's contemporary Friedrich August Kekulé (1829–1896), also dealing with difficulties pertaining to the question of *coniunctio* (Jung 1946, p. 179). Jung describes it as a wandering alchemical idea that "finally reaches its chemical goal".

Rather, I intend to use the "logic" of alchemy to elucidate the epistemological profile of "Mendelism". And this will provide us with a first clue for answering the question why "time was not yet ripe" in 1866 for Mendel's ideas.

9.5 Separate and Recombine

Of the many publications Jung devoted to alchemy in the later stages of his life, *Mysterium Coniunctionis* is perhaps the most important one (Jung 1995). According to Jung, the basic maxim of alchemy was *solve et coagula* – separate and recombine. Alchemy tends to understand the world in terms of basic oppositions: hot – cold; humid – dry; red – white; warm – frigid; good – bad, etc. Some natural entities are "pure", such as gold, but most natural entities are hybrid forms, combinations of contrasting elements. They contain good things and bad.[21] The combination of opposites into one entity is called a "chemical wedding", and the union of Mars (the male factor) and Venus (the female factor) is an exemplification of this process of conjunction *par excellence*.

Alchemists are intrigued by the fact that hybrid forms are able to contain apparently incompatible elements or "opposites" (*coniunctio oppositorum*). The visible element is combined somehow with its hidden (invisible) opposite. But how can incompatible elements coexist in one and the same entity? According to alchemy, this is possible because the dominant factor temporarily *represses* the opposite one. In the course of an alchemical procedure, however, it becomes possible to separate them once again. In this manner, alchemists tried to liberate "pure" but repressed entities in their laboratories. Alchemists tried to set free what was somehow "within" (Fischer 2004, p. 5). In Jung's terms, they tried to recover the repressed element. In an alchemical procedure, the pure but hidden factor is given a chance to reveal itself. It is clear that Mendel's work was also about hiding and setting free again certain repressed (recessive) "factors". But the analogy goes much further than that.

The alchemical phrase *coniunctio* roughly corresponds to what modern chemists would refer to as "synthesis". According to alchemists, laboratory work basically consists in reducing compounds to their "elements" or "factors" and in recombining these elements or factors into new conjunctions. But these new conjunctions do not display everything they contain. Natural as well as artificial entities are to be seen as combinations of active and passive, visible and invisible, conscious and unconscious elements, and one of the definitions of alchemy is that it is the art to make manifest what is hidden, and to hide what is manifest (Jung 1995, p. 283). The visible and hidden elements may be disconnected ("solution") so that they reappear precisely as they were available in the beginning, before they were combined, either by the hand

[21] *In rerum natura nihil est, quod non in se mali tantum quantum boni contineat* ("In nature there is nothing that does not contain as many good things as bad", 1995 p. 74).

of nature or by the hand of man. Almost everything we encounter in the real world contains the hidden opposites of its visible features (1946/1958).[22] This is also the case with human beings. According to Jung, our conscious personality is connected somehow to a hidden self, an unconscious alter ego. There is always the possibility however that, under certain circumstances, the repressed elements reappear. What goes for other entities goes for human beings as well. These unconscious factors may reappear in dreams or works of art, in therapeutic sessions or in novels – such as *Dr. Jekyll and Mr. Hyde* – but also in the character traits of subsequent generations. A son may be similar to his father in certain respects, but he may well be his very opposite, his alter ego in others. In terms of career choice or partner choice, for example, he may reveal and realise his father's hidden, repressed desires.

So far we have been discussing single pairs of opposite factors. The combination of two pairs of opposite factors constitutes what alchemists refer to as a "Quaternity", another concept of pivotal importance in the alchemical tradition. The combination of a red male rose, for example, with a white female one would count as a "quaternity". In the case of both opposites, one factor is usually the dominant and the other the "inferior" one, and therefore bound to become repressed. If we combine both pairs of opposite factors, one of the four resulting entities will contain both inferior factors. Therefore this "fourth" element of a quaternity will be quite unlike the other three and will more or less stand apart. It is different in the sense that it makes manifest what remains invisible in the other forms. This is why the *proportio sesquitertia*, the ratio 3:1, is of pivotal importance in alchemy. In the fourth entity reappears what is somehow present, yet hidden in the other three. Or, as alchemical wisdom has it, whenever there are three entities of something, there will always be a fourth, hidden somewhere. And whenever there are four entities of something, one of them is likely to be quite unlike the others.

One of the most important examples of the 3:1 ratio are the four elements of ancient Greek physics. There are four basic elements, but the fourth element (fire) is different from the other three and stands apart, because of it volatility – it is hardly a material element at all, rather something like warmth or light. It is therefore no coincidence that, whereas the other three elements are still present in contemporary science as the three states of aggregation (solid state, fluid state, gaseous state), the fourth element (fire) reappears in a completely different manner (namely as energy). In other words, if we start with four elements there is always the tendency to reduce them to three, whereas if we start with three elements there is always the tendency to rediscover a fourth one.[23]

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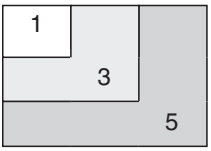
[22] "Nach alchemistischer Lehre enthält jedes Element 'innen' sein Gegenteil" (1946/1958, p. 254).

[23] To the mind of an alchemist, for example, it is no "coincidence" that Plato's *Timaios*, his most "alchemical" work, begins as follows: "One, two, three – but where, my dear Timaeus, is the fourth?" (Plato 1929/1999, 17 A). Another example Jung gives of the importance of the 3:1 ratio is the ambiguous relationship between Virgin Mary and the Trinity, which involves three male persons and one (initially repressed) female person, that nonetheless makes its reappearance time and again.

It is not difficult to discern the logic of the "conjunction of opposites" and the *proportio sesquitertia* as part of the basic conceptual framework of Mendel's trials. The conjunction of opposites is a phrase he almost literally uses.[24] He also speaks of a hybrid form as a combination ("Combination") of elements ("Elemente"). The Mendelian 3:1 ratio can be regarded as a modern biological version of this *proportio*. Indeed, one could even go a step further and discern a basic affinity between the *mathematics* of alchemy and that of Mendel. The mathematics of alchemy was based on the Pythagorean understanding of numbers. According to Pythagoras, the cosmos is structured in a perfectly mathematical fashion and the basic features of minerals, plants or planets can be described in terms of ideal mathematical proportions. In this respect, the gnomon-concept is extremely important. Gnomons are numbers that can be represented as carpenter's squares (such as 1, 3, 5 or 9) and they fit into a matrix:



They can be combined in various ways and used to describe natural entities. Mendelian proportions (e.g. 1:3:3:9) can be regarded as numerical relationships between "gnomons". Other analogies between Pythagoras and Mendel can also be mentioned. For example, they were both members (even leaders) of religious scientific communities who spent their life in celibacy, and whereas Pythagoras introduced the primal equation of Euclidian geometry ($a^2 + b^2 = c^2$), Mendel coined the first important equation of contemporary biology, namely: $(A + a)(A + a) = A + 2Aa + a$.[25]

In pointing out such analogies, however, we may run the risk of becoming too speculative. Although as I said there may be a certain attractiveness to the idea that Mendel's key concepts can be connected to these ancient theories, it is important to keep in mind what it is we want to prove. I do not want to claim that Mendel was acquainted with, inspired by or even in support of alchemy – that is not the point. Especially in view of the "imperfection of the biographical record", we have to be careful not to jump to conclusions. Not only would it be impossible to prove such a claim, it would also be irrelevant for my purposes. What is important is that there are certain structural similarities, certain congruencies in terms of basic logic between Mendelism and alchemy. Mendel's experiments, intended to produce hybrid plant forms or to reproduce the original ("pure") forms in subsequent generations, can be described as conjunctions and disjunctions of opposite "elements".

[24] "Zwei differirende [Merkmale] vereinigen sich an der Hybride" (1866/1913, p. 6).

[25] It was perhaps no coincidence that both Mendel and Pythagoras had such a remarkable interest in *Leguminosae* such as Phaseolus (beans) or Pisum (peas).

Mendel even uses this very term in his paper.[26] Examples he gives are characteristics such as green and yellow (pod colour), or dwarfish and tall (height of plants), where the inferior or recessive factor temporarily disappears from view. But the hidden factors or traits will re-emerge sooner or later, the original strains will reappear. This process can be described as a kind of "botanical wedding", a conjunction of genetic opposites, the biological equivalent of the chemical wedding of alchemy. In terms of "basic logic" or "style of thinking", some important congruencies can therefore be discerned between alchemy as a proto-experimental tradition and the kind of experimental botany that started with Kölreuter and others and reached its climax in the work of Mendel. Kölreuter himself had already pointed to it, but Jung's analysis of the epistemological core concepts of alchemy lends it further support.

But what *exactly* did the alchemists and Mendel have in common? It was the belief, the *basic scheme*, the *synthetic judgement a priori* so to speak, that natural entities consist of combinations of discrete elements. They change when elements are added or removed, when "factors" become visible or repressed. This implies that changes in nature occur suddenly rather than gradually, in a discontinuous, leap-like fashion, as mutations. The idea that the "invisible" or "repressed" elements (e.g. a particular colour) may become visible all of a sudden is logically connected with the idea that the characteristics of the entities involved depend on discrete factors. These factors may be either visible or repressed, either dominant or inferior ("dominirende und … recessive [Merkmale]" as Mendel phrases it, p. 10). The sudden reappearance of the repressed trait in subsequent generations proves that the entities one is working with are hybrids. Due to the predominance ("das Übergewicht") of the visible trait, the opposite trait ("das andere an der Hybride", as Mendel phrases it) is no longer visible. These hybrids thus constitute examples of what alchemists referred to as a *contiunctio oppositorum*. The recessive trait has the tendency to "step back" ("zurücktreten", Mendel's term), but it is bound to reappear unaffected ("wieder unverändert zum Vorscheine kommen") somewhere in the future.[27] In short, Mendel and the alchemists both adhered to the discontinuity-principle. They were convinced of the fact that leaps do occur in nature: *natura facit saltus*. The colour of peas may *suddenly* change from yellow to green or from green to yellow. Parents with wrinkled peas may suddenly produce off-spring with perfectly round ones. Nature progresses through sudden, discrete, definite changes, rather than through infinitesimal small ones, invisible to the human eye. These discontinuous changes may eventually lead to the transmutation of one species into another.[28] According to Jung the discontinuity-principle was an "a priori"

[26] He uses German terms like "Combination" (p. 22) or "combiniren" (p. 37) and this can refer to "Merkmale" (p. 22) or "Elemente" (p. 41). He also speaks about the presence in hybrids of "differirende Elemente" and "widerstrebende Elemente" (pp. 41, 42), in alchemical terms: *coniunctio oppositorum*.

[27] "Des Ausdruck 'recessiv' wurde deshalb gewählt, weil die damit benannten Merkmale an den Hybriden zurücktreten oder ganz verschwinden, jedoch unter den Nachkommen derselben … wieder unverändert zum Vorschein kommen" (p. 10).

[28] "Die *Umwandlung* einer Art in eine andere … " (pp. 43, 46).

statement (1946, p. 180), something that was part of the basic structure of alchemic thought. It exemplified its logic of Either/Or, in contrast to the post-alchemic logic of More and Less.[29]

Interestingly, however, the new physics that emerged from 1900 onwards rehabilitated this idea, in the form of the quantum concept. In a way, Mendel's biology can be regarded as quantum biology. Rather than turning from green to yellow very slowly and gradually, in the course of countless generations, through many intermediate forms, as is the case in the Darwinian understanding of change, peas may leap from the one to the other all of a sudden because these features somehow depend on discrete units. These units may remain hidden or latent for some time, but (as the alchemists already said) what is hidden may become manifest – all of a sudden. Indeed, Mendel's experiments perfectly meet the definition of alchemy cited by Jung: It is the art of making visible what was previously hidden (or repressed), and of repressing what was previously visible.

The conclusion is *not* that Mendelian genetics is a form of alchemy. We *may* conclude, however, that alchemy and Mendelism have something in common, something very basic, namely the principle of discontinuity, as well as the idea (closely related to it) that natural entities such as plant forms can be understood in terms of combinations of definite "elements". Natural entities may be "pure" forms, but often they contain combinations of "opposites", one of which will be temporarily "invisible", "dominated" or "repressed". One of the reasons why Mendel's ideas failed to be in agreement with the "spirit of the time" was the fact that, in the nineteenth century, modern science had been able to overcome and "repress" its disturbing alter ego, alchemy. Was Mendel himself, as a neo-gothic biologist who adhered to the discontinuity-principle, a kind of "recurrence of the repressed", something that had to remain invisible, had to be forgotten once again, had to be repressed by the dominant logic of the time, the logic of continuity and gradual progress? Think of the posthumous burning of his papers, containing among other things the records of his experiments with various other species besides *Pisum* and *Hieracium*. And why was the year 1900, the year of Mendel's rediscovery, suddenly more favourably disposed to the epistemological profile of his thinking, so that his discovery could finally become visible again? These are the questions I would like to address in the following sections, using comparative epistemology as my method.

9.6 Playing Chess with Nature

Gregor Mendel's monastery was built in the fourteenth century, at a time when Roger Bacon developed his concept of a *scientia experimentalis*, and it is intriguing to think of Mendel's work as the neo-gothic revival of medieval ("gothic") experimentalism.

[29] Mendel explicitly states that he will focus his attention on traits that differ in a discontinuous manner ("deutlich und entschieden") rather than on those that differ in a gradual, continuous fashion ("mehr oder weniger", 1866/1913, p. 7).

Mendel lived and worked at a time when architecture experienced something of a massive recurrence of the repressed: the return of the *gothic* style in the form of neo-gothic architecture. The Houses of Parliament in London, for example, erected between 1834 and 1864, constituted one of the highlights of the neo-gothic wave in European architecture and the process of its construction roughly coincided with Mendel's edification as a scientist. The great bell was winched into position in 1858, when Mendel was already engrossed in his experiments. The neo-gothic, neo-medieval style was visible in other realms of culture as well, such as art. Mendel was a contemporary of Dante Gabriel Rossetti (1828–1882), for example, whose lifework consisted in rehabilitating the late medieval, preraffaelite artistic style, and of Gustave Doré (1832–1883), famous for his neo-gothic illustrations of the Bible, Dante's *Divine Comedy* and similar "neo-medieval" publications. In theology, the neo-gothic mood was represented by authors like Cardinal Newman, still famous for his conversion to Roman Catholicism. Mendel himself as a youth had joined the glorification of the late-medieval mind when he wrote a paean to Johann Gutenberg who in the 1430s had invented the moveable type. Intuitively, the German pioneer Gutenberg had been an object of identification for him. Whereas his contemporaries failed to acknowledge his achievement sufficiently during his lifetime, Mendel wrote, he would nonetheless feel satisfied when, arising from his grave, he would notice how his art was thriving among those who came after him.

In his novel *Mendel's Dwarf* Simon Mawer puts considerable emphasis on the neo-gothic backdrop of Mendel's research, for instance when he mentions that Newman was going over to Rome "*exactly at the same time* that father Gregor … was watering his first-generation peas" (1998, p. 170). Mawer refers to contemporary laboratories of molecular biology as the "cathedrals" of the new age … were priests and scribes decipher and transcribe the texts, and find damnation written just as clearly as they ever did in medieval times" (p. 66) – observing *en passant* that these laboratories are quite often situated in neo-gothic premises. His comparison of the modern laboratory with a medieval scriptorium resonates of course with the widespread comparison of DNA with a library or a text to be copied, and of genes with letters or words.

Mawer's novel is a story about a dwarf (Benedict Lambert) who happens to be a key expert on genetics and who is said (by family legend) to be genetically related to Mendel (he would be his great-great-great nephew). His life's work ironically consists of finding the gene that "caused him", and of developing a genetic test that will allow future parents (by means of selective abortion) to prevent the birth of children suffering from dwarfism (achondroplasia) – such as Benedict Lambert himself. As a dwarfish biologist he constitutes a kind of visualisation or exemplification of what can go wrong (and should somehow be prevented) in the process of human procreation (copying the code). This is how Mawer describes the reaction of laboratory researchers when Benedict Lambert enters their laboratory for the first time:

> They looked up from their benches and stared. … In the street it is the fascination of the freak show, of the monster, of the walking gargoyle, in the laboratories, within the temples of molecular biology, it is the thrill of seeing a manifestation of the texts that they read with such minute attention, as though a beast from the Apocalypse were walking through the scriptorium of a medieval monastery and by his existence confirm the truth of everything that the monks just had transcribed. (p. 67).

This is one among many comparisons Mawer makes between late medieval gothic science (copying and glossing ancient texts) and "neogothic" (Mendelian) biology (analyzing and transcribing the language of DNA). Mendel led the life of a medieval monk, a life of celibacy, punctuated by timetables and calendars. This allowed him to become involved in as drudgery a work as that of counting and counting thousands of peas, year after year, a monk-like type of activity. Mendel's monastic lifestyle made it possible. He really represented neo-gothic biology.

Mendel's research, however, was not the only form of biology that flourished in this monastic *context of discovery* at Brno. On the contrary, his pea experiments constituted a kind of follow-up of the research activities his colleague Franz Thomas Bratranek had been involved in, although they ostensibly differed from them quite dramatically. Bratranek was undoubtedly the most famous friar of the Augustinian monastery during his lifetime. Abbot Cyrill Napp considered him the most outstanding scientific figure in the monastery (Orel 1996). What did Mendel's most respected scholarly colleague think of nature in general and of plant life in particular?

His book *Beiträge zu einer Aesthetik der Pflanzenwelt* ["Contributions to an Aesthetics of Plant Life"] was published in 1853 – the very year Mendel took up working in his garden. In this book a view on plant forms is presented that at first glance appears to be as far removed from Mendel's experimental work as possible. Bratranek's "green aesthetics", as it is sometimes called, constitutes the other extreme of neo-gothic biology so it seems. Apparently, their styles of research could hardly differ more. According to Bratranek, nature presents itself to us primarily as a meaningful *whole*, a *landscape*, and particular plant forms give this landscape an identity, a face. In other words, typical plants forms determine a landscape's physiognomy. As was already explained in Chapter 7, Bratranek adheres to the "romantic" idea that landscapes invoke in us a certain subjective mood, symbolised by the plant forms that represent it. And this explains the almost magical rapport between subjectivity (*Stimmung*, "mood") and objectivity (the landscape, notably the typical plant forms encountered in it) that so often befalls us while wandering through charming natural surroundings. On the other hand, a certain mood may urge us to transform a landscape by means of gardening, in order to attune it to our subjectivity.[30] The rapport between sensitive individuals and landscapes explains why certain plant forms will strike us as particularly beautiful and valuable. A poet will write about this particular plant form in order to articulate the mood that was invoked in him by the landscape type in question. And this mysterious concordance, this empathy between subject and object, between man and nature, poetry and plant forms, arouses in us a sense of profound happiness.

Bratranek's view of nature builds on the ideas of Goethe, Alexander von Humboldt and others, but he is also familiar with representatives of the alchemical tradition, such as Paracelsus, whose ideas had a notable influence on Goethe as

[30] "Die Stimmung des Menschen [wird] durch den Vegetationscharakter der Landschaft geleitet, und andererseits spiegelt die Innigkeit selbst ihre Gestaltung in der Wahl von Pflanzen und in solcher Umgestaltung der Landschaft ab" (1853, p. 23).

well. The latter's masterpiece *Faust* is basically a drama about alchemy.[31] Notably, Bratranek agrees with Paracelsus that a profound parallelism exists, not only between subject (poet) and object (flower), but also between, for instance, flowers and stars.[32] Stars constitute a heavenly, sidereal garden, while both starry and vegetable flowers may have a "magical" influence on us (p. 14). Individuals may have a star and a flower of their own, marking their identity. This correspondence is part of the idea of a cosmic parallelism that exists between the various *spheres*[33] of reality: the mineral, vegetable, animal, human, planetary and sidereal spheres, etc. The sun flower, for example, is associated with gold (metal) and with the sun (heavenly body). Various practices were based on this idea, widespread in previous epochs, not only astrology, but also the habit of Germanic priests, described in Chapter 3, to study the neighing and snorting of wild horses they kept in sacred groves.

This idea of cosmic affinities was a key concept of alchemy. Alchemists discerned fundamental affinities between the various realms of nature: between minerals, plants and human beings, but also between the heavenly bodies and man. Our languages still contain many reminiscences of these ancient theories, for example, when we speak about "veins" in the crust of the earth, and the "mouth" of a volcano, comparing "mother earth" to a massive body. The various spheres or kingdoms of nature were seen as mirroring one another and Bratranek's key area of interest, the congruency between subjective mood and landscape, is part of this universal parallelism. But in order to discern all this, he argues, we must consciously withdraw ourselves from scientific reasoning, from activities such as classification and calculation.[34] Rather, we must rely on the subjective experiences of poets. People in general and poets in particular may interact with nature in a more intuitive vein, and Bratanek's research builds on this basic mental sensitivity, as documented by poetry, fairy tales and other forms of literature. The dialogue between subjective experience and plant forms is part of the great cosmic play of mirroring analogies.

Should we regard the "poetic" views of Bratranek and the "mathematical" views of Mendel as logical opposites? In a certain way: yes, but it depends on what we precisely mean by this term. Bratranek's idea of communication between humans and plant forms refers to particular ways of experiencing and interacting with nature. It invites us to look at nature or a forest in a particular way. Mendel himself also communicated with the plants forms in his garden, albeit in a rather different manner. He saw them not as exemplifications of landscapes, but rather as mosaics,

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[31] Carl Gustav Jung calls it the highlight of the alchemical tradition: "das letzte und grösste alchemistische Werk" (1946, p. 221).

[32] "Jeder Stern am Himmel ist ein geistiges Gewächs, dem ein Kraut bei uns auf Erde entspricht, und jener zieht durch seine anziehende Kraft das ihm entsprechende Kraut auf der Erde an, und jedes Kraut ist daher ein irdischer Stern und wächst über sich dem Himmel zu" (p. 205).

[33] *Spheres* (Greek: σφαιρα) here to be taken in its literal sense as a series of concentric globes (Sloterdijk 1999).

[34] Science ("verständige Wissenschaft") desires to calculate and classify ("berechnen, numeriren und classificiren", p. 6).

as compilations of discrete factors. That is why Mendel became an experimenter rather than a poet and why his methodology was mathematical rather than aesthetical. In Bratranek's view, plant species have a meaning. Individuals, social classes, political parties[35] and countries identify themselves with plants. The *Edelweiss* as a plant form, for instance, symbolizes the alpine landscape, giving it an identity and a face. In a similar way we could say that the garden pea is full of meaning. It symbolizes the vegetable world, the household garden, the domain of early childhood, of motherhood and the "oral stage". Whereas in poetry and fairy tales this dimension of meaning is retained, in Mendel's work it is "repressed". The garden pea has become a model organism, the object of accurate calculations. The mathematician and the poet have gone their separate ways. Mendel and Bratranek are the ego and the alter ego of neo-gothic biology. They articulate complementary views than can no longer be merged into one single comprehensive view. What is repressed in Mendel (the *meaning* of particular plant forms) is emphatically emphasised in Bratranek, and vice versa: the calculative view of scientific reasoning is consciously rejected in Bratranek's work. And still, their views somehow belong together, they originated in the same intellectual community, the same context of discovery. The one is the reverse image of the other. Unfortunately, although Bratranek wrote about roses, lilies and fuchsias (Mendel's favourite plant form), he mentioned the garden pea just once, in passing. Others, however, paid due attention to it. Prominent poetical counterparts to Mendel, in which peas and other plant forms have *meaning*, are not at all absent. These literary documents, as *reverse images* of his work, may help us to deepen our understanding of Mendel's views.

One of Mendel's contemporaries was Lewis Caroll (1832–1898) who likewise tried to combine botany with mathematics, but in a literary fashion. *Alice in Wonderland* was written and published in 1865, the very year in which Mendel presented his research findings. It contains an interesting passage about a large rose-tree near the entrance of a garden. The roses growing on it are white. Alice enounters three gardeners, busily painting the roses red. Why are they doing such a thing? There ought to have been a red rose-tree, they explain. They put a white one in by mistake, and the Queen will be furious if she discovers it (1865/1965a, p. 75). In other words, characteristics of roses (such a colour) are discrete (either white or red), rather than continuous. Apparently, the gardeners planted a mutation and now they are busy tranforming the rose-tree from the one variety into the other, but their techniques for doing so are rather primitive, and fraudulous at that. To really change a rose from white to red would amount to something like horticultural alchemy.

Mendel's method for communicating with his plant forms, for entering into a dialogue with the species in his garden can perhaps be clarified if we think of the way in which Alice in *Through the Looking-Glass* interacted with the plants forms she encountered in the garden (Carroll 1872/1965b). Alice quickly discovers that it is not impossible to communicate with flowers:

[35] The plane-tree of Socrates, the red rose of socialism, the potato of the working classes, the white lily of French aristocracy, etc.

> "O Tiger-lily," said Alice, addressing herself to one that was waving gracefully about in the wind, "I *wish* you could talk!"
> "We *can* talk," said the Tiger-lily: "when there's anybody worth talking to." (Carroll 1872, p. 26)

Nature does talk, flowers do talk – but only to those who are worth talking to, who are able to ask the right kind of questions in the right sort of way. Nature is willing to speak, but only if she is being addressed in a proper language. Only then is she willing and able to answer the questions posed to her. How are we to question nature? The next scene in the book provides us with a hint:

> "For some minutes Alice stood without speaking, looking out in all directions over the country – and a most curious country it was. There were a number of tiny little brooks running straight across it from side to side, and the ground between was divided up into squares by a number of little green hedges, that reached from brook to brook. "I declare it's marked out just like a large chessboard!" Alice said at last. … "It's a great huge game of chess that's being played – all over the world." (p. 32)

What are we to make of this awkward scene? Simon Mawer's novel proves helpful here. At a certain point he draws the attention of his readers to a famous photograph of Mendel, taken from a group photograph of the friars of the Augustinian monastery at Brno in 1862. Mawer writes:

> Father Gregor holds a Fuchsia flower. He holds it up almost for the camera to see, and he squints at it pointedly, with a quizzical expression, as though asking it a question. … Father Gregor holds a fuchsia and asks it a question. (1998, p. 43)

But how is it possible to ask questions to a flower? The answer is given elsewhere:

> [Mendel] watched and examined and thought. He had the mind of a chess player (he *was* a chess-player) and he watched nature's moves patiently. (p. 60)

Mendel played chess with nature. He charmed her into playing a game of chess. He made a move, using a particular combination, and waited for nature to respond. The same idea, the same image of friar Mendel playing chess with nature is used in Henig's book:

> Skilled chess player that he was, he was thinking through his next move and his next. … He wanted to see what would happen to the non-dominating trait. (Henig 2000, p. 80)

Mendel was able to speak with nature, and particularly with flowers, because he addressed them in a language that allowed nature to answer him. He was, in a way, the scientific counterpart of Alice. He addressed nature in the manner of a chess player, transforming his garden into a checkerboard. As Henig (2000, p. 215) points out, Mendel's checkerboard later evolved into Punnett's matrix or Punnett's square (Punnett 1911) with traits like colour, size or shape serving as chess pieces. Mendel's experiments were part of a movement known as the mathematisation of nature. Playing chess with nature was a mathematical and experimental way of questioning her.

There are other literary sources, however, roughly contemporary to Mendel's work, that may help us to elucidate the epistemological profile his research practice. Two of the fairy tales written by Hans Christian Andersen (1805–1875) happen to

be pea stories – they are devoted to garden peas. Indeed, like Mendel, Andersen has written on peas. In 1853, the very year in which Bratranek published his plant aesthetics and Mendel began his activities in the garden of his monastery, Andersen wrote a pea story that actually describes something of a pea experiment.[36] It combines, as an epistemological hybrid, as it were, the two perspectives that are emerging as separate and "pure" in the writings of Bratranek and Mendel. On the one hand it describes the garden pea as the perfect icon of the household garden. It identifies this garden as a particular, intimate place, a childhood landscape. This is the poetic, Bratranek-like aspect of the story. On the other hand, it clearly displays the structure of an experimental design, in which numbers and conditions play a role: peas are being counted and tested.

Five peas, taken from one and the same shell, find themselves suddenly exposed to the outside world. It is a story about the struggle for life under different conditions. Initially, while still safely growing in their shell, the world had seemed completely green, and therefore safe, but when all of a sudden the shell is torn off by the hand of a little boy, their view of the world is bound to change. It is, so to speak, their trauma of birth. One by one, the boy shoots them away with his pea-shooter and each pea lands in a different spot. At first glance, it is a typical childhood story. From a psychoanalytical viewpoint, the story is a psychic exercise and the peas may be seen as allowing the boy to anticipate the psychic transition from the oral phase (in which peas represent food and motherhood) to the phallic phase (for he also can be seen as practicing proto-phallic activities with a proto-phallic instrument). But then a reversal occurs: the fairy tale becomes something of an experiment. The pea become experimental entities in a trial, each pea being exposed to specific conditions. Only one of them will eventually be able to grow into a mature plant. A childhood game inadvertently gives way to an experimental setting.[37]

The one pea plant that survives happens to grow just outside the garret where a young girl is recovering from her illness. Their vicissitudes seem to mirror one another – they both barely make it: a vegetable entity (representing the vegetable sphere) as an accompaniment of a human subject. The pea is the only flower in her "little garden", the only other living entity with which the girl amuses herself during her recovery. She has a garden containing just one plant: N = 1, so to speak. An intimate bond of affinity develops between these two living beings. Upon her recovery she gently kisses the delicate leaves. Once again, it is the idea of parallelism between human subjects and a particular plant form. It was Mendel himself who chose the fuchsia as his personal plant and called his peas his "children". Mendel can be compared to the pea-shooting boy, planting peas in various settings and under various conditions, but also to the girl who forms such an intimate bond, a mental *rapport* with her vegetable alter ego. Mendel himself fell ill at critical

[36] "Fem fra en ærtebælg" ("The Pea Blossom"). Andersen (1993), pp. 404–406.

[37] The primal experiment was of course recounted in the famous parable of the sower who went out to sow his seeds. Some fell along the road, some on the rocks, still others amid thorns, and some on good, fertile ground (Matt. 13:3–23; Mk 4:2–20; Lk 8:4–15).

times during his life, spending extended periods of time in his bed, and one could say that after one of these crises, when he failed his second examination, it really were the pea plants that saved him. Yet, in his case, N amounted to very many.

A second story by Andersen, a far more famous one, happens to be about peas as well. *The Princess on the Pea*, written by Andersen in 1835, is a story about a prince who sets out to find a suitable princess.[38] How can he be sure that the princess is a real princess? There is always something that raises his suspicion. How to distinguish, in a reliable manner, a real princess from a fake one on the basis of "phenotype" alone? Unfortunately, the prince lacks the means, the methodology so to speak, to answer this type of question in a reliable way and this epistemological deficit seriously frustrates his chances of establishing intimate relationships with women, for we are told that he finally comes home again to live with his parents, as a bachelor. His mother, however, is an expert when it comes to the epistemology of partner choice. As soon as a marriage candidate (a girl who claims to be a princess, although her outward appearance – her "phenotype" as it were – does not seem to confirm this) presents herself, she quickly decides to set up an experimental design, a test.

> 'Well, we'll soon find that out,' thought the old queen. But she said nothing, went into the bed-room, took all the bedding off the bedstead, and laid a pea on the bottom; then she took twenty mattresses and laid them on the pea, and then twenty eider-down beds on top of the mattresses.
> On this the princess had to lie all night. In the morning she was asked how she had slept.
> 'Oh, very badly!' said she. 'I have scarcely closed my eyes all night. Heaven only knows what was in the bed, but I was lying on something hard, so that I am black and blue all over my body. It was horrible!'
> Now they knew that she was a real princess because she had felt the pea right through the twenty mattresses and the twenty eider-down beds.

In other words, the queen subjects the girl to an experimental test (N = 1). Without informing the subject, she exposes her to an experimental condition in which a pea functions as a subluminal cue, so to speak. Sensitivity, rather than outward appearance, is the criterion. The experiment requires a whole night. Whereas the independent variable is the presence of a pea, the dependent variable is the amount of sleep the girl will get. The next morning, when asked to estimate the amount of sleep she had, her answer is highly significant. "Nobody but a real princess could be as sensitive as that", the Queen concludes, and so "the prince took her for his wife, for now he knew that he had a real princess".

Although in terms of outward appearance (phenotype) she may not look like a princess at all, the decisive trait ("exceptional sensitivity") is apparently part of her genetic make-up. Extreme environmental conditions such as meteorological hardship (the bad weather and the thunderstorm to which she had been exposed in the beginning of the story) can perhaps temporarily conceal it, but they cannot completely repress or erase it. This characteristic feature is bound to manifest itself under experimental conditions sooner or later. Moreover, being a princess is a matter of either/or. Either

[38] "Prinsessen på ærten" ("The Princess on the Pea"). Andersen (1993), pp. 25–26.

one is endowed with this extreme form of sensitivity or not. It is a discrete unity or factor. It introduces a discontinuity between "true" princesses and normal people (in whom this trait will be, if present at all, "repressed"). Although Andersen describes an experiment that may be regarded as primitive (N = 1) in comparison to Mendel's work with thousands of pea plants, they share the experimental style of thinking, as well as the conviction that the traits under study are discontinuous and discrete. In short, there is a Mendelian atmosphere in Andersen's story. The prince is looking for a real princess: a pure and rare variety. Being a princess would probably count as homozygote recessive in terms of Mendelian genetics. The affinity resides not only in the fact that Andersen's story describes an experimental setting, but also in the fact that the a priori logical structure is basically the same.

Thus, Andersen's fairy tales represent a literary counterpart to Mendel's classical paper. Moreover, the views (apparently incompatible) of Mendel and Bratranek are combined in these stories – apparently they are not logically incompatible. On the one hand, the pea emerges as a meaningful plant form that represents (in psychoanalytic terms) the transition from the oral to the phallic phase, from the childhood garden to the marriage bed – for also in Andersen's second pea story the pea pod becomes transformed from an edible entity into an erotic symbol, that can easily be associated with either semen – as in *The Pea Blossom* – or with the clitoris – as in *The Princess on the Pea*. That the restlessness of the princess has erotic significance is obvious – it was essentially a test of love, focusing on physical symptoms. A particular form of sensitivity is awakened in her body. At the same time, the structure, the design of the story is determined by an experimental (indeed: Mendelian) style of thought. Thus, Andersen's story indicates how the works of Mendel and Bratranek, apparently quite separate, as ego and alter ego, can be recombined and merged as complementary views.

There is at least one other literary classic, one other literary "double" that seems to mirror Mendel's work, although it is about humans rather than about peas, namely Robert Louis Stevenson's story of Dr. Jekyll and Mr. Hyde (1886/1981). It is a tale of two psychic dimensions coming together in one single person. One of these dimensions, the manifest personality, is Henry Jekyll: a pure gentleman of average height. The other one, the latent or repressed personality is Mr. Hyde: a dwarfish criminal. Whereas Jekyll lives in a bourgeois neighbourhood (Cavendish Square, the "citadel of medicine"), is engaged in respectable academic pursuits and entertains academic friendships, his hidden "other" or alter-ego lives in Soho, a creature of the twilight and the night. Jekyll is described as a perfect representative of the *homo academicus* (he is introduced as "Henry Jekyll M.D., D.C.L., L.L.D., F.R.S., etc."), whereas in his description of Mr. Hyde, Stevenson emphasises the latter's deformity, his "troglodytic" malformation. The story is a more modern version of the tragedy of Mephistopheles and Faust,[39] where a repressed aspect of Faust's personality seems to separate itself from a psychic unity that had become unstable due to Faust's psychological problems, his epistemological neurosis, his mid-life crisis.

[39] Jekyll shares with Faust the latter's aversion to "the dryness of a life of study" (p. 85) and the "self-denying toils of [his] professional life."

Like Faust, Henry Jekyll is an outstanding bachelor scientist in his mid-life. Yet, notwithstanding his impressive academic track record, there is in him a tendency – indeed: a hidden, *recessive* tendency – towards the "unscientific", as his colleague and lifelong critic Lanton clearly observes: a tendency to become engaged in "scientific heresies", such as "transcendental medicine" (p. 76).[40] These illicit activities reveal that his psychic personality is not a unity, but rather a combination of two factors that can be separated from one another.[41] His laboratory is a rather secluded site, difficult to enter and located in what formerly had been a dissection room (a research field that had been regarded as highly dubious and heretic in the past). He transformed it into a "modern" experimental laboratory, but in his research facilities a series of strange experiments, reminiscent of alchemy, are conducted – in utmost secret.

Stevenson's tale is a story about the basic "duplicity of life", the "duality of man", and about sudden transformations, from one personality into another, by means of chemistry (or alchemy). In Jekyll's laboratory, human personalities change, not gradually, as in normal life, but in a sudden, leap-like fashion: *natura facit saltus*. The story is usually seen as an anticipation of Freud, but we could also see it as a counterpart to Mendel. Dr. Jekyll is a hybrid personality who, in the course of the story, dissolves, falls apart, so that the "lower" element is set free, only temporarily at first, but in the end for good. The higher element is bereft of its "supremacy" and dethroned by the "lower element", suddenly "expressing" itself. Referring to his counterpart, Jekyll says: "This too was myself". The ordinary self is a compound, a hybrid. By exposing himself to a drug (a white powder), the repressed, recessive element may separate itself from this compound and express itself in its pure form. Whereas the ordinary self is double: a heterozygote so to speak (secretly struggling with a "hidden tendency"), the hidden dimension, as soon as it absolves itself form the hybrid union, is a homozygote, a downright criminal. Or, as Dr. Jekyll phrases it quite explicitly in the novel: "It [i.e. Mr. Hyde, his "other" character] seemed more express and single, than the imperfect and divided countenance I had hitherto accustomed to call mine. … Hence, although I had now two characters, as well as two appearances, one was wholly evil, and the other was still the old Henry Jekyll, that incongruous compound of whose reformation and improvement I had already learned to despair" (84/85). Indeed, Jekyll was "composite" (91), or heterozygote, but in his "hours of weakness" he "returned to this subordinate station of a part instead of a person" (101). Thus, *Dr. Jekyll and Mr. Hyde* is about the recessive element setting itself free. Separated from the dominant aspects of Jekyll's personality, this hidden part suddenly becomes visible in its own right. Jekyll is engaged in an experiment that displays similarities to Mendel's trials, although whereas Mendel performed his experiments

[40] This idea of transcendental medicine returns in Jekyll's own confession: "It chanced that the direction of my scientific studies … led me wholly towards the mystic and the transcendental" (p. 79).

[41] [The] direction of my scientific studies … reacted and shed a light on the perennial war among my members (p. 79).

on peas, Dr. Jekyll performs them upon himself. The researcher is his own research subject or model organism. But the idea is similar: *separate and recombine*. Separate what (in ordinary personalities) is combined, and recombine the elements once again. As Jekyll himself phrases it: the basic objective of his research is "the separation of these elements", these "polar twins", the just and the unjust, continuously struggling (p. 80). Unfortunately, as seems to be more often the case in practices of alchemy, the second part of the experiment ("recombine") proves rather more difficult.[42]

Jules Verne wrote a novel that is quite similar to Stevenson's in various respects, namely *Le secret de Wilhelm Storitz* [The Secret of Wilhelm Storitz] (1910/1913). This book (posthumously published) is also about a scientist, living in seclusion and secretly engaged in strange experiments that turn out to be alchemical (rather than chemical) trials. In fact, Wilhelm Storitz is literally and repeatedly called an "alchemist". While Jekyll had been engaged in "transcendental medicine", Storitz has devoted his life to "transcendental chemistry" (p. 245). Instead of transforming himself into another aspect of his own self, as happens in Stevenson's story, he makes himself invisible, but the basic tenet is quite similar. Wilhelm is the son of Otto Storitz, a famous chemist, who greatly contributed to the progress of physics and who rightfully earned his place in the annals of science, although he was already notorious for his occasional excursions into the field of alchemy. In the same way that Mr. Hyde had been the "son" (more or less) of Dr. Jekyll, Wilhelm is Otto's progeny. He is the "second generation", so to speak, in whose research practices become manifest what remained more or less hidden and illicit in those of the first generation. Whereas his father was still an epistemological hybrid, Wilhelm is a downright alchemist, a "pure" alchemist, who has left the path of scientific chemistry unequivocally and for good. He moves about in the twilight, following by-passers closely, like an invisible shadow, frightening them. His laboratory is remarkable similar to that of Jekyll. At first glance, it seems an outright chemical laboratory, with books, heating devices, glass work, etc. But a strange odour makes it clear that a secret compound is being produced there. By introducing it into his organism, the secluded introvert Wilhelm Storitz manages to transform himself into his ghostly alter ego. Living the life of a bachelor (like Jekyll), his invention allows him to enter the houses and bedrooms of women, thus endangering, as Verne formulates it, the intimacies of family life. It is of course remarkable to notice that, although chemistry was placed on a firm scientific footing by Lavoisier and others in the eighteenth century, thereby replacing alchemy (or "gothic" chemistry) for good, literary authors of the nineteenth (and early twentieth) century were still fascinated with alchemical practices as the repressed and hidden dimension of chemistry, as its epistemological double or secret aspect. One could regard it as a neo-gothic fascination, as *neo*-alchemy, and a return of the repressed.

[42] Jekyll himself attributes this failure to "impurities" of the sample of the compound that causes the change, but the impossibility of replication is a standard problem in alchemy and due to the fact that so many conditions (not only chemical but also psychological and astrological ones) have to be favourable for the experiment to succeed.

We may conclude that, from a comparative epistemological perspective, Mendel's work was not at odds with his cultural environment. Comparable experiments as the ones he performed were recorded by literary authors. In their stories, they describe experiments that share some structural similarities with Mendel's. We have discussed a number of stories about the presence or absence of discrete causal factors, and of recessive factors that are allowed to separate themselves and manifest themselves in the context of scientific or literary experiments. What Zola claimed for novels apparently may apply to stories and fairy tales as well. Although Andersen's queen is a "lay" person, she uses forms of reasoning that resonate with the experimental method as it was emerging in the formal discourses of science, notably in the life sciences, where this style of reasoning was more or less new (imported from physics and chemistry). At the same time, there is an epistemological distance between the tendencies of these tales (including Mendel's) and mainstream discourse in the life sciences of the day. It is no coincidence that Jekyll is accused of having reverted to scientific "heresies" – namely alchemy: the art of provoking leap-like changes by means of procedures that may prove somewhat difficult or hazardous to replicate. Mendel's work is not at all out of tune with what literary writers of his time such as Andersen, Carroll, Stevenson and Verne were doing.[43] To the extent that a lack of congruency hampered the outreach of his work, it concerned the *scientific* discourse of Mendel's time. What is repressed in academic discourse on natural history, namely the logic of discontinuity, is retained in literary genres. Mendel's problems with the *Zeitgeist* predominantly concerned its scientific dimension. His being "at odds with his time" predominantly concerned his relationship with his *scientific* contemporaries, with the *scientific* trends and tendencies of his era. Elsewhere I pointed to important similarities between Mendel's work and a number of previous endeavours, such as Kölreuter's work. But how are we to situate Mendel vis-a-vis biology as it existed and evolved during his own lifetime, in the 1850s and 1860s?

9.7 Science Communication

Although Gregor Mendel's fame rests on his article on peas, he actually published not one, but two papers on plant hybrids. In the second one, which was presented to the Society for Natural History in 1869 and published in the Society's proceedings in 1870, he presented his experimental results with *Hieracium*. As was indicated above, this was Carl Nägeli's favourite experimental plant. Experimentation with *Hieracium* proved extremely tedious. It has minute flowers with even more

[43] Perhaps also Franz Kafka's story *Die Verwandlung* (written in 1912) should be mentioned here. Yet, although it is about a sudden and dramatic change (from one species into another) it clearly belongs to a different genre. In no way whatsoever is the change associated with an experimental trial. It is simply an absurd event, beyond causation. Unlike for example in Stevenson's tale, no effort whatsoever is made to explain the event in scientific (psychological, biological, etc.) terms.

minute sexual parts and artificial pollination had to be carried out using a lens. Mendel almost ruined his eyes in the course of the project. But the more fundamental obstacle was the way these flowers reproduce. They normally reproduce not sexually, but through parthenogenesis and this rendered them useless for the kind of research Mendel was interested in. Simon Mawer calls it an "absurd plant" and argues that it was the worst choice Mendel could have made. And he puts the blame solely on Nägeli, who talked him into this line of investigation. Due to this mistake, Mendel lost his way, and in the end even his confidence, Mawer argues. Henig basically agrees with him: "Because of apomixes, the results Mendel got from *Hieracium* undermined his confidence in everything he had done before. … Undone by the bizarre behaviour of *Hieracium*, [Mendel] now doubted all his previous ideas … [he] lost faith in his own results" (p. 161). Eventually, he gave up his research. His only contact with the established academic world proved a failure. Mendel really did stand apart.

According to Orel (1996), however, this view (that Mendel should never have made the step from garden peas to hawkweed) is highly questionable. On the first page of his article Mendel makes it quite clear that his pea research is part of a much larger programme,[44] involving a whole range of model species: pea, bean, fuchsia, mirabilis, maize, bees and others, while in his early days he had already worked with mice. After 8 years of research with peas it was time to study hybrid forms in other plants and to try his theory on a more challenging target. And Hawkweed was an obvious choice, being one of the model species of contemporary research in the field of botany. Indeed, "Mendel's choice of *Hieracium* as a new experimental plant was in no way unfortunate. … It was a logical step forward in the research that had begun with the *Pisum* experiments" (Orel, p. 184). Mendel himself was quite clear about this. Precisely *because Hieracium* was such a highly controversial plant form, he saw it as a challenge to test his theories on this notoriously complicated species.[45] It was, moreover, Mendel's wish to get in touch somehow with the research activities of outstanding experts like Nägeli, and therefore it was his own logical choice to try his luck with *Hieracium*. From a scientific point of view, it was not at all a side track. If this should work, the validity and robustness of his theory would be greatly enhanced. That his experiments with *Hieracium* yielded indecisive results did not make them usesless, of course. It merely showed that not all plant forms comply with the laws he had established earlier and that a lot of work still had to be done. Unfortunately, Mendel himself was beginning to leave the field, and that was why he decided merely to publish a short summary of his (not very satisfying) results so far (1870/1913, p. 52).

In short, although usually the *Hieracium* experiments are regarded as unsuccessful owing to an unfortunate choice of model plant, Orel convincingly argues that it was

[44] "Eine Endgültige Entscheidung kann erst dann erfolgen, bis Detail-Versuche aus den verschiedensten Pflanzen-Familien vorliegen".

[45] "Ueber keine andere Gattung ist so viel geschrieben, sind so viele und heftige Kämpfe geführt worden. … Das Verhalten der Hieracium-Bastarde muss notwendig durch Versuche ermittelt werden" (1870/1913, pp. 48–49).

a logical next step for a researcher like Mendel. The problem was not that Nägeli talked him into a dead alley, the problem rather was that, although Mendel systematically collected data from a wide variety of species, he only published his results with *Pisum* and *Hieracium*. This made it impossible for readers to appreciate the true extent of his investigations. It eclipsed his gradual progress from relatively "simple" experiments with peas to more complex problems. Perhaps his work would not have been so completely ignored, Orel argues (p. 180), if he had presented all his data.[46] The reason for abandoning his research, according to Orel, was not his disappointing results with *Hieracium*, but rather his substantial administrative difficulties and duties, in combination with his deteriorating health (due to stress, excessive smoking, overweight and lack of exercise). Posthumously, some notes jotted down by Mendel on his results with other species were found, but they are far too fragmentary to allow us to reconstruct the full scope of his experimental program (Olby 1966).

Nägeli was not the only famous biologist who in 1866 kindly received a reprint from Mendel. The Augustinian friar also sent a copy to another famous contemporary, namely Charles Darwin. It is interesting to see how at a certain point, during the 1860s, their research trajectories skimmed one another. Unfortunately, however, whereas Mendel was avidly interested in Darwin, the latter took no notice whatsoever of the former. What may have been the reason, given the fact that Darwin was a prolific correspondent who included large amounts of data in his publications that reached him through letters he received from colleagues and readers? And why was Darwin so successful in his own time, while Mendel's work had to be *re*discovered? What were, besides the things they had in common, their points of disagreement?

When *The Origin of Species* was about to be published, there was a difficulty over the title (cf. Chapter 3). Darwin had wanted it to be called *An Abstract of an Essay on the Origin of Species and Varieties Through Natural Selection* (De Beer, p. 155), but the publisher objected. Still, it was Darwin's firm intention to devote the remainder of his life to the elaboration of this mere "abstract" into a series of extended studies. Yet, writing the *Origin* so debilitated Darwin (Henig 2000) that he was not only forced to take a rest cure immediately after the book's publication, but became a chronic invalid more or less for the remainder of his life. Because of his bad health, only the first part of the huge and ambitious project he had designed for himself was finished. In 1868 he published *Variation of Animals and Plants Under Domestication* (1868/1988), basically a follow-up and extended version of the first chapter of the *Origin* – we already discussed it in Chapter 6. It is this book that brings him remarkably close to Mendel's lifework. Mendel made a thorough study of it during his abbacy, as is proven by his careful handwriting in the margins. Many of the remarks he made were critical, notably deploring Darwin's lack of methodological strictness (his anecdotal method). In this book Darwin not only writes about ducks, as we have seen earlier, but also about a broad variety of other

[46] "The picture that emerges is of a man very actively and effectively experimenting, aware of the importance of his discovery, and testing and extending it on a wide variety of forms. None of these results were published; it is difficult to suppose that his work would have been so completely ignored if he had presented this confirmatory evidence" (Sturtevant 2001, p. 12).

species under domestication. In Chapter 9, on cultivated plants (cereal and culinary) Mendel came across Darwin's remarks on some experiments with *Pisum Sativum* (pp. 302 ff.). Darwin notices a considerable amount of variation in terms of height, manner of growth, period of maturity, shape (wrinkled or round peas), colour (blue and white peas) and other features. Systematic analysis of numerical data, however, is absent. Darwin was not a quantitative experimenter. And unlike Mendel, he did not work with large numbers of plants. His style is anecdotal and the pages devoted to *Pisum Sativum* merely contain a variety of facts coming from various sources. Darwin, however, also writes about other species that interested Mendel. If there was so much proximity of interest, in what respects precisely did Mendel and Darwin differ from one another?

The first difference was already mentioned. Mendel's work relied to a considerable extent on numbers. He introduced the methodological and mathematical tools of experimental physics into biology at a time when biology was still for the larger part a matter of fact finding or "stamp-collecting", as Rutherford notoriously phrased it. Most publications Mendel consulted disappointed him, as they failed to provide precise numerical data. The reappearance of hidden traits in living beings had long been known in an inexact sort of way, but many authors still were of the conviction that exactness did not apply to living entities. Darwin's *Variation* belongs to this category. It does not follow a systematic experimental design. Scientific research was seen by biologists like Darwin as an inductive, Baconian process, whereas Mendel worked more like an experimental physicist who wanted to test a particular theory or hypothesis by means of a carefully planned experiment, and he was quite happy to consider and analyse his results in mathematical terms. Moreover, in order for a quantitative analysis to be possible, an extremely large number of plants had to be studied. Mendel used some 10,000 plants and counted something like 300,000 peas. This implied that the researcher involved in such a process would have to focus on a limited number of model species for an extended period of time. Darwin, however, preferred to include data from as many different species as possible. In other words, Mendel's work involved a special kind of mind-set, a particular way of organizing one's work, a particular style of record-keeping. It involved keeping track records of every single plant. This difference between Darwin and Mendel is also reflected in their style of writing. Mendel's style was precise and concise, methodical and mathematical, whereas Darwin's style was anecdotal and conversation-like or letter-like.[47] For that reason we can easily imagine why the latter's output was more accessible to the readers of his time. Moreover, Darwin evoked a grand idea, the idea of evolution, whereas the grand idea behind Mendel's work (the possibility of modifying life or of creating new species) remained more or less implicit in his text.

Another important difference is that Darwin, notwithstanding his bad health, was a prolific writer in terms of output – his collected works take up as much as

[47] Mendel way of thinking was more similar to that of Galton than to that of Darwin. In fact, Galton became involved in an experiment with peas at a certain point (Olby 1966, p. 77). Unfortunately, he was not really a gardener and he was not familiar with Mendel's work.

twenty-nine volumes. Mendel published only two papers on plant hybrids, besides his meteorological papers that need not interest us here – something like the bare minimum for someone to count as an author at all. And even in the case of the experiments on peas and hawkweed it is clear that only part of his results were described in these two papers. If he had collected *all* his data, not only those on *Pisum Sativum* and *Hieracium*, but also those on mice, beans, fuchsias, bees and various other species, he would no doubt have been able to produce an impressive volume, very much like Darwin's *Variation* in terms of scope, but quite different in terms of methodology and style. It would have put his work on *Pisum* and *Hieracium* in a much broader perspective. In short, I disagree with Mawer's statement that later in life Mendel's intellectual activities (such as beekeeping and meteorology) degenerated into mere "stamp collecting" (p. 263). Although it is true that he found less and less time for his scientific work, his experiments with bees and other species were still extremely carefully designed and in concordance with the basic ideas he had put to test in his epoch-making research with the garden pea. A comprehensive publication would not only have saved his research data from these later years from being posthumously destroyed, but would also have stressed the importance of his methodological concepts. Later in life, Mendel often told his nephews that they would find papers for publication which he himself had not been able to publish during his lifetime. Shortly after his death, however, these papers – the Mendelian counterpart of *Variation of animals and plants under domestication* so to speak – were burned. Orel is undoubtedly right when he emphasizes that a more extensive publication would have made the logic behind his experiments more accessible to his readership. And it is too easy only to accuse his successors for having destroyed his intellectual legacy. Mendel himself should have been less hesitant, less reluctant. He should not have left the task of publishing his valuable data, this highly important counterpart to Darwin, to others. On the other hand, he realised from the very start[48] what a Guarguantian task it would be, precisely because of his systematic way of working. To establish a general law of hybridisation would involve detailed trials concerning a great number of life forms.

Yet, if a Mendelian counterpart to Darwin's *Variation* had been published, it would have become clear that, notwithstanding many similarities of interest, the epistemological difference between Mendel and Darwin was substantial. And this difference is more profound than their divergent strategies of communication or the use of mathematical tools. It affects the basic epistemological profile of their work, their style of thinking. Both men believed in change, but they endorsed completely different conceptions of change. Darwin believed in minute, gradual changes, in the logic of more and less. He could not accept an understanding of evolution in terms of "definite steps" (Olby 1966, p. 82). *Natura non facit saltum*

[48] "Wenn es noch nicht gelungen ist, ein allgemein gültiges Gesetz für die Bildung und Entwicklung der Hybriden aufzustellen, so kann das Niemanden Wunder nehmen, der den Umfang der Aufgabe kennt, und die Schwierigkeiten zu würdigen weiss, mit denen Versuche dieser Art zu kämpfen haben. Eine eindgültige Entscheidung kann erst dann erfolgen, wenn *Detail-versuche* aus den verschiedensten Pflanzenfamilien vorliegen" (1866/1913, p. 3/4).

was one of his most favourite phrase, his basic axiom, his synthetic judgement a priori so to speak, his "canon" as he calls it, citing it on no less than five occasions in the *Origin* (1859/1985, pp. 223, 233, 263, 435, 445). Change is a gradual and continuous process. Evolution occurs through countless small changes. As such they are hardly noticeable. In the case of hybrids, parental differences are merged or blended. It is through the slow but continuous accumulation of minute differences that change is introduced:

> Natural selection acts solely by accumulating slight, successive variations, it can produce no great or sudden modification; it can only act by very short and slow steps. Hence the canon of 'Natura non facit saltum'. (p. 444/445)

In Mendel's view, however, nature evolves in a leap-like fashion, through discontinuous variations. He thinks in terms of Either/Or, rather than in terms of More or Less. This binary logic finds a perfect expression in the symbols Mendel used: upper-case (A) and lower-case (a) letters. There is nothing in between. In the 1860s, slow, continuous change was still the dominant idea in the realm of science. Influential authors such as Lyell and Darwin propagated it. They preferred to attribute sudden changes and ruptures that seemed to occur in the history of evolution to the incompleteness of the geological record rather than to real discontinuity. This explains why the "spirit of the time" was not yet ready for Mendel and why the biologists of the time were not yet susceptible to his ideas. If this is true, then how are we to explain the fact that in 1900, all of a sudden, Mendel's style of thinking could so readily be assimilated by a new generation of biologists. What had happened?

9.8 The Year 1900

This is how Sottin (1959) describes the lack of impact Mendel had in 1865. Although his paper was clear and precise, Mendel's audience soon grew restless and bored:

> It was obvious that not a single person at that meeting … realised that he had just heard an epoch-making report; nor that he had been present at the founding of a new branch of biology – the study of genetics. As far as the members of the Brünn Society were concerned, nothing of great importance had been said. The monk had delivered a boring lecture about endless experiments. … The brilliance of Mendel's work was completely lost on the amateur scientists. (p. 152)

The contrast with the events of 1900 can hardly be greater. On the first page of her biography, Henig (1900) describes what happened to the famous biologist William Bateson when during a train ride to London he was confronted for the first time with an old, but far from boring article from a small journal, written by an obscure monk. She writes: "When he boarded the train, he could have had no idea that in the next sixty minutes he would read a paper that would change [the course of his] career" (p. 1). He immediately joined De Vries, Correns and Tschermak (a "quaternity") in their cause and even made a pilgrimage to Brno to visit the site where

the mysterious "saint" of modern genetics, who apparently had been born a generation too soon, had lived and died.[49]

In order to understand this remarkable change, we have to look at the year 1900 in some more detail. In that year a number of scientific events took place that had something in common. To begin with, Max Planck (1858–1947) introduced the photon-concept, that is, he rehabilitated the idea of discontinuity in physics. On an elementary level, light and darkness is not a matter of more or less. Rather, light consists of particles that can be either present or absent. Photons can either penetrate a piece of glass or be reflected by it (and the probability of both events is equally divided). Beginning with the photon-concept of Planck, the discontinuity-principle quickly gained impetus in physics. It was at the basis of quantum-physics. Niels Bohr discovered that the distance of an electron to the atomic nucleus cannot be expressed in gradual terms. Rather, electrons leap from one "orbit" to the next. Whereas change on the macro-level is gradual (linear, continuous), change on the micro-level is discontinuous and abrupt. The emergence of the discontinuity principle can be witnessed in others realms of science as well. In the same year 1900 Hugo de Vries (1848–1935) introduced his concept of mutation. Once again: *natura facit saltus*. Nature evolves through sudden, leap-like changes. New traits do not emerge slowly and continuously, they come about suddenly. Also in 1900 Karl Landsteiner (1868–1943) discovered the existence of blood types (A, B and O). The blood in our veins is not "more or less" similar to or different from the blood of others. It is either similar or dissimilar, due to the presence or absence of discrete, definite elements, units, factors. Finally, the year 1900 is also the official year of publication of *Die Traumdeutung* [The Interpretation of Dreams] by Sigmund Freud (1856–1938). Again: "conscious" or "unconscious" is not a matter of more or less. Rather some ideas or memory traces are available while others are recessive or repressed. And even in art, with the emergence of fauvism, reality is suddenly represented by means of discrete strokes of paint. Paintings suddenly begin to resemble mosaics. In other words, in or around the year 1900 the discontinuity principle suddenly breaks free. Something has changed in terms of the basic view of the world among both scholars and artists. The "spirit of the time" is now all of a sudden quite susceptible to and "ready" for the idea of leap-like change, of discrete entities and ruptures. This explains the "uncanny synchronicity", as Henig (p. 178) describes it, the simultaneous rediscovery of Mendel's work by three biologists in the spring of 1900, when a new century began. It is no coincidence that they "chanced upon the same article at almost exactly the same time" (p. 178).

The difference between 1866 and 1900 is the difference between Darwin and Mendel. Both were interested in variation and change, both were involved in collecting data on domesticated species, but their basic views on nature greatly differed. This is emphasized by Sottin (1959) when he writes: "Darwin's nature takes no

[49] The "rediscovery" of Mendel should not be taken all too literally. As Orel and others have pointed out, not that many people have really read Mendel's paper; even less have read it in German, while even today hardly anyone (outside expert circles) is aware of the fact that he also wrote and published a paper on Hieracium. For the larger part, Mendel's work and ideas are still unknown.

jumps … [but in Mendel's case] inherited changes or variations are discontinuous". And Orel (1996) likewise emphasises that Mendel replaced the holistic, gradually evolving image of a species by an "atomistic" or "mosaic" conception, where an organism is regarded as a composition of discrete "elements" or "factors". Unlike Darwin, Mendel believed that "traits passed from parent to offspring as discrete, individual units in a consistent, predictable, and mathematically precise manner" (Henig, p. 7). This idea, which failed to impress his contemporaries, was celebrated by a new generation of biologists, such as Bateson and De Vries.[50] Mendel's discontinuity-concept was, so to speak, a biological idea that had been "recessive" in the days of Darwin but now reappeared abruptly in the writings of a different generation in order to become dominant – the become the new "canon" – during the "century of the gene" (Fox Keller 2000).

The question I set out to answer in this chapter was: why was Mendel's research virtually ignored in 1866 and rediscovered in 1900? Several answers have been considered, such as Mendel's communicative style. The focus, however, was on the idea that somehow Mendel had been "ahead of his time". I indicated that, if his work is placed in a broader cultural context, Mendel represents "neo-gothic biology" at a time when the neo-gothic style flourished in architecture and other realms of culture. Moreover, he was not the only author who has written a classical story on peas. His scientific paper shares important characteristics with some well-known stories by literary contemporaries. Hans Christian Andersen also wrote on peas, and his ideas were remarkably similar in certain respects to Mendel's. His pea stories also describe experimental settings and in one of them, a pea is used in an experiment designed to establish the absence or presence of a discrete factor. The idea is not that Mendel was somehow "influenced" by these literary sources or vice versa. Rather, the idea is that Andersen, Stevenson and Mendel share a basic logic. As contemporaries, they think along similar lines.

Finally, also Charles Darwin wrote about peas and important similarities can be indicated between Darwin and Mendel as well. Darwin clearly shared Mendel's interest in a broad variety of species under domestication. Their basic difference was that Darwin believed in gradual change, while Mendel subscribed to the discontinuity-principle. The rejection or repression of the idea that nature makes leaps had been part of the struggle of modern science to free itself from alchemy, a research tradition for which the belief in leap-like changes had been an epistemological core conviction. In the year 1900, this basic epistemological conviction suddenly conquered the field again, in physics, biology and biomedicine, but also in other realms of culture. In 1866, Mendel's publication had been ill-starred. His ideas were shared by literary authors, but not by prominent biologists. Literature

[50] Mendel's adherence to the discontinuity-principle also adds a special dimension to his youthful admiration for Johann Gutenberg (described above) who in fact reduced language to a limited set of discrete, moveable elements. This is especially telling in the light of the widespread comparison of genes with letters. Note that Mendel himself used letter (A, a, B, b) for referring to what he called "factors" or "elements".

retained (or anticipated) lines of thinking that had temporarily become recessive in scientific discourse. Yet, under the new constellation of 1900 Mendel's style of thinking quickly rose to prominence. Due to an epistemological mutation, so to speak, the *Zeitgeist* suddenly took sides with Mendel. In the course of the twentieth century, Mendel and Darwin (who had been epistemological counterparts during their lifetime) were brought closer together. Under the banner of the "new synthesis" even Darwinism would eventually be forced to endorse the idea of discontinuity, firmly embedded in the logic of genetic research as established by Mendel. In other words, Darwin and Mendel finally came together in a new and powerful *coniunctio oppositorum* called "evolutionary genetics".

Chapter 10
Jules Verne's Oeuvre: A Literary Encyclopaedia of Science and Technology

10.1 To the Centre of the Earth

In the first chapter of *Alice in Wonderland*, Alice follows a rabbit into a rabbit-hole. The hole goes straight on "like a tunnel" for some way and then suddenly dips down. She finds herself falling down what seems to be a very deep well, passing bookshelves, maps and pictures:

> Down, down, down. Would the fall *never* come to an end? 'I wonder how many miles I've fallen by this time?' she said aloud. 'I must be getting somewhere near the centre of the earth. Let me see: that would be four thousand miles down … but then I wonder what Latitude or Longitude I've got to?' (Carroll 1865/1965a, p. 24)

The book was published in 1865, shortly after Jules Verne's *Voyage to the Centre of the Earth*, which was published the year before. In the time-span of a few seconds, and on a much smaller scale, Alice is exposed to similar experiences as Axel in Verne's novel. In Axel's case, the journey is consuming much more time. Indeed, one could say that Carroll's version is a miniaturisation of what in Verne's novel is projected on a grand tableau. But apparently, both authors were fascinated by the same idea: a journey through a tunnel towards the centre of the earth, passing numerous latitudes and longitudes.

An important difference is, however, that Verne describes a *scientific* journey, scientifically documented, indeed: a scholarly expedition to an Icelandic Volcano (Sneffels). The team consists of three members: Otto Lidenbrock, professor of mineralogy at the University of Hamburg, his adolescent cousin Axel and a local Icelandic guide named Hans. But, also in this case, the "quaternity principle", already mentioned in Chapter 9, is at work. Wherever there are three of something (persons, elements, etc.), a fourth is hidden somewhere. And indeed, in Verne's novel, there is a fourth element, a "hidden" scholar, who made the expedition possible and plays a decisive role as the team's informant and predecessor, namely Arne Saknussemm, a "famous alchemist" of the sixteenth century.

Who is Arne Saknussemm? In order to answer this question, and to put this "fourth element" into its proper perspective, we have to ask ourselves another question first, namely: who is Professor Lidenbrock? For they are like ego and alter ego. From the very outset it is clear that, although Lidenbrock's name, as Verne informs

us, is "mentioned with honour" in academic circles, and although he is being consulted by famous scientists and natural historians (p. 3), there is something dubious about him as well. Not so much because he is the worst possible teacher for his students, but rather for reasons having to do with the basic direction of his research, his basic views. He is the type of erudite scholar who is drawn to the arcane. Indeed, although Humphry Davy, Humboldt, Becquerel and several other heroes of modern science drop by every now and then for some good advice, they seem not to be very open about their relationship with Lidenbrock and prefer to keep their communications with the professor secret. Their visits to Lidenbrock are something of an embarrassment, like a Victorian gentleman paying a visit to a brothel. But why?

Not simply because he is such a "volcanic", explosive personality. The real reason is that a decade ago, in 1853, Professor Otto Lidenbrock had published a controversial book with a telling title: *Treatise on Transcendental Crystallography* (p. 3). What is "transcendental crystallography"? Although we are not really informed about the contents of the book, it is not difficult to imagine its basic epistemological profile. Remember that in Chapter 9 we discussed similar titles, namely "transcendental medicine" (the specialty of Dr. Jekyll) and "transcendental chemistry" (the specialty of Wilhelm Störitz). Lidenbrock's book belongs to the same genre. As a scientific genre, it is highly suspect. It exemplifies a return of the repressed, namely *alchemy*.

Historically speaking (and framed in quasi-Mendelian terms), alchemists constitute a "first generation" of experimental researchers. Their work can be seen both as a preparatory research practice, furthering the progress of modern science, *and* as an epistemological obstacle, hindering its development. As we have seen in Chapter 9, alchemy constituted a choice research object for Carl Gustav Jung and his circle. Hans Eduard Fierz-David (1952), for example, professor of chemistry and a friend of Jung's, wrote a history of chemistry in which he emphasised that the influence of alchemy on modern science extended well into the nineteenth century. Yet, its influence tended to be neglected for two reasons. First of all, alchemists themselves tended to opt for secrecy: they were notoriously reluctant to share their results with outsiders.[1] Cryptology was there favourite genre, so to speak. And they encrypted their messages on purpose, so that their views would only be accessible for fellow alchemists. This atmosphere of secrecy was reinforced, however, by their successors, the modern chemists, who tended to be very reluctant to confess the extent to which they (or some of them at least) profited from alchemical practices.[2] Indeed, one could say that the alchemists had been the

[1] "Die Alchemisten behielten ihre Weisheit für sich und schrieben nur für Eingeweihten, ganz im Gegensatz zur heurtigen Zeit, wo jeder Chemiker seine Resultate so schnell als möglich publik macht" (Fierz-David 1952, 4).

[2] There are exceptions to this rule, of course. In one of his letters to his father, Louis Pasteur remarked: "I am looking for the philosopher's stone, and you too have read about the joys and the disappointments of those alchemists who came before me. They always believed that they were about to grasp it. That is how I feel …". (Debré 1994/1998, p. 64)

proverbial giants on whose shoulders modern scientists were standing. And Lidenbrock – or a part of him at least – was a living remainder of this intellectual "lost world", stubbornly dwelling in a kind of alchemical cave, while progress had taken his professional colleagues much further down the path of scientific "evolution".

What is alchemy? As was already indicated in Chapter 9, alchemists believed that sudden, leap-like changes ("transmutations") were possible in nature. Moreover, they believed that everything in nature strives for perfection and that there is an inherent desire in metals, for example, to be transformed into gold, while all that is lifeless desires to become alive. This natural process towards perfection, or at least towards a higher state of being, tends to be extremely time-consuming, however. Therefore, in his laboratory, an alchemist would try to act as a servant of nature ("minister naturae"), assisting nature in its eternal strive for purity by accelerating the pace of the transformation process. In order for an alchemical experiment to succeed, a number of conditions had to be realised. Physical and chemical conditions (light or darkness, the right temperature, purity of substances, etc.) were important of course, but so were astrological ones (the art of choosing the opportune moment) as well as psychological ones. The researcher had to be morally "pure" himself in order for the experiment to succeed, while engaging in alchemical research was regarded as an exercise in self-purification. This meant that trials were difficult to replicate. If an experiment failed, if (for instance) an experimenter failed to transform lead into gold, this did not imply that the experiment was impossible *as such*. Rather, the alchemist would probably conclude that he himself was not yet "pure" enough, or that he had failed to await the optimal astrological constellation, or to cite the right passage from the proper sacred text. In other words, alchemy was not one particular discipline, but rather a *comprehensive* research practice, a *universal* science. It involved astronomy, geology, pharmacology and experimentation as well as psychology and theology and numerous other branches of learning. It was a comprehensive science – a *Totalwissenschaft*.

Besides astrology, cryptology was an important auxiliary discipline, not only in the context of dissemination, as was already explained above, but also as a research tool used for deciphering sacred scriptures, such as the Gospel of John, a text that was treated more or less as an experimental manual. Encrypted messages had to be recovered from these ancient sources by means of intricate techniques of decoding. Still another aspect of alchemy was the belief in parallelism, i.e. the idea that there is a concordance between the different "spheres" (or "globes") of reality, for example, between the movements of heavenly bodies and simultaneous events in the sub-lunar world below (the guiding idea of astrology). Finally, in order for an experiment really to succeed, the experimenter remained dependent on an act of grace: a willingness of nature to manifest and disclose herself on the decisive moment. Although various heroes of modern science (such as Boyle and Newton) are known to have been engaged in alchemistic practices, this aspect of their work tended to remain hidden and invisible. Indeed, they tended to be highly secretive about it themselves, and their alchemical

affinities had to be reconstructed by means of careful research (or even detective work) by professional biographers.[3]

Finally, the alchemist's basic *moral* attitude towards the world differed from that of modern researchers. Alchemists lived in a world of value whose entities could be placed on a value scale. Gold, for example, was more valuable, more "noble" than lead. They did not look upon nature as modern chemists do, namely as a neutralised, disenchanted world, where entities such as atoms are basically described in quantitative terms (atomic weight and so on).[4] Moreover, alchemists believed that they themselves, through their research activities, were progressing towards perfection. Besides reading and experimentation, other sources of information were important as well, such as the interpretation of dreams. Finally, a notable character trait of alchemists was their enthusiasm, their epistemological *furor*. A discovery or breakthrough was likely to evoke in them a state of epistemological intoxication.

Roger Bacon (1214–1294) who in his *Opus Maius* anticipated the invention of flying machines and steam ships, is generally regarded as one of the founding fathers of the modern scientific method (the *scientia experimentalis*), but at the same time he was heavily involved in alchemical and astrological research. Chemistry and alchemy, the conscious ("ego") and the unconscious ("alter ego") dimensions of modern science so to speak, had not yet been clearly separated from one another in Bacon's days. Alchemy had not yet been "repressed", and the scientific Self had not yet emancipated itself. The alchemical manual *Speculum Alchemiae*, for example, which was translated into English as *The Mirror of Alchimy* in 1597, was attributed to Bacon. Together with Albertus Magnus and a number of other prominent "gothic" scientists he represented the "first generation" of experimental researchers.

The heroes of modern science (eminent researchers such as Newton, Boyle, Lavoisier, and others) constitute what might be termed the "second generation". Although they "stand on the shoulders" of their alchemical predecessors, and profited from their preparatory efforts, the mind-set of alchemy was repressed in order for quantitative experimental research to emerge. Indeed, an "epistemological rupture" (Bachelard 1938/1947) proved inevitable. The world had to be rigorously

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[3] In the case of Isaac Newton, for example, Richard Westfall (1980) has carefully documented the extent to which Newton was really involved in alchemy, whose profundities fascinated him, rather than in primitive chemistry (p. 285) and how well he was acquainted with the alchemical corpus. Indeed, Westfall estimates that, in his posthumous notes, "well over a million words [are] devoted to alchemy" (p. 290). His most important manuscript in this area bears the title *The Vegetation of Metals* (p. 305). Moreover, it was from the world view of alchemy that he borrowed his crucial, but mysterious, and more or less "irrational" concept of *attraction* (action-at-a-distance).

[4] Although Lidenbrock apparently subscribes to the equivalence of all metals ("ces métaux, depuis le fer jusqu'à l'or, dont la valeur relative disparaissait devant l'égalité absolue des spécimens scientifiques", p. 6), other aspects of his research practice are clearly reminiscent of alchemy, such as his interests in runes, in ancient manuscripts and symbols in general, in cryptology, in alchemical authors and theories, etc. The famous exclamation in *Faus*t – "Zwei Seelen wohnen, ach! in meiner Brust" (1808/1910, p. 1114) – also applies to Lidenbrock. He is an epistemological hybrid: an alchemist as well as a chemist/mineralogist – a *coniunctio oppositorum*.

disenchanted. Basic images (such as the earth as a gigantic mother-organism) were replaced by symbolic languages (numbers, mathematical symbols, chemical nomenclature, formulas, etc.). From that moment onwards, an immense epistemological distance began to separate "modern" chemistry from "gothic" alchemy. As was indicated above, however, this process of epistemological segregation and repression was never really completed. The two epistemological layers remained actually much closer in contact with one another than is usually suspected. They continued to communicate with one another, through various channels.

In this volume, however, I am primarily interested in the "third generation" of researchers, the nineteenth-century successors of these famous second-generation heroes. In Mendelian terms, it is to be expected that, in some of them at least (one out of four no doubt), the repressed (recessive) element will return, namely alchemy and its auxiliary disciplines such as cryptology, astrology, oneirology (i.e. interpretation of dreams), etc. Some of these third-generation scientists are "real" scientists, others are literary figures. Or perhaps we should say: some of the sources we are using in our analysis of these "third-generation" researchers are biographies, while others are novels or even hybrid documents.

The work of Freud, for instance, can be placed in this series, as someone who belongs to this "third generation": a physiologist who, at a certain point in his career, became engaged in dream interpretation. The title page of *Die Traumdeutung* ["The Interpretation of Dreams"] contains a famous formula, borrowed from Vergilius: *Flectere si nequeo superios, Acheronta marebo* ["If I cannot persuade the gods, I will move the netherworld"]. This maxim should be taken here in an epistemological sense. If I cannot persuade standardised experimental science, I will turn my attention to another truth regime, to the repressed, forbidden realms. Interestingly, in *Die Traumdeutung*, Freud completely ignores alchemy. After mentioning some ancient Greek authors (Aristotle and Artemidoros) he immediately jumps to the followers of Schelling, suggesting that they inherited their interest in dreams from ancient Greek sources. In Freud's *Gesammelte Werke*, alchemists are mentioned only once, in passing. Clearly, Freud is one of those representatives of the "third" generation for whom it would be an embarrassment to acknowledge their indebtedness in the form of an epistemological "coming out" – if they are conscious of their intellectual "perversity" at all. This "repression" is more than compensated, of course, by his archrival Jung, whose superabundant interest in alchemy can indeed be interpreted as a return of the repressed and as an instance of "oedipal" criticism directed towards the previous generation of "fathers", notably Freud.

Another example of a "real" scientist belonging to this "third" generation is Friedrich August Kekulé von Stradonitz, who was interested in the structure of benzene. In 1865, after fruitlessly grappling with this problem professionally for a long time, the secret structure was suddenly revealed to him in an alchemical dream, a nightly vision of Ouroboros: the mythological snake that bites its own tail. He himself described the event retrospectively as follows: "I dozed off. Again the atoms danced before my eyes … everything in motion, contorting and turning like snakes. And behold, what was that? One of the snakes took hold of its own tail and whirled derisively before my eyes. I woke up as though I had been struck by

lightening. … I spent the rest of the night working out the consequences".[5] Fierz-David (1952) describes him as a "visionary" (p. 235), a researcher for whom sudden insights, provoking experiences of great enthusiasm, constituted a structural element of his context of discovery. It is the combination of an alchemical method (reliance on dreams) with an alchemical content (the Ouroboros-symbol) that made this eureka-experience, allowing for the emergence of organic chemistry as a research field, a marker in the history of science.

Literary counterparts of real scientists (such as Kekulé) are Lidenbrock, Jekyll and Störitz, among others. All these research endeavours, either fictional or real, documented in novels and biographies, have one thing in common, namely: alchemy provides the cue, the key. What applies to Kekulé, applies to Lidenbrock as well: it is a "forgotten", but rediscovered alchemical reminiscence that puts the nineteenth-century third-generation researcher on the right track. In Verne's novel, it is the famous alchemical traveller Arne Saknussemm who provides Professor Lidenbrock with the decisive hint. Although Saknussemm was convicted for scientific "heresies"[6] (p. 51) and all his works were burned, Lidenbrock happens to come across a runic cryptogram he managed to leave behind – like a palaeontological imprint, a mere fragment, as a reminder of a lost world of ideas. With the help of cryptology, and assisted by his cousin Axel, Lidenbrock finally deciphers the message. In an Icelandic volcano, it tells them, there exists an opening to a tunnel that gives access to the centre of the earth. Saknussemm went down that tunnel in the sixteenth century, leading the way as it were, and now he invites his readers to follow him, as their scholarly Virgilius. He guides the travellers as their epistemological shadow. Lidenbrock experiences the message as a "revelation" that completely "transfigures" him (p. 23). To Lidenbrock, the centre of the earth is not a neutral place, of course, but rather the innermost circle of the ancient κοσμος, the womb of the great earth-mother, and the transfiguration Lidenbrock experiences is a relapse into the epistemological *furor* typical of alchemy. Outwardly, however, he remains a modern scientist, using a variety of advanced scientific contrivances, carefully taking notes and continuously assembling quantitative data, for the purpose of preparing a scientific report about his findings. Yet, beneath this modern surface (his epistemological ego) there is a different layer, an uncanny epistemological enthusiasm, a remarkable sensitivity to cues of a certain epistemological origin. As I said, Lidenbrock is something of an epistemological hybrid, – *coniunctio oppositorum*.

Their journey towards the centre of the earth is actually a travel backwards through time. It takes them through the bio-history of the earth, recorded in ancient

[5] "[Ich] versank in Halbschlaf. Wieder gaukelten die Atome vor meinen Augen. … Alles in Bewegung, schlangenartig sich windend und drehend. Und siehe, was war das? Eine der Schlangen erfasste den eigenen Schwanz und höhnisch wirbelte das Gebilde vor meinen Augen. Wie durch einen Blitzstrahl erwachte ich; auch diesmal verbrachte ich den Rest der Nacht um die Consequenzen der Hypothese auszuarbeiten."(Anschütz 1929, II, S. 942). Cf. http://www.sgipt.org/th_schul/pa/kek/pak_kek0.htm.

[6] Dr. Jekyll was also accused of scientific "heresies" (cf. Chapter 9).

formations (like the books, maps and pictures in *Alice in Wonderland*). In this manner the palaeontological layers can be studied in a much more reliable and systematic manner than through chance findings and "superficial" (literally) excavations. Like Alice, they encounter giant mushrooms and other bizarre phenomena and life forms. It is also an alchemical journey in the sense that it is an experience from which they themselves emerge completely transfigured. For Axel, initially a carefree adolescent, it is a metamorphosis, a kind of epistemological ritual the changes and "ennobles" him.

Finally, in a gigantic subterranean cave near the centre of the earth, they are confronted with living specimens of Jurassic species that long ago became extinct on the surface. Deep underneath the crust of the earth, the evolution of Jurassic species has "frozen" more or less and come to a standstill. In this manner, Verne actually *created* the Jurassic monster genre that was further developed by later authors such as Arthur Conan Doyle (1912/1981) and Michael Crichton (1990/1991; 1995/2002) in the twentieth century. Verne's lively descriptions of the battles among these huge and voracious monsters set a model for these later writers. Under extreme circumstances, in far-off, isolated and inaccessible places, evolution followed different pathways, or even found itself completely halted. These extraordinary sites constitute gigantic natural parks where animals from vanished geological epochs are preserved and therefore can be studied as living specimens. It is, once again, a return of the repressed, in the sense of a return of the extinguished. Moreover, travels like that of Lidenbrock and his team can be regarded as instances of extremophilia. Scientists display a desire to study nature under extreme circumstances. Indeed, laboratories and other research facilities are often built to *create* extreme conditions (in terms of temperature, vacuum, etc.) in an artificial way, but in Verne's case, these conditions are realised through mobility, site visits to far-off places, often with the help of innovative machines that allow them unprecedented mobility in order to explore the unexplored regions of the world. In the crust of the earth, geological formations, containing records of living conditions during previous geological eras, but even extinct life forms themselves, are conserved *in optima forma*. As if evolution is present both as a library (the formations) and as a movie (the living monsters).

One of the highlights of Verne's novel is Axel's (waking) dream. As we have seen, for an alchemical research practice, dreams constitute an important source of information. This goes for Axel's dream as well. After being exposed to an impressive series of geological and palaeontological observations and discoveries, the process of biological evolution that is, the origin of species – is revealed to him in a dream, in two directions, from the beginning to the present and back again. All the paeleontological monsters of the various geological era, series of giant animals and plant forms, come to life before his eyes. All the life forms, whose fossil remains he has seen, are more or less reborn in what seems like an oneirological movie, or movie-like dream – an anticipation of Crichton's/Spielberg's *Jurassic Park*. Geological periods pass before his eyes like days or hours. His dream is truly a summary of the history of life, a summary of creation – but creation understood

in evolutionary terms.[7] It also indicates that this scientific journey has really changed Axel as a subject, from a naïve and easy-going adolescent, a superficial surface-dweller, into someone who really becomes involved in the progress of science (and this is of course in accordance with the alchemical idea that scientific research is actually a spiritual exercise, a mental journey).

Moreover, the travellers become involved in a series of scientific discussions. The most prominent, no doubt, is the hollow earth-dispute. It is the "manifest" objective of Verne's novel to demonstrate, with the help of informed imagination, the plausibility of the idea, the "hypothesis", that the earth is hollow inside – an idea that is present in a number of other Verne novels as well. It has a long history, grounded in the idea of the universe consisting of concentric spheres, with the hollow earth as its innermost sphere. The alchemical traditions subscribed to this idea, and Lidenbrock's fascination with it is part of his alchemy-complex no doubt.

Interestingly, unlike Humphrey Davy, Von Humboldt, Franklin, Becquerel, Milne-Edwards, Sainte-Clare-Deville and others, Charles Darwin is never mentioned in Verne's book. Verne's authorship was based on systematic and extensive desk research and the novel can be read as a well-informed dialogue with the scientific discourses of his day. Verne's reading resulted in a systematic collection of thousands of notes which he built into an archive, to be used as a basis for his writings. The views of scientific contemporaries come to life in Verne's lively novel. Familiarising his readers with recent scientific discoveries and disputes was an important objective for Verne. He wrote his book when *The Origin of Species* was being translated into French. One reason for not mentioning Darwin was, of course, that he was not French. Moreover, Verne's focus is not on the details of the process of evolution as such, but rather on some of the more "philosophical" disputes that evolve from this idea, such as the question how to harmonise the concept of evolution with the idea of creation. More importantly even, Verne's novel joins in with the debate on gradualism versus catastrophism. The latter view, associated with Georges Cuvier (1769–1838) holds that the extinction of species occurs through cataclysms. Quiet periods in geological history end in mass extinctions, triggered by violent geological changes. Verne seems to accept the concept of evolution as obvious, although he notices that geological periods can perhaps be regarded as biblical days in the sense that, if we review them in retrospect, they pass the mind's eye at such a pace that the analogy becomes more or less plausible. As for gradualism, Verne seems to take a moderate position on this issue. On the one hand, the travellers notice various instances of extremely slow and gradual change, through accumulation of very slight changes. On the other hand, Verne is clearly fascinated with the idea of a catastrophe. Many of his novels actually end with catastrophic events, transforming complete landscapes and extinguishing life forms on a massive scale. Apparently, in his view, evolution is a combination of gradual changes (the usual situation) and dramatic events. In other words, the structure of his novels reflects the dynamics of evolution: a small-scale beginning (preferably on an

[7] "Toute la vie de la terre se résume en moi" (p. 154).

island), next a story of dissemination and expansion, and finally a catastrophe, a disruptive darkening of the earth, a climate change.

10.2 Verne's Work as an Encyclopaedia of Arts and Sciences

Jules Verne is not always regarded a serious writer. On the contrary, histories and anthologies of French belles-lettres have been written that do not even mention his name. He is still seen by many as a children's author. Some critics, however, such as Raymond Roussel or Michel Foucault, regard his work as highly significant. In this chapter, his work will not be presented as a series of adventure stories, but rather as a literary assessment of science and technology and their impact on society and human life. Verne can rightfully be regarded as the chronicler of his own epoch, the machine age. For although he is often considered a writer of "science fiction", this is not really true. He wrote about his own era. The books written by him in the 1860s, for example, are situated in the 1860s. He explicitly builds and reflects on developments in science and technology that were actually happening when he wrote his novels. Moreover, as was already mentioned above, his books are well-documented and based on systematic research.

One way to clarify his "strengths and weaknesses" as an author is by comparing him to some of his contemporaries. The nineteenth century was the golden age of *psychological* novels and plays. Leo Tolstoy (1828–1910) and Henrik Ibsen (1828–1906), to mention just two contemporaries of Verne, were born in the same year. They are generally regarded as outstanding psychologists. As was already mentioned in Chapter 5, Tolstoy's novel *Anna Karenina*, published in 1878, is generally regarded as a classical study into the psychology of marriage. The novel begins and ends, however, with the arrival and departure of a train. It is this train that puts the novel between parentheses, so to speak. The first encounter between Anna and Vronsky takes place at a railway station, and in the end Anna commits suicide by throwing herself under a train, while shortly after that Vronski leaves the civilised world, heading for the front, by train, in the hope of getting himself killed. In the 1870s the train was still a novelty, an impressive technological phenomenon. Tolstoy carefully describes the impact trains and railway stations have on human existence. Major cities become connected with one another and new forms of human mobility and communication are suddenly made possible. Yet, the train is also experienced as an uncanny mechanical monster, δεινος in every respect. This is how Tolstoy, at the beginning of *Anna Karenina*, describes the arrival of a train:

> The approach of the train was made more and more evident by a bustle of preparations in the station, the rush of porters, the appearance of gendarmes and attendants, and the arrival of people meeting the train. Through the frosty vapour could be seen workmen in short sheepskins and soft felt boots crossing the network of rails. The whistle of an engine and the rumble of something heavy could be heard in the distance. … Indeed the engine was already whistling in the distance. Soon the platform began to vibrate as the train swung in; puffs of steam were driven downwards by the frosty air; slowly and rhythmically the piston

> of the middle wheel rose and extended, covered with hoarfrost. Behind the tender came the luggage-van, with a dog whining inside, gradually slowing down and making the platform shake more than ever. At last the passenger coaches jolted to a standstill. A sprightly guard jumped out, blowing the whistle as he did so, and then one by one the impatient passengers began to get down. (1878/1978, p. 73/74)

Yet, the train quickly disappears into the background. The emphasis, in the novel as such, is clearly on human psychology and human relationships.

In a similar vein, Ibsen's play *The Lady from the Sea*, already quoted in Chapter 1, begins and ends with the arrival and departure of a large steam ship, a δεινος phenomenon, that opens up the Norwegian coastal area and connects it with international networks, bringing in tourists, for example. The steamer puts Ibsen's drama between parentheses. But the play as such focuses on human psychology, notably the psychology of marriage.

Jules Verne has also written a number of stories about steam ships, the most important one being *Une ville flottante* ["A Floating City" (1871)]. It is a story about the *Great Eastern*, a steam ship of gigantic proportions, large as a whole city. In principle, Jules Verne is interested in human psychology, of course. Like Ibsen's play, Verne's novel is about a man who fell in love with a woman suffering from psychological problems: unresolved tensions and conflicts from a distant past. Yet, in Verne's case the emphasis is not on these human beings, but rather on the mechanical artefacts that transport them – preferably huge machines and the impact *they* have on human beings. The giant steamer is a machine that literally consumes human beings. It is an urban society, a microcosm, a floating city that brings old and new continents together and allows maritime nature to emerge in a completely different manner. The steamer's features are described in a rather exact and quantitative way, in the language of an engineer.

As a rule, Verne's psychology, notably his psychology of love and marriage, seems somewhat stereotypical and naïve. Verne, Tolstoy and Ibsen all write about people, and they all write about machines, but whereas in the writings of his contemporaries the emphasis is on psychology, in Verne's case the emphasis is on machines. He writes about people who invent, or use, or refuse to use, machines. His novels study the ways in which science and technology influence the way in which people travel, communicate and perceive the world around them. Quite often, the people using and inventing machines are scientists. In that case, the machine is an apparatus that allows new forms of research to be carried out. One could say that in *Vingt mille lieues sous les mers* [*20,000 Leagues Under the Sea* (1870)], the main character of the novel is neither Captain Nemo, nor Pierre Aronnax, but rather the *Nautilus* as such: a floating research station, comparable to the space stations of today.

Verne was a workaholic. Although he made his debut at a relatively late age (in 1863), he published something like ninety novels (two or three novels every year). In this manner he created a literary encyclopaedia, covering all the major research fields (both fundamental and applied) of his era, a comprehensive overview of science and technology and their societal potential.

10.3 Extremophilia: Experimental Research Under Extreme Conditions

One could say that all Verne's novels are *structured as a journey*. Moreover, they are also structured *as an experiment*.

The first claim is obvious, more or less. His novels are literally and explicitly presented as journeys ("voyages extraordinaires"). Their point of departure is usually a major city (Paris, London, Liverpool, Glasgow, Hamburg, New York, Philadelphia, San Fransisco, Moscow, etc.) and they take the travellers to extremely remote areas, far beyond the realms of civilisation, where they find themselves exposed to extreme conditions (the North Pole, the South Pole, Siberia, uninhabited islands, the Amazon forest, a subterranean cave, the Sahara desert, etc.).

But the second claim is no less important. In fact, both elements are closely intertwined: it is an experimental journey, an experimental trial in the form of (or in the context of) a journey. Many of his novels are literally and explicitly presented as an experiment, and virtually all of them can be *read* as such. The voyage to the moon, for example, is repeatedly called an experiment,[8] while the moon travellers spend their time performing experiments (such as experiments with zero-gravity).[9] Because the American Civil War has come to an end, the members of the Gun Club (experts in ballistics who had put their expertise in service of artillery warfare) suddenly find themselves deprived of the possibility to "test" their theories and calculations "experimentally". They can no longer continue their "field" trials. Indeed, it seems as if their science will be transformed into an innocent, "platonic" endeavour ("artillerie platonique", p. 10). In fact, the members of the Gun Club (most of whom already had been severely mutilated and dismembered in the course of their experimental practices) feel more or less emasculated. Therefore, their President (Barbicane) proposes to conduct an "experiment" ("expérience", p. 24) on an even larger scale than the Civil War allowed, by building a giant canon for the purpose of shooting a bullet at the moon. Moon research conducted from the surface of the earth seems to have reached its technical limits and this explains the sense of malaise, the absence of progress in the field. Moon science ("selenology") has come to a stand still. A "direct communication" with the moon seems indispensable. This "unprecedented experiment" will not only stimulate further research, but will bring the field as a whole on a much higher level. It will revolutionise the field. So far, all voyages to the moon have been imaginary or literary voyages, written by authors such as Jean Baudoin, Cyrano de Bergerac, Edgar Allan Poe, and others. Although these "imaginary experiments" ("tentatives imaginaires", p. 29) are interesting and stimulating in themselves, they cannot be regarded as satisfactory any longer. Barbicane proclaims that he has seen enough of these "literary experiments" ("tentatives littéraires", p. 30). Their basic

[8] "Une tentative scientifique sans précédent dans les annales de la science", 1870, p. 1.

[9] "Ils passaient leur temps à faire des expériences", 1865, p. 210.

flaw is that they lack the exactitude that is so typical of a truly scientific approach. They fall short on the level of mathematics. It is now high time for a real and serious trial,[10] the first no doubt in a whole series of experiments ("série d'expériences", p. 39). And indeed, Verne's novel contains extensive and even plausible mathematical calculations. This transformation of ballistics into a peaceful and even "moral" field of enquiry is rightfully called a "sublimation". The death drive gives way to the erotic one. The capsule is like a spermatozoon on its way to a huge, white and bleak, shining, virgin, motherly body. It will be an act of fertilisation, a second creation. Before long, the moon will be populated by masses of human beings. The journey will bring human beings on an equal footing with the great Creator of life (p. 79). It will be the beginning of an era of space colonisation. While God created the planets (motherly bodies), man created the bullet-shaped capsule (the spermatozoon) that will fertilise these abiotic heavenly bodies.

Moreover, Barbicane and his colleagues are the research subjects of their own trial. Like the "gothic" monk Bertold Schwartz, the legendary, fourteenth-century inventor of gunpowder (and as such an important representatives of the medieval *scientia experimentalis*) they are clearly aware of the fact that they may lose their lives while conducting their trials. Schwartz paid for his invention with his life, and their experiment may become an act of scientific suicide or self-sacrifice as well. But in the case of Barbicane and his colleagues, a mathematical handling of the trial will guarantee their safety. Personal courage is replaced by mathematical certainty. The number of moon travellers reflects the quaternity ratio, discussed in Chapter 9. Three members imprison themselves inside the capsule, while a fourth decides to stay behind on the last moment in order to observe their progress form the surface of the earth.[11] They take a number of research animals with them on board, notably two dogs, and one of them dies during the trial. One of the important problems to be solved in an experimental manner is how to maintain a viable oxygen level while getting rid of the carbon dioxide the moon travellers produce. In order to solve this problem, they rely on experiments that have already been successfully performed by two chemists, who used research animals ("anima vili") however, rather than human subjects.[12] Although their experiments had been carefully conducted, it was as yet unclear to what extent their results could be safely extrapolated to humans. "Anima vili" was a technical phrase, coming from nineteenth-century research ethics – from the maxim: *Fiat experimentum in corpore vili* or *in anima vili*, to be exact. This maxim was used to indicate that experiments, if possible, should be conducted

[10] "J'ai donc l'honneur de vous proposer, mes braves collègues, de tenter cette petite expérience" (p. 32); "rien ne serait négligé pour assurer le succès de cette grande expérience" (p. 42), etc.

[11] A second "quaternity" is also noticeable: while three of the team members are experts, a fourth is a lay adventurer.

[12] "[L]es deux chimistes, MM. Reiset and Regnault, avaient expérimenté avec succès. Mais, il faut le dire, l'expérience avait eu lieu jusqu'alors *in anima vili* – quelle que fût sa précision scientifique, on ignorait absolument comment des hommes la supporteraient" (1865, p. 309).

on "lower" or "less valuable" bodies" (i.e. on animals rather than humans, and on "lower" rather than "higher" animals).[13]

Science is present in Verne's novels in two ways. In the first place as the science that makes the experimental journey possible, but also in the form of the science that is *made possible* by it.

In the two novels devoted to the journey to the moon (1865, 1870), ballistics is the science that *makes possible* the experiment by allowing experts to determine exactly how and when the capsule should be fired in the direction of the moon. Subsequently, however, new forms of scientific research are *made possible* by the experiment. The moon journey allows selenographic inquiries (i.e. the mapping of the surface of the moon) to be carried out in a much more accurate and reliable manner than ever before. In the past, the moon's surface had to be surveyed with the help of telescopes. Now it can be studied from a close distance ("de visu"). One could say that, in the novels of Verne, new apparatus, new contrivances, such as the moon capsule, take the researchers *to the things themselves*, as phenomenologists would phrase it: "Zu den Sachen selbst". In this manner, the moon journey has a concrete scientific outcome. The *Mappa Selenographica* published by De Beer and Mödler of 1830 can be corrected and improved and a whole series of scientific disputes concerning the moon can now be settled. The field experiences an epistemological quantum leap overnight.

The same goes for Captain Nemo's *Nautilus*. On the one hand, a number of scientific and technological disciplines are necessary for the apparatus to be built (mechanics, electrophysics, etc.). At the same time, the *Nautilus* is a floating laboratory, a mobile observatory that makes new and more reliable forms of research possible, by going *to the things themselves*, such as: oceanography, deep sea zoology, marine archaeology, marine mineralogy, etc. On the one hand, the Nautilus is a master piece of mechanics and electrophysics. On the other hand, it is a mobile research facility that transforms the ocean into a giant "aquarium" (p. 120/123) so that it can be opened up for scientific analysis. The obscure and opaque depths of the ocean are literally enlightened by the lights of the Nautilus. These lights, in combination with a giant glass window, produce the clearing that allows maritime nature to manifest itself, more or less for the first time. Earthly science ("science terrestre", p. 70) had reached its limits and was suffering from a sense of malaise. Aronnax himself was more or less suffering from a mid-life crisis. At the beginning of the novel, instead of continuing his research, which had obviously come to a stand-still, he is wasting his time with trivial pursuits (such as: giving various kinds of advice) and *far niente*. Nemo studies the ocean under completely different conditions, thereby putting the field on a much higher level. He studies the submarine world directly (de visu) rather than indirectly. Earthly science is represented in the *Nautilus* in the form of an impressive library. Aronnax's book is the "youngest" book, the most advanced specimen of the "old" epistemological regime. Nemo's own oceanography, however, is represented by

[13] The phrase occurs, for example, in Kant (1798/1971).

various research contrivances, built into his floating observatory, the most important being the huge glass window, already mentioned, through which submarine life forms can be studied, not anatomically, but alive and in the context of their own natural environment. In other words, Nemo's submarine even makes Ishmael's cetology "superficial". While the latter remained at the ocean's surface, Nemo really follows the whales into their own dark habitat. He refuses, however, to publish his results. Nemo is the archetypical "genius", and Aronnax, a university professor, becomes his student, so to speak, who (after a long holiday) suddenly finds himself enrolled as a Ph.D. student in a prestigious cutting-edge laboratory. Sophisticated research apparatus allow Nemo and his team (a group of silent, scientific monks) to make exact measurements continuously concerning numerous parameters such as temperature, pressure, depth, etc. It is a completely different, really modern scientific practice. All of a sudden, official science as it had been practised thus far seems a rather primitive and outdated affair.

In *Cinq semaines en ballon* [*Five Weeks in a Balloon* (1863)], pneumatics and aerodynamics are the sciences that *make* the experiment possible, while geography (until then more or less a matter of adventure) is placed on a much more scientific footing. Pneumatics and aerodynamics allow Samuel Ferguson and his fellow air travellers to build a highly advanced balloon. This apparatus makes a new form of mobility possible and opens up new possibilities for (geographical) research. It allows them to study the geography of Africa in a more reliable and comfortable manner. The journey is literally called an "experiment without precedents" ("Tentative sans précédents"). In order for the experiment to succeed, Ferguson conducts a number of preparatory experiments as well, but only the real experiment can determine the adequacy of his (highly disputed) theories. Notwithstanding a number of highly dramatic events, the experiment proves a great success as the map of Africa becomes literally visible (unfolds itself) beneath them.

Also typical for Verne's novels is that the experimenter invites (or even forces) his most prominent critics or antagonists to take part in the experiment. In this manner, the experimental trial is continuously monitored by a critical reviewer, so to speak. This is also part of the experimental structuring of the Verne novel: the logic of conducting and assessing an experiment, the logic of experimental design even determines the casting. Thus, the sceptic can be converted into an enthusiastic follower. In this manner, Ferguson invites his opponent Dick Kennedy to supervise the experiment of flying over Africa in vivo and the same goes for Barbicane, who invites his opponent Nicholls to travel to the moon. In some cases, the critics become involved in the experiment against their will. Thus, by forcefully imprisoning them on board of his aeroplane, Robur (the "conqueror") forces his major antagonists to witness the experiment. In this manner he intends to prove once and for all that the future of air travel belongs to aircraft built on the basis of the principle "heavier than air" (such as helicopters and airplanes), rather than devices built on basis of the principle "lighter than air" (such as balloons).[14]

[14] Robur-le-Conquérant ["Robur the Conqueror" (1886)]

In *Voyage to the Centre of the Earth* (1864) cryptology and geography (as we have seen) are the disciplines that makes the voyage possible, whereas palaeontology and geology are the disciplines that can now be studied in a more reliable way.

The *Voyages et aventures du capitaine Hatteras* ["Voyages and Adventures of Captain Hatteras" (1866)] describe the ways in which highly advanced sailing boats make new forms of research possible in unexplored arctic regions: notably meteorological research under extreme conditions. The North Pole is described as a gigantic "laboratory" where highly innovative experiments concerning very low temperatures can be performed by scientific travellers under extreme but real-life conditions.[15]

Une fantaisie du docteur Ox ["A Fantasy of Dr. Ox" (1872)] is again quite literally presented as an experiment. The inhabitants of a Flemish town are exposed to relatively high levels of oxygen and the impacts of this condition on their physiology and behaviour are carefully registered and analysed.

In *Les enfants du capitaine Grant* ["The Children of Captain Grant"] geography, as an exact science, guides the travellers on their "mathematical" journey, following a straight orbit around the globe, in a precise and methodical manner, while cultural anthropology is one of the sciences that profit from their journey. Their sophisticated steam ship is, quite literally, a *search engine*.

Another "mathematical" journey is even more famous: *Le tour du monde en quatre-vingts jours* ["Around the World in Eighty Days" (1870)]. In this novel a number of contrivances for human mobility are analysed, notably the two great innovations of the 1860s: the express train and the ocean steamer. Verne carefully describes these new forms of mobility as well as the new experiences of space and time they make possible. This mathematical journey is undertaken in order to test whether a hypothesis that is mathematically correct can actually be put to practice. Verne describes the impact this new form of mobility has in terms of how time and space are being experienced. Its main character (Phileas Fogg) no longer "travels", in the traditional sense of the term. Rather, he is a physical "body" that traces an orbit around the globe, confining himself in a series of mechanical capsules.[16] In terms of space, the earth seems to have grown smaller and as far as the temporal dimension is concerned, a new attitude towards time emerges: punctuality. Everything has to be done exactly on time. Moreover, time has become relative, it has become a function of displacement, a function of mobility. If a person travels around the globe in exactly 80 days, will he arrive exactly in time? The answer must be that it depends on the position and motion of the observer in space. Paradoxically, in this case, time has not take up as much time as was initially expected, and the time measurements of the traveller himself deviate increasingly from real time. By actually travelling around the globe, the factor time can be

[15] As Dr. Clawbonny, the team's scientist phrases it: "Ces contrées sont un vaste laboratoire ou l'on peut faire de curieuses expériences sur les basses températures".

[16] "Il ne voyageait pas, il décrivait une circonférence … un corps grave, parcourant une orbite, suivant les lois de la mécanique".

modified. It is, one could say, an Einsteinian intuition. Indeed, in his book on the theory of relativity, Russel writes: "Time depends on motion. Two perfectly accurate clocks, one of which is moving very fast, will not continue to show the same time if they come together again after a journey" (1925/1969, p. 20). Subsequently, he describes a thought experiment involving research subjects who are standing (watch in hand) on different train platforms moving with great velocity away from one another. This will affect "their" time. Although the scale and speed of Verne's trains are somewhat too small, too "earthly", for these Einsteinian effects to become measurable, the intuition is there. This is what Verne's experiment tries to convey: that in the new world of science-based travel, time and space themselves, as basic dimensions of experience, become modifiable.

So far, we have emphasised the scientific side of Verne, his epistemological ego, so to speak. Yet, there is another side to him as well. On the one hand, he describes and perceives the world as scientists or engineers tend to do, *through* the eyes of his scientific heroes, developers of new technologies, prodigious calculators. On the other hand, Verne is rather sensitive to what Bachelard (cf. Chapter 2) described as the logic of imaginary thinking, the logic of the archetypes. And this is his "other" dimension, his alter ego. Verne's world, explored by scientists and engineers, literally teems with (either real or imaginary) monsters. His biology is basically a teratology. Verne's oeuvre stages a struggle between the monster-type (and various other archetypes) on the one hand, and a science-based worldview on the other. Sometimes, the scientist will reveal that the monster is a fabulous entity, in the sense of non-existing. On other occasions the monster is "naturalised" through strategies of classification. Let us have a closer look.

10.4 Elementary Imagination: Verne's Work as "Teratology"

How can one present Verne's ninety novels in an orderly fashion? It seems an impossible task. According to Gaston Bachelard, however, literary imagination still tends to follow the ancient classification of the world into four basic elements: earth, water, air and fire. These elements not only structured ancient Greek thinking about the universe and, subsequently, the mind-set of alchemy, but they continue to guide our perceptions, our imaginations, even in modern times. Moreover, these elements can be associated with a number of typical (or rather: "archetypical") images. For example, the element earth is associated with the archetypical "Mother Earth". In this section I will use Bachelard's theory of "elementary imagination" to present Verne's oeuvre in a concise manner.

Verne's *Journey to the Centre of the Earth* obviously belongs to the category of novels that focus on the element "earth". The same goes for the many novels Verne wrote about far-off, isolated islands, whose stranded inhabitants flesh out Robinson-like existences for themselves. Other "earth"-novels are set in remote and inaccessible places, such as rain forests, deserts or mountain tops. Verne's remarkable fascination for the South Pole and the North Pole, as immense expanses of ice, places them as boundary objects, so to speak, between earth and water.

According to Jung and Bachelard, the archetypical image connected with the element earth is the image of the giant mother: the earth as a gigantic motherly body. For example, *Journey to the Centre of the Earth* can be read as a journey of three (or four) earthlings on their way back towards a gigantic uterus, the centre of the earth as the core region of an enormous female body, in whose life-preserving liquids Jurassic life forms (that somehow never made it to the surface) are kept alive eternally, as perpetual fetuses, so to speak. The idea of the hollowness of the earth relies on this imaginary association with a huge motherly body, rather than on scientific evidence: a secret opening to a tunnel that gives access to the centre of the earth. The idea of the earth as a gigantic body is, of course, an alchemical association as well. It emphasises the concordance between the animal sphere (normal-sized bodies) and the mineral sphere (macro-bodies). Everyday language still contains traces of this association, for example, when we say that there are "veins" hidden in the crust of the earth.

In *Five Weeks in a Balloon*, the continent of Africa is represented as a forbidden, resisting virgin mother, and Ferguson is referred to as the "modern Oedipus" who will conquer the obstacles that hindered others in achieving their goal of penetrating deeply into this *terra incognita*. It is also significant that the South Pole is described by Verne as a huge magnet, in the form of a giant Sphinx [*Le sphinx des glaces*/"An Antarctic Mystery" (1897)]. Countless travellers are attracted and deluded by the immense frozen expanses surrounding it, and died on their way to this forbidden part of the world which man seems prohibited to enter. Shipwrecked sailors who find themselves on deserted island are like orphans who have to begin their life anew in the absence of a caring mother – who is actually replaced by a stepmother, a surrogate mother.[17]

Other images connected with the element earth are the cave and the mine (or: the natural and the artificial cave), as the dark and claustrophobic insides of the mother's body. In these caves, bizarre life forms manage to exist, Jurassic life forms, for example, inhabiting subterranean lakes, but also strange human beings, representatives of vanished worlds, who decided to spent their life in a deserted mine, far beneath the surface of the earth [*Les Indes Noires*/"Black Indies" (1877)] in order to carry on the kind of life that has vanished in the modern world on the earth's surface because of progress. The mine itself is described by Verne as an enormous monstrous "corpse", a deceased body containing veins and lungs. The novel tells the story about an effort to revivify this corpse by inhabiting it, so that dead matter becomes alive again and coal is transformed into gold again (i.e. death, meaningless matter receives symbolic value again, becomes humanised – the alchemical idea of sublimation). The mine is like a giant dark uterus, a huge cave, filled with a subterranean lake, the inside of a living and life-preserving body of

[17] Marie Bonaparte in her extensive study on Edgar Allan Poe writes: " Tous les voyages dans la lune, dont les hommes ont rêvé de toujours, ont d'ailleurs ce sens profond de retour nostalgique au sein maternel. La plupart des récits d'explorations et d'aventures dont raffolent les enfants, de l'*Ile au Trésor* de Stevenson jusqu'aux romans de Jules Verne et en deçà et au-delà, possèdent aussi, comme le récit de *Pym* … les mêmes racines" (1958, p. 450).

which normally only the external parts are exposed (the landscapes at the surface). The alchemical connotations are evident here as well. The experiment consists in bringing a girl who spent her life in the mine to the surface, exposing her to daylight and outside air in order to find out how her senses and her organism will respond to this type of stimuli. These responses are carefully recorded, as in a laboratory report.

Yet another "earth"-novel is *Le village aérien* ["Village in the Treetops" (1901)]. Once again, it is about strange life forms hidden in unknown territory (somewhere in the Congo region in the heart of Africa). This time, the scientific discipline that is furthered or made possible by travelling is anthropology, and its archetype is the mysterious "missing link", a hybrid, anthropoid ("monstrous") life form, an intermediary between man and ape.

The mother and the monster archetypes are also present in novels that belong to the "water"-category. To begin with, every sea journey is a temporary state of separation from the motherly body, a detour towards some kind of geographical, earthly "mother", old or new. And on the way to these old or new mothers (for instance: old or new continents), monsters are encountered. In *20,000 Leagues Under the Sea*, the South Pole is literally described by Verne as a gigantic, silent, unapproachable, ghastly, terrifying, fascinating, virgin "mother". The Nautilus resembles a spermatozoon wandering through a lonesome ocean in search of this huge female body. And when finally the encounter takes place, the sperm cell is almost suffocated and consumed by this gigantic body of ice, on whose perfectly white skin fine bleu arteries stand out. Once again, the earth as such is represented as more or less being alive – the world as a macro-organism. And on its way to this giant white mother, the Nautilus encounters a series of maritime monsters. But they can be subdued by modern technology and even studied at leisure.

For the element "water", depth is very important. As we have seen in our analysis of *Moby-Dick*, water is associated with mobility, with opening up the world, widening one's horizon[18] and with connecting continents. But at the same time, water is associated with nothingness. Hidden underneath the treacherous ocean surface are lurking the terrifying depths, in the form of ocean troughs, where bizarre and gigantic life forms dwell. Verne's great water novel *20,000 Leagues Beneath the Sea* is a monster story, even more so than *Journey to the Centre of the Earth*. The first chapters convey a *Moby-Dick*-like atmosphere, as a strange, huge and remarkably swift whale-like apparition is spotted at various parts of the maritime world. Due to the inability of prominent experts such as Professor Aronnax from Paris to come up with a rational explanation of the phenomenon, an epistemological interregnum is created in which the authority of science is temporarily suspended and room is given to speculation and imagination, to "fantastic ichtyologies".[19] Professor Aronnax sets out to calm the epistemological turmoil by capturing the

[18] Cf. Chapter 4.

[19] "On vit réapparaître … tous les êtres imaginaires et gigantesques, depuis la baleine blanche, le terrible "Moby Dick" des régions hyperboréennes, jusqu'au Kraken démesuré" (p. 3)

gigantic fish in order to determine its zoological identity in an anatomical manner and to store it among his maritime collections. For indeed, he knows how apt the "untutored mind" is to lose itself in crypto-zoological fantasies when it comes to the mysteries of the great ocean depths and their inhabitants, although it is not unlikely that gigantic living forms do manage to subsist in those regions. His objective is to capture, dissect and classify the monster ("*ce digne animal*", p. 13). Eventually, however, he is forced to shift to a mechanical exploration rather than a zoological or anatomical one, as the mysterious "whale" turns out to be a technological artefact.

From the point of view of comparative epistemology, Verne's novels clearly side with science in its struggle against other, less "advanced" knowledge forms. Practical people, notwithstanding their sharp senses, strong muscles and concrete knowledge of maritime environments, are represented as belonging to a pre-scientific, "Rabelaisean world" (p. 21). Dialogues between experts on marine biology on the one hand and "practical whalers" on the other tend to be of a didactic nature. Eventually, the magnificence and sublimity of the whale as a natural entity is completely eclipsed by an artefact of human technology in the form of a gigantic submarine, built by Captain Nemo. The gigantic "thing" that surpasses all existing species of whales, turns out to be constructed by a "modern Galileo". The real whale's spout and flukes are nothing in comparison to this sophisticated monster of steel. Like Ishmael, Professor Aronnax's ship is attacked by a "whale" and he falls into the ocean, but while Melville's novel more or less ends with this event, in the case of Verne it is actually the beginning. The submarine turns out to be a well-equipped research station, as well as a museum. It is a scientific monastery devoted to various forms of scholarly inquiry. Undisturbed by storms and other meteorological conditions at the surface, the *Nautilus* quietly and comfortably pursues its explorations in the silent world below. It is the oceanic counterpart of Ferguson's balloon. As I said, the ocean itself is transformed into an "immense aquarium". By means of the huge glass window, maritime life forms can be carefully examined and classified. Dialogues that evolve between Ned Land (the harpooner) and Conseil (Professor Aronnax's assistant) in front of this window on the question "What it as fish"?[20] are exercises in comparative epistemology, but of a rather biased type, as Verne clearly sides with the scientific worldview. Both men accuse the other of not really knowing what fishes *are*. It is a conflict between two forms of knowledge, two activities, namely chasing (*chaser*) and classifying (*classer*) whales. The *Pequod* and the *Nautilus* belong to completely different worlds, and the same goes for Captain Ahab (who claims that the sea is the same to him as it was to Noah, p. 1096) and Captain Nemo (a hero of modern technology who analyses the chemical composition of sea-water as well as its temperature at various depths). In terms of comparative epistemology one could say that, although in the first chapters a more or less "imaginary cetology" is allowed to roam free, before

[20] "Sur ce sujet, une discussion s'éleva entre les deux amis, car ils connaissent les poissons, mais chacun d'une façon très différente" (p. 120).

long a much more scientific view becomes dominant, and imaginary teratology is once again repressed. Symptomatic of the predominance of the scientific outlook is the fact that Verne's book contains a large amount of quantitative data on various subjects (submarines, whales, oceans, etc.). Although initially the *Nautilus* itself is described as a monster, it is actually a highly advanced research tool that allows Nemo and his crew to study the real monsters that inhabit the maritime depths: huge whales (notably Sperm Whales), but also a gigantic octopus, gigantic shells, gigantic sharks, etc. Maritime teratology is surely among Nemo's favourite research subjects.

Also in various other journeys over water recorded by Verne, travellers are confronted with monstrous life forms (e.g. giant ice-bears). The novel *Les histoires de Jean-Marie Cabidoulin* (or *Le grand serpent de mer* [The Great Sea Serpent (1901)]) is an account of an epistemological struggle. The views, expectations and ideas with regard to maritime life forms that linger among sailors and seafaring people from all walks of life, stubbornly oppose the epistemological supremacy of the scientific world view. It is an old uncanny world, but progress of science is slow, and archetypical images associated with the sea and its hidden depths prove difficult to subdue. As was indicated in Chapter 2, the paradigm of Verne's water novels was Poe's *The Narrative of Arthur Gordon Pym of Nantucket* (1838/1976), analysed extensively by Bachelard as "poetic chemistry" and imaginary oceanography.

In the two novels Verne devoted to moon-travelling, the protagonists travel through space, rather than over sea, but the idea is basically similar: a temporary separation from "mother earth" and a technology-based effort to find another, whiter, more virgin-like mother. A capsule (spermatozoon) is fired by an enormous phallus-shaped canon in the direction of the moon, a heavenly body that is repeatedly and explicitly referred as a "mother" in Verne's book. A moon landing would imply that eventually new life will be produced there, that the human race will be allowed to spread and multiply, by impregnating this lunar counterpart to the earth-mother whose reservoirs of raw materials may one day become exhausted.

The element air is associated with freedom, openness and (above all) height. Floating through the air is clearly associated with a sense of freedom. By allowing engineers to build balloons, helicopters and aircraft, modern technology makes these new, free-floating forms of mobility possible. Thus, *Five Weeks in a Balloon* is an "earth"-novel (devoted to studying the earth below), but also an "air"-novel (devoted to the experience of travelling through the air). Other examples of air novels are *Robur-the-Conqueror* and *Master of the World*. Robur is the Captain Nemo of the element air so to speak. His aircraft is called a gigantic bird of prey, an aerial monster ("monstre aérien", 1904/1997, p. 20).

And earlier example (published posthumously) of an "air"-novel describing a balloon flight, is *Drame dans les airs* [A Drama in the Air (1851)]. It is based on a story by Verne's acknowledged predecessor, Edgar Allan Poe (1967/1976) called *The Unparalleled Adventure of One Hans Pfaall*. In her analysis of Poe's story, Marie Bonaparte claims that the meaning of Poe's balloon is "evident" (1958, p. 449). The balloon is the mother, carrying the traveller as her child. Moreover,

as both Poe's and Verne's story indicate, it is important that one knows how to *use* the new "motherly" powers of technology, emerging in the new large metropolises ("Mother Cities") of the present in a responsible manner. In Verne's novels, heroes of air travel display a tendency to go beyond their limits, thus exposing themselves to excessive risks and unnecessary dangers. It is, one could say, the Icarus-complex. Technology liberates us from the sway of earthly ("fatherly") powers, but if technology is used without the proper amount of prudence, and for trivial rather than for serious purposes, the contrivance may fail us and we may all of a sudden find ourselves exposed in an unsheltered way to an element in which we are not really at home – declining, falling, disappearing – as soon as the mother-machine is deficient or suddenly absent. The new powers built into modern technologies imply that individuals who use these technologies should be able to live up to its rather substantial moral demands in terms of discipline. Initially, in the 1860s, Verne was rather optimistic in this respect. The scientists building and using these contrivances tended to be moral exemplars, quite able to live up to the demands and constraints embedded in these new technologies. Technology implied self-discipline and self-constraint. Towards the end of his career, however, Verne becomes increasingly pessimistic. Not technology, but human beings themselves are the real problem, the real threat. They are too ambitious, too irrational, too emotional to use the new technologies in an intelligent and prudent way.

The fourth and final category of Verne's novels are the "fire"-novels. And indeed, the novels devoted to the element of fire have their monsters as well: monstrous canons producing gigantic, catastrophic explosions. According to Gaston Bachelard, the explosion is the basic image or archetype that is associated with chemistry. And indeed, in Verne's work, all novels involving chemistry or chemists end with a dramatic explosion: *Les cinq cents millions de la Bégum* [1879], *Face au drapeau* [1896] and *L'étonnante Aventure de la mission Barsac* [1920]. Another archetype, belonging to fire and the scientific disciplines associated with it, is "invisible radiation", the archetype of physics (e.g. *La chasse au météore* [1908]).

Title	Year	Science	Science	Element	Archetype
Drame dans les airs	1851	Pneumatics	Physiology	Air	Mother
Cinq semaines en ballon	1863	Pneumatics	Geography	Air	Mother
Voyage au centre de la terre	1864	Cryptology	Geology, palaeontology	Earth	Mother, monsters
De la terre à la lune	1865	Ballistics	Selenography	Space	Mother
Voyages et aventures du capitaine Hatteras	1866	Mechanics	Physics, geology	Earth	Mother
Les enfants du capitaine Grant	1867	Geography	Anthropology	Earth	
Vingt mille lieues sous les mers	1869/1870	Physics	Oceanography, archaeology, etc.	Water	Mother, machine-monster, monsters, genius

(continued)

Title	Year	Science	Science	Element	Archetype
Autour de la lune	1870	Ballistics	Selenography	Space	Mother
Une ville flottante	1871	Engineering	Psychology	Water	Machine-monster
Aventures de trois Russes et trois Anglais	1872	Geodesy	Zoology	Earth	Mother
Le tour du monde en quatre-vingts jours	1873	Mechanics	Logistics	Earth	
L'île mystérieuse	1874	Pneumatics	Technology	Earth	
Les Indes noires	1877	Mining	Psychology	Earth	Mother, Machine explosion
Les cinq cents millions de la Bégum	1879	Chemistry	Industry	Fire	Explosion
Aventures Chinois en Chine	1879	Philosophy	Statistics	Earth	
Matthias Sandorf	1885	Engineering	Psychology	Water	Genius
Robur-le-Conquérant	1886	Aerostatics	Aerostatics	Air	Machine-monster, genius
Ile à hélice	1895	Engineering	Tourism	Water	Machine-monster
Face au drapeau	1896	Chemistry	Artillery	Fire	Explosion
Le sphinx des glaces	1897	Geography	Magnetism	Water	Mother
Le village aérien	1901	Geography	Anthropology	Earth	Missing link
Jean-Marie Cabidoulin	1901			Water	Monster
Maître du monde	1904	Aerostatics	Aerostatics	Air	Machine-monster, Genius
La chasse au météore	1908	Physics	Economics	Space	Invisible radiation
Le secret de Wilhelm Storitz	1910	Alchemy	Detection		Homunculus
Mission Barsac	1919	Mechanics	Management	Earth	Explosion

In the diagram above, a number of Verne novels are listed, together with the *elements* to which they belong, the *sciences* (or practices) they assess and the archetypical *images* they invoke.

Verne's encyclopaedic oeuvre is an archive of monumental, perhaps even "monstrous" proportions, a real treasury for comparative epistemology. It may function as a benchmark, so to speak, for assessing and understanding similar endeavours of future writers, such as Michael Crichton – the Jules Verne of our own time.

Part IV
Conclusion

Chapter 11
Epistemological Exercises: Towards a Typology of Knowledge Forms

11.1 What is Knowledge?

Epistemology can be defined as the branch of philosophy that studies the origins, validity, reliability and limitations of knowledge. But what is knowledge? According to Plato and others, knowledge is something like *true* or *justified* beliefs or claims. This definition raises another (and perhaps even more difficult) question: *What is truth?*[1] A famous answer to this decisive question was inspired by Aristotle and standardised by scholasticism as follows: *adequatio intellectus ad rem*. In modern language, this means something like "a correspondence between truth claims and facts". As Heidegger has argued in various writings, however, this definition entails a simplification. Before facts can be established or acknowledged, we first of all must allow the world to appear in a certain manner. Nature has to be brought to light. This is what science is basically about. This is, as it were, the basic labour of science: making diffuse nature discrete. Nature must be discerned, uncovered, revealed in a certain manner before it can be analysed, before knowledge claims can be brought in connection with "facts". This applies to human knowledge in general, but it certainly applies to the technosciences of modern times. Scientific equipment is developed in order to allow nature to appear, to become visible, in a certain way. Therefore, in the case of science, truth or knowledge cannot be defined merely as "the correspondence between science and nature". Rather, we must acknowledge that the nature that is studied in scientific laboratories, under strict conditions, is a rather artificial and preformatted kind of nature. Only certain aspects of nature are allowed to reveal themselves. A laboratory is basically a *camera obscura*, in which nature *as such* – as φύσις – is shut out as much as possible, in order to analyse particular aspects of nature, in splendid isolation as it were. Therefore, science and nature cannot be separated from one another. Technoscience is emphatically present in its own research objects, its own "nature". *Wo Es war soll Ich werden* – scientists constitute themselves as epistemological subjects within the context of their technology-based research practices. They study the impact on natural entities of their own doings. Extrapolation (the translation of laboratory

[1] Cf. Pilate's famous question in John 18:38.

H. Zwart, *Understanding Nature*

knowledge to real life, "mundane" conditions, where nature is much more "diffuse") is always a delicate matter.

In the case of literary documents, things are even more complicated. These documents may do various things. Some literary documents set out to analyse nature or, rather, they analyse the ways in which *human beings* experience nature, under particular conditions. But they may also, in a very explicit manner, study the ways in which scientists interact with nature. Mary Shelley's novel *Frankenstein* for instance studies the ways in which particular knowledge forms (notably alchemy and modern chemistry) allow nature to appear. In other words, literary documents may tell us something about nature, or about experiences of nature in the life-world, but they may also tell us something about science, about the way scientists perceive nature, or both. This implies that, if we ask ourselves to what extent literary documents can be epistemologically relevant, the answer is bound to be far from univocal. As became clear in the context of our case studies in previous chapters, literary documents can be helpful when it comes to addressing particular epistemological quandaries. Indeed, they can broaden our understanding of the natural world, as well as of the natural sciences, but they may do so in various ways. In order to answer the question in what ways literary documents are important for epistemology as a research field, we must draw up something like a "typology" of literary forms, a classification of literary genres – from an epistemological perspective of course. Not a typology in terms of "novels" versus "plays", or "poetry" versus "prose", or "tragedy" versus "comedy". What would an epistemological typology of literary forms amount to?

11.2 An Epistemological Typology of Literary Forms

As was indicated in the *Introduction*, literary genres may remind us of the existence of other knowledge forms than the ones usually taken into consideration by epistemologists or philosophers of science. As a rule, these "other" forms are presented as more "intimate", more "natural" even, than normal science, with epistemological profiles of their own. They exist "outdoors", as it were, in verbal, informal forums of exchange. Novels, poems or plays may contain snapshots of these divergent knowledge forms. But how exactly does literature make these knowledge forms visible or accessible? As we have seen in previous chapters, there is more than one answer to this question. On the basis of our research so far, it is possible to draw up a (provisional) typology.

First of all, literary genres may function as forms of research in their own right, as ways of making everyday experiences of living nature (landscapes, animals, flowers, etc.) more articulate and precise. Literary techniques may then be seen as ways of collecting and analysing experiences and observations that are neglected, to some extent at least, by more academic disciplines – novel writing or playwriting as a way of rendering diffuse nature more discrete – literature as "science without laboratories". Similar to the way in which Tolstoy has been regarded as a "psychologist"

(and *Anna Karenina* as an inquiry into the psychology of marriage), although he was never formally trained as such, Jack London may be regarded as an "animal psychologist". His dog novels contain insights that are not – or at least: *not yet* – articulated in a scientific manner. Knowledge-based practices such as animal husbandry, horticulture and navigation have been described in literary documents long before they were put on a scientific footing and became the object of systematic scientific research. For centuries, accounts of voyages of exploration tended to be hybrid genres: combining stories of adventures with more or less scholarly accounts. When on October 11, 1492 Christopher Columbus all of a sudden noted in his diary that throughout the night he could hear the sounds of birds passing – *Toda la noche oyeron pasar pájaros* – an indication that he was in fact approaching land – this was both a scientific observation (the first of many devoted to the birds of the New World) and a dramatic turning point in a compelling story. As we have seen, Darwin's *The Origin of Species* can still be regarded as a hybrid of this type: a scientific account that retains key features of narrative genres – of travelogues.

Moreover, literary genres may not only be regarded as *studies* of the natural world, that is, as forms or research in their own right, but also as *archives*, as collections of particular knowledge forms – epistemological specimens so to speak. Sometimes, such literary sources may contain fragments of knowledge forms (vocabularies, methodologies, ideas) that have flourished in the past, but are no longer regarded as acceptable in official academic quarters. These knowledge forms *have been* scientific in previous epochs, but will no longer be respected as such. In this case, the interest in science is of a historical or even archaeological nature. Some of these knowledge forms are about to become extinct, about to disappear for good, as epistemological remainders – as "endangered" epistemological genres (this applies, for instance, to some of the speech genres represented in Melville's *Moby-Dick*).

Other genres represented in literary documents are still highly vulnerable, highly innovative and forward looking. In such as case, a literary document may depict and analyse a scientific discipline *in statu nascendi*, an anticipation as it were of a future academic discourse (as is the case for instance in Ibsen's *The Wild Duck*). Documents such as Ibsen's play may be regarded as literary "recordings" of epistemological events: "the birth of a research animal", as well as of a particular laboratory setting – the birth of a particular experimental practice. In a similar way, Alexander Dumas has written about tulip cultivation as a proto-scientific practice. A play or novel like this, describing the genesis of a particular research field, could be written about, say, Mendel – and Mawer has done this more or less. Documents of this type are interested in science, in scientific discourse, but in an archaeological (backward looking) or anticipatory (forward looking) manner.

On other occasions, literary genres may be (tacitly or outspokenly) *critical* of science. In that case, they may describe or even promote (in a fragmented or in a systematic manner) styles of thinking that are *incompatible* with science – for instance because these rival styles rely on "imaginary" elements (basic images and their networks of associations) rather than on "symbolical" elements (such as numbers, logical operations, mathematical, physical or chemical symbols).

Take, for example, the two classic literary documents on the natural sciences that were published during the first decades of the nineteenth century: *Faust* [1808] and *Frankenstein* [1818]. Goethe's drama may be regarded, among other things, as a "short introduction" into alchemy, more or less like Mozart's *Die Zauberflöte* [The Magic Flute] is a short introduction into freemasonry. In such a text, a particular discourse from present or past (such as alchemy) becomes the object of epistemological analysis and assessment. In the case of Goethe's drama, however, alchemy is presented in an agonistic manner, as a rival discourse, an epistemological challenge – challenging an undermining scholasticism. This heterogeneity, which is more or less absent in Mozart's case, is emphatically present in both *Faust* and *Frankenstein*. Yet, whereas in Goethe's play scholasticism as an intellectual dead-end is confronted with its dubious alter ego – the much more dangerous discipline of alchemy, notably the quest for the *homunculus* – *Frankenstein* stages a confrontation between alchemy and modern science. Its basic objective, from an epistemological point of view, is to show that, notwithstanding the conscious efforts of the modern sciences to actively repress their alchemistic reminiscences, ancient ideas and associations are nonetheless retained in modern forms of discourse, as symptoms of the lingering sway of their epistemological "unconscious" or alter ego. Therefore, Mary Shelley's novel is the *Anfang*, the true beginning, the inevitable starting point for a comparative epistemology. The struggle between modern science and alchemy, described in such a compelling way in her epoch-making novel, has significantly influenced my own analyses, notably of the work of Mendel (Chapter 9) and Verne (Chapter 10). Her novel is, as it were, the field of comparative epistemology *in statu nascendi*.

In the case of Shelley and Goethe, scholasticism, alchemy and modern science are treated with dead earnest: they are taken quite seriously as important knowledge forms that may dramatically affect our life and world. Other authors may rather revert to caricature and exaggeration, as is the case in Gulliver's voyage to Laputa (ridiculing experimental research) or in Dickens' novel *Hard Times* (the Grandgrind episode as a parody of the practice of taxonomy). This is, as it were, the epistemological version of the distinction between "tragedy" and "comedy".

In other words, novels and other literary genres may assume a variety of epistemological roles. They may be regarded as:

1. Forms of research in their own right (literature as *phenomenology*)
2. Archives of outdated or even extinct speech genres (literature as a depository of knowledge forms, as *archaeology*)
3. Parody (literature as *criticism*)
4. Descriptions of emerging research practices *in statu nascendi* (literature as *maieutics*)
5. Descriptions of the agonistic struggle between incompatible knowledge forms, such as alchemy and modern science, agonistic in the Nietzschean sense of the term (literature as *genealogy*)

In previous chapters we have studied important examples of these literary forms:

Literature as *phenomenology*	Jack London, *The Call of the Wild*
	Maurice Maeterlinck, *La vie des Abeilles*
Literature as *archaeology*	Herman Melville, *Moby-Dick*
	Henrik Ibsen, *Enemy of the People*
Literature as *criticism*	Jonathan Swift, *Voyage to Laputa*
	Charles Dickens, *Hard Times*
Literature as *maieutics*	Alexander Dumas, *The Black Tulip*
	Henrik Ibsen, *The Wild Duck*
	Simon Mawer, *Mendel's Dwarf*
Literature as *genealogy*	Goethe, *Faust*
	Mary Shelley, *Frankenstein*
	Theodor Storm, *The Grey Rider*
	Jules Verne, *20,000 Leagues Under the Sea*

The problem with classifications such as this one is that they suggest that literary documents have *one* unequivocal profile, *one* role to play, whereas in reality one and the same document may have various functions – may have more than one epistemological identity or face. "Notably, the distinction between archaeology" and "genealogy" is a fluid one. Henrik Ibsen's play *Enemy of the People* for instance is listed here as an "archaeological" document because it analyses older "layers", older "formations" of theories and vocabularies concerning micro-organisms than the scientific ones that were in vogue in academic circles at the time of the dramatic event. But at the same time, it is a "genealogical" document, of course, because it analyses the epistemological tension or even *clash* between old and new vocabularies, doing so in terms of *power*. It analyses the strengths as well as the vulnerabilities of an emerging truth regime, notably its political significance in terms of public health or "biopower". And it can even be regarded as *maieutics* to the extent that it analyses a newly emerging knowledge form (detecting pathogenic micro-organisms with the help of a microscope) that has not yet established itself, has not yet acquired a robust epistemological profile of its own. In short, literary documents may be of interest to us for a variety of reasons. Ibsen's play has an archaeological, a genealogical as well as a maieutical dimension – and that, of course, is what makes it so interesting from an epistemological perspective.

The same goes for Ibsen's *The Wild Duck*. In Chapter 6, we compared this play with contemporary emerging research practices, notably the work of Spalding. As a rule scientific documents tend to be homogeneous more or less in terms of their epistemological profile. Spalding's "aside" comparing research notes to court journals is typical for reports written when a research field is still in its period of gestation. In normal science, remarks like that tend to disappear. Ibsen's play is heterogeneous rather than homogeneous. It focuses on the epistemological conflicts arising between the incommensurable views involved, namely the scientific and the romantic view. This is its "genealogical" dimension. But, as we have seen, Ibsen's play has a "maieutical" dimension as well. It stages a new way of perceiving and interacting with animals.

According to Martin Heidegger, the value of true art resides in the extent to which it discloses important but forgotten or as yet undiscovered dimensions of being. Indeed, in his view, a work of art, rather than a scientific paper, is bound to be the place where αληθεια, the disclosure or opening up of new forms of animalhood, or of novel human–animal relationships, is likely to occur. *The Wild Duck* as

a work of art announces, discerns and stages for the first time an important event, about to realize itself in experimental practice. According to Heidegger, art precedes science. The primal scene, the original emergence of a new possibility for interacting with research animals could only occur in a literary text.

From the point of view of comparative epistemology, this is a questionable claim. It would be somewhat arbitrary to attribute the possibility of disclosure to literary writings only. Similar instances of αληθεια can be found in scientific documents as well. Some documents, such as Spalding's original research account, almost read like narratives. While Ibsen (with his seismographic sensitivity) sensed the emergence of a new view on animals, similar instances of openness and revelation were presenting themselves within the discourses of science as well. And whereas forms of disclosure and discovery may emerge within the realm of science, literary documents may be rather obscuring and concealing, impoverishing the animalness of animals (as tends to be the case in the fable literature discussed in Chapter 3). It would be a prejudice, in other words, to regard literary works as epistemologically privileged per se.

If we reflect on Jules Verne's works in terms of this typology we can say that, first of all, their purpose often is to describe the *birth* of a new research practice, based on a novel apparatus or machine, a new research tool that allows the field in question to undergo an epistemological transformation. But Verne also describes the epistemological *struggle* between imaginary thinking and the scientific worldview as well as the transformative, irresistible or even disruptive power of new machines. Although at first glance his analysis seems rather one-sided (biased in favour of science), the more one reads him, the more it becomes clear that things are more complicated. In fact, there is a basic similarity between his work and the philosophy of Gaston Bachelard. On the one hand, he describes the epistemological leap or rupture that allows science to emancipate itself from the epistemological "cave" of imaginary thinking. On the other hand, Verne is clearly fascinated by archetypes, as a symptom of his involvement with an imaginary mind-set. His oeuvre is a perfect archive for studying, not only the logic of science, but also the logic of elementary imagination and the role of scientific and elementary archetypes. His work allows us to study the tension, the struggle between these two styles of thinking. In Plato's simile of the cave (1935/2000, 514 a–517 a), the archetypes are the puppets whose shadows are cast upon the wall. Science is the painful effort to guide someone, or to guide ourselves, towards the exit – education comes from the Latin word *educere* (to lead or escort someone towards outside). Through scientific education we can escape from the sway of the archetypes. Faust's famous maxim also applies to Verne: "Zwei Seelen wohnen, ach! in meiner Brust" (1112). He is fascinated by the archetypes, but at the same time willing to follow the scientific mind towards the realm of truth.

11.3 The Nineteenth Century

As was indicated in the *Introduction*, this volume has a diachronic as well as a synchronic axis. On the one hand, we have discussed the relationship between science and literature more or less "in general". In Chapter 3, for example, we briefly described

two important traditions, the scientific practice of classification (*historia animalorum*) on the one hand and the fable literature on the other, diachronically (i.e. as they evolved in the course of history). In our case studies, however, the focus was on *contemporary* knowledge forms emerging during a particular historical episode. This episode can be roughly defined as the second half of the nineteenth century. Why this episode is so important was indicated in the first two chapters. During this period, the life sciences distanced themselves from (emancipated themselves from) natural philosophy. In literary circles, the new scientific worldview, as well as the methodology on which it was based, met with enthusiasm as well as distrust. Some literary authors (such as Zola) identified themselves with the project of science. Others, however, gave voice to epistemological discontent. When in 1900 epistemology as a philosophical movement was launched, its supporters tended to side with literature as a way of articulating experiences in the life-world that were obscured in laboratory work. In short, the nineteenth century was the time when novel-writing, playwriting as well as experimental research acquired their modern profile. Which of these practices produced the most adequate "representation" of the ways in which human beings experience and interact with the natural world? The novel emerged as a powerful instrument for studying psychological, sociological and even biomedical issues. At the same time, experimentalism (Bernard, Mendel, Pasteur, Koch, Pavlov, etc.) placed the life sciences on a much more scientific footing. From the point of view of comparative epistemology it is no coincidence that novels and experiments (notably in the life sciences) are contemporary phenomena. They share a number of common features, but tend to be agonistic as well. They are each others counterparts. And finally, during this same period, evolutionary theory emerged. The idea of evolution was not only elaborated in scientific documents, but also in literary ones. It was during the second half of the nineteenth century, therefore, that crucial comparative epistemological issues were being raised. It was the epoch during which epistemological disputes (the "literature versus science" dispute) reached its climax.

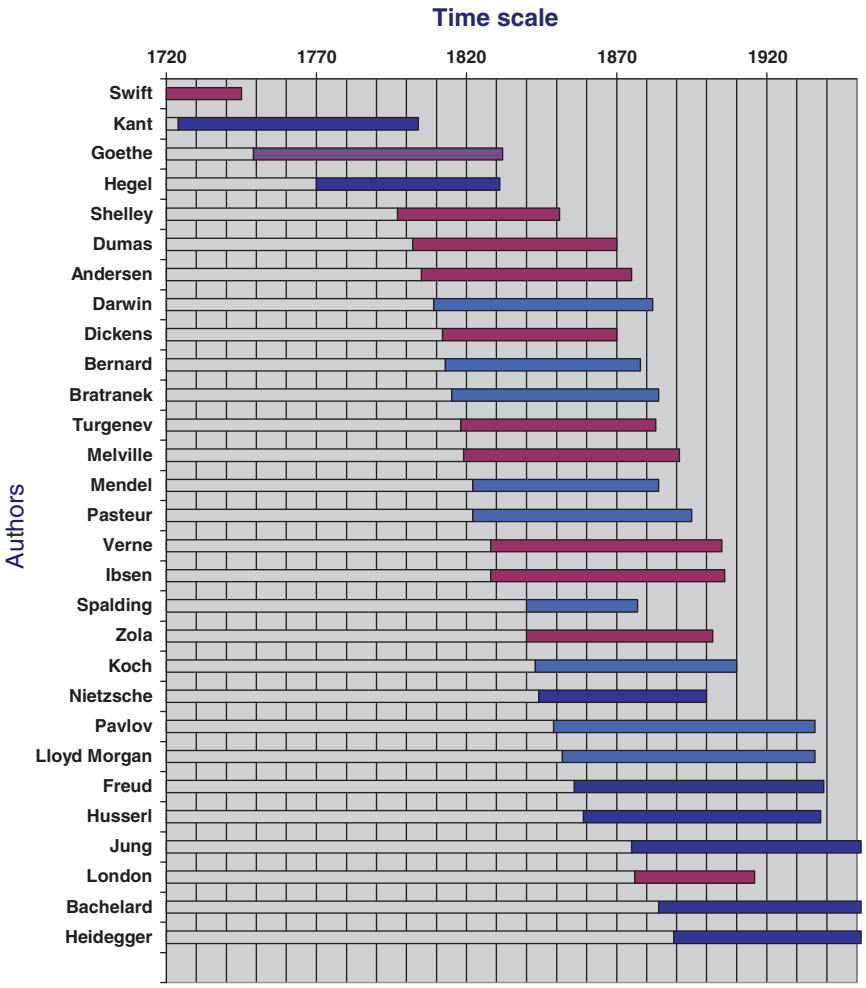
I have listed the *dramatis personae* of this volume in the table on the next page.

While philosophers either precede this episode (Kant, Hegel) or reflect on it, as two side panels so to speak, the scientists (experimentalists) and the literary authors (novelists, playwrights) are contemporaries.

As far as the life sciences are concerned, the nineteenth century gave rise to at least two grand ideas, namely evolution and the experiment. Although ideas concerning evolution had been articulated before Darwin, while physiological and biomedical experiments had been conducted on a limited scale in previous centuries, it was during the second half of the nineteenth century that evolution and experimentation really became standard ideas. Therefore, this focus on the nineteenth century raises some issues, to be developed in subsequent sections of this chapter.

First of all, the concept of the experiment allows us to address the question how exactly we should understand the relationship between literature and science (Section 4). Should we regard these forms of discourse as two incompatible "cultures"? Or will the idea of an experimental design allow us to discern a basic affinity between both?

Secondly, the idea of evolution is a key concept both in literature and science during this epoch. How is this idea addressed in these discourses (Section 5)?



Finally, although from a comparative epistemological point of view the nineteenth century is a decisive episode, the focus of this volume on this period also limits its scope. In the final section I will indicate in broad outline what a comparative epistemology of the twentieth century would look like (Section 6).

11.4 Two Cultures?

The tendency has emerged to see science and literature in opposition to one another. This notably applies to the "two cultures" theorem of C.P. Snow, discussed in the *Introduction*. At first glance our case studies seem to confirm this view. The "logic" of literary documents is the logic of "imaginary thinking", relying on basic images (archetypes) and their networks of associations, rather than on scientific evidence.

There is a clear epistemological proximity between experiences of nature articulated in literary documents and the way in which nature is experienced in the life-world.

At the same time, it became clear that this opposition is really a simplification. Snow's arguments are largely based on anecdotal information rather than on systematic analysis of scientific and literary sources. In important respects, science and literature are actually very similar. First of all, we have indicated that quite often, literary documents are structured as an experimental design. Hegel already noticed that the novel was an art form that was evolving in the direction of more scholarly forms of writing (Chapter 2) and our case studies confirmed this. Our argument was that, as the fable literature was the literary counterpart of the *historia animalorum* tradition (both genres being interested in – moral or anatomical – classifications), the nineteenth-century novel was de literary counterpart of the scientific experiment. Many novels can be read as reports of experiments. This not only goes for the novels of authors like Zola, who consciously applied the principles of experimental research to his work, but it goes for many other novels as well. Moreover, it may also apply to plays. We have extensively analysed *The Call of the Wild* by Jack London (Chapter 5) and *The Wild Duck* by Henrik Ibsen (Chapter 6) and we explicitly regarded both documents as literary experiments. The idea of an experimental design allowed us to discern their basic structure. Finally, in Chapter 10 it was argued that virtually all the ninety novels written by Jules Verne were designed as an experiment. Their purpose was to test particular theories or hypotheses by allowing scientific travellers to make careful observations under extreme conditions in unexplored regions. Furthermore, in many cases these travellers not only acted as researchers, but also as research subjects themselves, or as critical reviewers. And Verne tended to present his novels as accounts of an experimental journey, involving innovative, science-based contrivances for mobility, measurement and observation.

Moreover, we have argued not only that literature is similar to science, but also that science is in important respects similar to literature. For instance, we have argued (notably in Chapter 8) that experimentation constitutes a *dramatic* form of research, a dramatic "art", and that an experiment is basically a performance. In other words, there are very fundamental similarities between the ways in which literary and scientific documents are structured. Finally, in Chapter 7 it was emphasised that we should not identify Romanticism with art, and Rationalism with science. Rather, while Romanticism inspired important forms of research, Rationalism gave rise to important forms of art. The tension between these two cultural forces is a tension *within*, rather than *between* art and science as cultural domains.

If both discourses are so similar, why do we distinguish them at all? Besides fundamental similarities, there are a number of differences as well. First of all, as we have seen, literary documents may constitute instances of research in their own right. To the extent that this is so, their methods and orientation tend to differ from those of science. Whereas a research report will focus on the "object" (for instance, the behaviour of the research animal), a literary document will give due attention to the subject pole as well. Thus, in literary works the subject (the individual researcher or research team) is visibly present, visibly at work. In the case of Maeterlink's work on bees, for instance, the author is a person with a definite identity. He constitutes himself as a subject in writing this personal account. The same goes for Darwin's book on earth

worms, of course, but that is precisely why this book is so "literary" in style. Also in cases where literary authors describe the (experimental) doings of others, as in the case of Ibsen's *The Wild Duck*, these individuals are not at all anonymous entities, researchers without a face, as is usually the case in the research reports and journal articles of normal science. Moreover, whereas in research reports the emphasis will be on the "context of justification" (systematically describing research question, design, method, results, statistics etc.) a literary document will highlight the "context of discovery" as well. This is why scientific documents coming from the early history of a particular field so often read like "narratives" or even novels – the discourse of the discipline in question has not yet been standardised, the "subject" (the individual researchers and his or her experiences) is still emphatically present.

Yet, as was indicated above, literary texts may play other epistemological functions as well. Some literary documents are of a "genealogical" type. They stage a clash between scientific and non-scientific worldviews, between scientific and non-scientific forms of interaction with the natural world. In the context of such a clash, both the logic of experimental thinking and the logic of imaginary thinking are fleshed out. In short, we cannot say that literature is "opposed" to science, or that literature belongs to a different culture, and has a world of its own. A genealogical novel is open to science as well as "opposed" to science. Mary Shelley's *Frankenstein* conveys both enthusiasm and discontent concerning the contemporary life sciences. Science is described from *within* (from a first-person point of view, from the perspective of Victor Frankenstein himself) as well as from *outside* (from a third-person point of view, an outsider perspective). The novel describes the logic of experimental thinking *as well as* the logic of imaginary thinking. And this goes for all truly genealogical novels.

11.5 A Grand Idea ("How Large the World is …")

What do Melville's *Moby-Dick*, Darwin's *The Origin of Species* and Verne's *Voyage to the Centre of the Earth* have in common? To a certain extent, these three impressive volumes address similar themes. To begin with, all three books describe scientific journeys, leading to dramatic theoretical results. Secondly, all three books convey a basic experience of astonishment, an awareness of how incredibly large the world really is. Finally, all three books address issues of genesis ("origin") and extinction.

Melville's *Moby-Dick* is the most backward looking of the three. It is a gigantic retrospect on a great variety of scientific, literary, philosophical, religious and other topics, genres or languages. One of the more dominant perspectives is the biblical perspective (the whale as Leviathan, survivor of the Flood) and the fabulous image of the whale connected with it (notably the story of Noah and the giant whale). Ishmael sets out to defend the imaginary whale against scientific strategies of classification and quantification. Still, Melville's book is an account of a scientific journey, an effort to flesh out a cetology (whale-science) in the context of an expedition. Although eventually this effort turns out to be something of an epistemological regression, the idea of a scientific journey as such is clearly present. It

determines the novel's basic structure. Moreover, although *Moby-Dick* turns out to be a fabulous animal, a descendant of the time-old fable literature, an animal that belongs to *cryptozoology* rather than zoology, he is *not only* this, for he is *also* an evolutionary animal, a palaeontological survivor, a leftover from previous geological epochs, threatened with extinction. Indeed, Ishmael not only discusses the animal's life and world, but also his future prospects in terms of survival. We are faced with a form of "animality" that involves two complementary dimensions: the imaginary and the scientific one. The comprehensive whale is a *coniunctio oppositorum*, a fabulous creature and a biological species – more or less as human beings are, we also combine two apparently incompatible dimensions: rationality and instinct, reason and impulse, self-consciousness and animalness. Furthermore, the scientific journey undertaken in *Moby-Dick* is similar to *The Origin of Species* also in another sense. In Melville's book, traditional sciences such as taxonomy are criticised, not only because of their lack of imagination (which for a scientist may actually be a virtue), but also because of their lack of scale. Only in the context of a sea-journey, amidst the wide and endless watery expanses, can we hope to understand the whale and his world. What is lacking, in established scientific practices, according to Ishmael, is an acknowledgement of the immense size and dynamics of the natural world. This is a truly Darwinian experience. *The Origin of Species* conveys the same message.

Darwin's book starts from the present (practices of breeding and horticulture), but positions it against a horizon of unprecedented dimensions. In literary terms, two styles are represented in Darwin's oeuvre: the garden style (the micro-world of pigeon fanciers and dog breeders) and the style of the great expanses (the macro-world of oceanography and evolution theory). Whereas his readership dwells in the former, Darwin's opens up for them the latter. This is why his book "reads like a novel", it opens up a world of experience. Whereas the garden style is peaceful, revealing a harmonious world, the macro-world is a world of relentless struggle. This idea of struggle, of competition and will to power, was one of the key ideas of this era. While Darwin described the struggle between varieties, Louis Pasteur highlighted the perpetual battle between microbes and macro-organisms (mammals and birds). On this grand scale, his story of genesis ("origin") and extinction – of animals but, eventually, of humans as well – is set. We have never realised, he writes, how large the world is, notably in terms of its temporal dimension. Evolution is proceeding for millions of years, and will continue to do so. The present is but a fleeting snapshot amidst an ocean of time – as I said, *Moby-Dick* is written in a similar vein.

Finally, also Verne's book exposes his readers to new dimensions. He opens up for them the internal depths of the earth. But he does the same for the internal depths of thinking. His book is a grand story about formations, of layers, not only geological ones, but also epistemological ones. Lidenbrock descends, not only literally, to uncover hidden and forgotten geological strata, but also figuratively, to discover forgotten intellectual worlds, one of whose remainders is Saknussemm's encrypted note. The latter's works have been destroyed, and the note is like a fossil, a trace, a palaeontological encryption. But as such, it opens up the intellectual

world of alchemy, a style of thinking for which the world consists of spheres and the centre of the earth is hollow. But it is also a style of thinking for which the world is grand and forever changing, transmuting. Epistemologically speaking, Verne's book is a hybrid, composed of two conflicting elements – *coniunctio oppositorum* – namely alchemy and modern science, merged into one great intellectual dream. It builds on alchemical cosmology, but it is also a story of genesis and extinction. On the one hand, the scientific travellers are heading, not only to the centre of the earth, but also towards the world's beginning, the very first stages of evolution. On the other hand, like Melville, who discovers a species, a monster, that (apparently) is about to become extinct, a leftover from a distant past, dwelling in the depths of the ocean, Verne also discovers *en route* a series of monsters, dwelling in the depths of the earth, leftovers from previous epochs. His book is the beginning of the Jurassic monster-genre, a branch of science literature that is bound to become important in the twentieth century. Its builds on the idea that Jurassic sites, as palaeontological islands as it were, have been retained somewhere, as "lost worlds", or can be put in place again. Like the novels of Michael Crichton (*Jurassic Park, Lost World*) Verne's novel is a "palaeontology of the present", so to speak. The extinct life forms are still alive, they inhabit a preserved, insular world. This also goes for Melville, who describes life forms that felt more at home in "that shuddering period, ere time itself began, when Saturn's grey chaos swayed through Polar eternities" than in the present. But it also goes for Darwin. He also discovered his islands where evolution has taken a different course (with a slower pace). Moreover he also describes isolated mountain tops as islands, from an evolutionary point of view. Here as well, descendants of species that became extinct elsewhere can still be found – the lost world theorem of Conan Doyle, Crichton and others. Once again, it is clear that we are not dealing with two opposite "cultures" – literature versus science. Rather, we are faced with a number of works that are inspired by the same idea. They set out to achieve the same thing: writing the account of a scientific journey, towards isolated habitats, a journey with an *impact*, leading to a concrete result, a dramatic expansion of our world, testing and refuting theories, devising new ones, changing our view of our world, its history and its inhabitants significantly.

11.6 Prospects for Further Research: Some Case Studies in Broad Outline

The focus in this volume has been on the nineteenth century, an era of discovery, classification, exploration, experimentation. The twentieth century, as far as the life sciences are concerned, is the century of biotechnology, of genetics, of manipulation – genetic and otherwise (Zwart 2007). It is an era that displays a tremendous increase of pace (acceleration) as well as of space (globalisation). And the computer emerges as the generic research tool, dramatically transforming all fields and all forms of scientific inquiry.

Around 1900, biologist Jacques Loeb (1859–1924) voiced the idea that nature must be regarded as raw material, to be modified and improved by biological engineers (Pauly 1987). Biology's core objective, Loeb said, is the improvement of nature. Why accept existing biological constraints as given? Why not use biological knowledge in order to improve life and – eventually – ourselves, much more directly and effectively than we have done so far? Why not prolong the human lifespan or opt for artificial instead of sexual reproduction? Although in the context of his experiments the actual power of science over nature was still rather limited, the ideological *framing* of his research (and the recognition of its potential impact for society) was clear enough.

A number of literary authors addressed these prospects opened up by science. First of all, the work of H.G. Wells (1866–1946) is important. Wells was trained as a biologist. In 1930 he published, together with G.P. Wells (his son) and Julian Huxley (brother of Aldous) a text book called *The Science of Life*. Reflecting on the research of Jacques Loeb on artificial parthenogenesis (non-sexual reproduction) in sea urchins, the authors ask themselves whether this would be possible in mammals (i.e. humans) as well. Their answer is affirmative. "In mammals the ovum is inaccessible to the experimenter, so that we do not know whether artificial parthenogenesis is possible. There is no reason to suppose that it is not . . . (p. 509). Like Loeb they argue that in the future, sexuality and reproduction will become separated for good: "Once more it becomes evident to us that sex is imposed upon reproduction and is in its essence a different thing" (p. 510). But these and similar issues are also addressed in Well's literary writings. One of his first stories is about a scientist who manipulates pathogenic micro-organisms in his laboratory. An "anarchist", posing as a visiting colleague, escapes from his laboratory carrying a test tube in his hands. There is a happy ending: the anarchist suffers from science illiteracy – he picks the wrong tube. London is not exposed to a plague. One of his most famous novels is *The Islands of Dr. Moreau* about a researcher who gradually transforms animals into human beings, using transplantation surgery. Eventually, the dreadful Dr. Moreau is killed by the monsters of his own making.

Aldous Huxley likewise responded to Loeb's challenge. The famous first chapter of his *Brave New World*, describing the "Central London Hatchery and Conditioning Centre" consciously echoes Loeb's ideas. Huxley's novel is a classic effort to describe the atmosphere of discontent that biotechnology incited in broad circles. The first chapter describes how the chemical environments of embryo's kept in vitro are systematically manipulated in order to adapt them to societal demands and the chapter actually contains some references to Loeb's views.

For the biosciences, the twentieth century ended with the announcement by President Clinton, Francis Collins and Craig Venter (on June 26, 2000) that the Human Genome Project (designed to sequence the human genome) was rapidly approaching its conclusion. Michel Houellebecq is one of the literary authors who responded to the emergence of genomics and its potential for human self-amelioration. *Elementary particles* (1998) is a narrative about a scientist who develops the algorithm that makes genetic enhancement possible, resulting in the emergence of a new, self-designed type of human being. While criticizing technologies of the self that

individuals experimented with in the 1960s, such as use of drugs and sexual liberation, Houellebecq propagates the idea that now, at the turn of the millennium, we are really entering a new era, in which much more powerful and science-based technologies will become available for self-improvement, leading us far *beyond* humanity as it had developed so far, on the basis of evolution. Although not many details are given in terms of exactly *how* this self-transformation, this leap into post-humanism will be achieved, the message is nonetheless clear enough.

When it comes to using novels as research tools for assessing the epistemological profile of the life sciences in the genomics era, Michael Crichton (1942) is an important author. He is the Jules Verne of our time. His work is a literary encyclopaedia, critically reviewing the sciences and technologies of our own era, in which every research field has "its own novel" so to speak. He analyses the impact of ICT and genomics on various research fields. For instance, in *Jurassic Park* he describes how palaeontology becomes an experimental science, and dinosaurs are transformed into research animals. When Alan Grant, an outstanding palaeontologist, is confronted with revivified versions of his model organisms, he immediately realises the epistemological significance of this event. Palaeontological quandaries that had occupied his research community for years, such as the issue of whether dinosaurs had been warm-blooded animals, whether they cared for their young and whether they were fast or slow, were now easily resolved by merely looking at these "surprisingly active" organisms:

> Grant's field of study was going to change instantly. The palaeontological study of dinosaurs was finished. The whole enterprise – the museum halls with their giant skeletons and flocks of echoing school children, the university laboratories with their bone trays, the research papers, the journals – all of it was going to end. (Crichton 1990/1991, p. 84)

In a sequel to this volume, Crichton will be a key author.

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