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ON THE HISTORICAL ROOTS OF NATURAL CAPITAL IN THE WRITINGS OF CARL LINNAEUS

C. Tyler DesRoches

ABSTRACT

No longer do resource economists merely regard nature as a collection of inert materials to be improved by human labor and manufactured capital; rather, nature is, to an increasing extent, taken to be a mindless producer of economically valuable ecosystem goods and services. Instances of natural capital are frequently said to produce such goods and services in a manner that is relatively detached from human agency. This article argues that, historically, the idea of nature as a systematic original producer capable of self-generation is hardly novel. The eighteenth-century roots of this idea can be found in the writings of Carl Linnaeus who depicted the whole Earth and all of its productions as the “oecconomy of nature.”

Keywords: Natural capital; nature; Physiocrats; Linnaeus; ecosystem goods and services; oecconomy of nature

JEL Classifications: B11; B12; Q00; Q57

INTRODUCTION

The most striking feature of natural capital, the one that makes this concept so remarkable in the first place, is that it presumes *ex hypothesi* that nature or parts of nature which have not yet been directly subject to human agency are capable of independently producing economically significant natural products. In the

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very least, the contemporary resource economists who regularly deploy this concept do not rule out such unaided productions a priori.¹

Natural capital denotes undesigned or original mechanisms of economic production, such as ecosystems. Consider, for instance, the pollination services provided by pollinator species, such as honey bees. Resource economists and others have recently claimed that such species perform economically significant roles in the cultivation of numerous crop plants, such as tomatoes, celery, and rapeseed. Recent estimates suggest the economic value of worldwide pollination services is approximately € 195 billion (Lonsdorf et al., 2011). Another sweeping study concluded that the Earth's entire biosphere, including a wide range of services generated by natural capital, such as the purification of water, nutrient cycling, and the detoxification of wastes, is worth between US\$ 14 and US\$ 54 trillion dollars, annually (Costanza et al., 1997). In all such cases, natural capital denotes, among other things, a rich variety of active, modifiable, and economically valuable production processes that are afforded to human agents by nature, *gratis*. Nature not only affords human agents with passive materials and raw resources to be improved by labor, but also endows them with production processes that generate valuable goods and services in a manner that is relatively detached from human agency.

This article analyzes the eighteenth-century historical roots of natural capital by focusing on the two most prominent features of this concept: originality and self-generation.² These features indicate that some instances of natural capital are production processes whose existence is owed to non-human material causes. Moreover, these processes are capable of producing in a manner that is relatively detached from intentional human agency. Of course, this focus does not entail that natural capital has no other characteristics or that every instance of natural capital must be completely detached from human agency and capable of self-generation. In fact, the concept shares many of the same characteristics as manufactured capital. Moreover, some instances of natural capital are intentionally modified and improved by economic agents.³ Be that as it may, this article sets aside shared features of natural capital and focuses on those which distinguish natural capital from manufactured capital: originality and self-generation (DesRoches, 2015).⁴

No other school of thought emphasized the inimitable role of nature's capacity to generate wealth more than the French Physiocrats during the mid-eighteenth century. Therefore, it would seem that if the distinguishing features of natural capital have a forerunner of any kind in the history of economic thought, it would be found in the writings of the Physiocrats. However, this article argues that, for various reasons, the independence of nature's productions among the Physiocrats is called into question. Instead, the idea of nature as an original and self-generative producer for human agents has roots in the writings of a largely neglected economic thinker, Carl Linnaeus. Following the work of Margaret Schabas (2005) and others, it will be shown that this Swedish botanist, one of Charles Darwin's heroes, was the first theorist to depict the whole Earth and all of its productions as the *oeconomy of nature*. On Linnaeus' late eighteenth-century account, the Earth was to be managed for maximum output,

and human beings were not only to profit from such productions, but had the obligation to ensure that nature's productions accrued to the enrichment of the human economy (Worster, [1977] 1994). Thus, while it may be true that the contemporary resource economists who deploy the concept of natural capital today have jettisoned any mention of theology and teleology – both essential features of the Linnaean system – nature *qua* independent and systematic producer of economically valuable goods and services are on full display in Linnaeus' *Oeconomy of Nature* ([1791] 1977).

NATURAL CAPITAL AND PHYSIOCRATIC THOUGHT

The Physiocrats, who described themselves as “*les économistes*,” were most prominent during the late 1750s until the early 1770s and are widely recognized for inventing various “*tableau économique*” that represented the dynamics of production and distribution across the entire economy on an annual basis. The Physiocrats are also widely known for having influenced Adam Smith's systematizing of economic phenomena in the *Wealth of Nations* and for rejecting the reigning Mercantilist doctrine that had been led by the Director of the East India Company, Thomas Mun, who privileged foreign trade to enlarge the Kingdom's stock. Headed by François Quesnay, the personal physician to King Louis XV and Madame de Pompadour, the Physiocrats were the most influential school of economic thought during the mid-eighteenth century and they were also the first to develop a clear view of capital's role in economic production (Hennings, [1987] 1990). Although Quesnay's success is normally attributed to his theoretical accomplishments, his main goal was practical: to derive maxims of wise governance that would lead to the greatest possible production of commodities and the happiness of humankind (Banzhaf, 2000).

Above all, the Physiocrats are renowned for having claimed that all wealth derives from the ground, a position that can be traced back to Richard Cantillon's ([1755] 1964) *Essai sur la Nature du Commerce en Général*. In fact, Anthony Brewer (1992) has argued that Quesnay's economics, characterized by the sole productivity of agriculture, appears to come directly from Cantillon's *Essai*; the main difference being that for the latter, land is the only scarce resource while for Quesnay the main constraint on economic production is agriculture performing below its potential, the cause of which was almost always a lack of capital investment.

The Physiocrats developed an abstract and deductive “system” – a circular-flow model of production and consumption that consisted of three interdependent social classes, only one of which was claimed to be truly productive (Riskin, 2003). Quesnay showed that the Farmers or Husbandmen, when combined with the natural powers of nature, are the lone bona fide productive social class. The other two classes in the model, the landowners and artisans, rely on the farmers for their basic needs and subsistence. These latter two classes are considered all but sterile because while they might succeed in transmuting various natural objects into useful forms, such activities are merely modifications

(“*façonner*”) and do not represent genuine or true production (“*produire*”), a special activity that could only be accomplished by the Farmers.

The Physiocrats held that the agricultural sector alone was truly productive. Why? The Physiocrats believed nature alone was capable of yielding a surplus or “*produit net*” (net product), one that subsequently circulated among the three main social classes. The net product was *the* central factor – the strategic policy variable – for the Physiocrats. Anything that increased the net product caused an expansion of economic activity while anything that reduced it, such as inadequate advances, caused a contraction (Meek, 1962). As Ronald L. Meek explains,

The Physiocrats’ theoretical system was that this net product was yielded by agriculture, and by agriculture alone. Agriculture as the supreme occupation, not only because it was morally and politically superior to others, not only because its produce was primary in the wants and always in demand but also – and mainly – because it alone yielded a disposable surplus over necessary cost. (1962, 20)

Artisanal and manufacturing activities figured in the Physiocratic model, but the members of these classes were deemed sterile because, in the long run, they were unable to produce a surplus over and above the costs that were incurred in production. Therefore, the two unproductive classes of society, the landowners and artisans, were directly dependent upon the “*produit net*” produced in the agrarian sector. As Quesnay explains in *Extracts from ‘Men’*:

Those who make manufactured commodities do not produce wealth, because their labour increases the value of these commodities only by an amount equal to the wages which are paid to them and which are drawn from the product of landed property. The manufacturer who makes cloth, the tailor who makes clothes, and the cobbler who makes shoes do not produce wealth any more than do the cook who makes his master’s dinner, the worker who saws wood, or the musicians who give a concert. They are all paid out of one and the same fund.⁵

The fund that Quesnay refers to at the end of the aforementioned passage is that which is generated by the land, but only after it has been properly prepared and worked by the Farmers or Husbandmen. It is crucial to recognize that, for the Physiocrats, while land is the *source* of all wealth, unassisted land or nature is insufficient for generating it. This claim is not uncontroversial since some scholars have suggested that nature alone is the prime mover in the Physiocratic model of economic production (Banzhaf, 2000). Be that as it may, it should be clear that Quesnay and the other Physiocrats, including The Marquis de Mirabeau, maintained that, strictly speaking, human labor and capital cause the agricultural sector to prosper, stimulate industry, and increase and perpetuate wealth throughout the entire society (see, for example, Quesnay’s *The ‘General Maxims’*). In other words, land is a unique and necessary, but insufficient condition, for the production and circulation of wealth among the three main classes in the Physiocratic model.

Further evidence to support this claim can be found in Quesnay’s *Extract from ‘Corn’* where he distinguishes between the roles played by Farmers and Artisans. He states, “one group of men causes this wealth to be generated by means of cultivation; another group prepares it for use; and those who have the

enjoyment of it pay both of these groups” (Meek, 1962, p. 73). This statement depicts an economy that produces wealth not merely by the forces of unassisted nature or land alone, but land that is stimulated in the right kinds of ways. Moreover, without sufficient capital, or what the Physiocrats referred to as “advances,” from the landowners directed toward agricultural production, Quesnay expects pure poverty among the people. He asks, rhetorically:

what then would be the fate of that poor man who is told to *go and plough the land*? Could he cultivate it on his own account? Would he obtain work from the farmers if they are poor? Farmers who find it impossible to meet the costs required for proper cultivation and to pay the wages of servants and workmen cannot employ the peasants. The land, lacking manure and all but uncultivated, can only leave all of them to languish in poverty.⁶

In his magisterial *Réflexions sur la Formations et Distribution des Richesses* (Reflections on the Formations and Distribution of Riches), a correspondent to the Physiocrats, Anne-Robert-Jacques Turgot ([1770] 1898), was even more explicit than Quesnay when recognizing the role of human agency as the “First Cause” of wealth production. Matching Quesnay’s standard Physiocratic model, Turgot, the Baron de Laune and Finance Minister to Louis XVI, also divided society into three classes: the Husbandman (productive class), the Artisans (the unproductive class), and the Proprietors (the disposable class). While scholars generally deny that Turgot was a genuine member of the Physiocrats, hardly anyone would deny that this friend and interlocutor of David Hume’s accepted the inimitable role of land in the production of wealth (Meek, 1962; Riskin, 2003; Vardi, 2012). In fact, Turgot maintained that the Husbandman was to the economic realm what Aristotle’s Unmoved Mover was to the entire Universe. Just as Aristotle had concluded in Book 8 of *Physics* that, logically, there must be an initial unmoved mover to explain all of the other motion in the universe, Turgot suggests that, in the realm of economic phenomena, it was the Husbandman and not the land or nature that imparts the first impulse (“*donne le premier mouvement*”) which generates wealth. The Husbandman’s labor alone causes the land to produce, without which, “the land produces nothing” (Turgot, [1770] 1898, p. 16).

The portrait Turgot paints of wealth production, however edifying it may appear to be on the surface, is arguably confused. In fact, in his *Réflexions sur la Formations et Distribution des Richesses*, Turgot appears to contradict himself when he simultaneously claims that the Husbandman is the sole source of wealth and the Earth is the sole source of wealth.⁷ The former claim is emphasized throughout most of his short book where Turgot states that it is the Husbandman who is the “sole source of all wealth,” the “sole source of the riches,” that, once produced, circulates throughout society, animating the other classes that constitute society. However, later on, in the very same book, Turgot describes the first time humans cultivated the Earth when he states:

it is the earth which is always the first and only source of all wealth; it is that which as the result of cultivation produces all the revenue; it is that also which has provided the first fund of advances prior to all cultivation. The first Cultivator has taken the seed he has sown from plants which the earth has sown from plants which the earth had of itself produced; while

waiting for the harvest he has lived by hunting and fishing, and upon wild fruits: his tools have been branches of trees, torn down in the forests, shaped with stones sharpened against other stones; he has himself captured in the chase animals wandering in the woods or caught them in his traps; he has brought them into subjection and trained them; he has made use of them first for food and afterwards to help him in his labour. The first fund has grown little by little; the cattle, especially, were of all moveable wealth that which was most easy to accumulate: they died, but they reproduced themselves, and the wealth which consists in them is in a way imperishable: this fund, moreover, grows by the mere process of generation, and gives an annual produce, either in milk, or in fleeces, in hides and other materials, which, with the wood obtained in the forests, have formed the first fund for the works of industry. ([1770] 1898, p. 46)

While explicitly recognizing that Turgot may have been inconsistent when attributing different things with the status of “sole source of wealth”, it is also clear that, with Quesnay, Turgot cannot be said to emphasize nature’s *unassisted* productions of wealth, or goods and services, certainly not in any way resembling what modern-day economists do when deploying the concept natural capital. For both of these eighteenth-century economic theorists and for the Physiocrats generally, unaided nature was incapable of producing wealth. If the Physiocrats had emphasized nature’s systematic and unassisted productions, then their theoretical framework would have been a prime candidate for being a precursor to natural capital since both would have emphasized nature’s independent productions.

To be clear, the emphasis here on nature’s unassisted productions in this section is not meant to suggest that every production process denoted by the concept of natural capital is completely detached from human agency. On the contrary, as mentioned earlier, some instances of natural capital can be augmented and improved or modified by human agency without losing their status as an instance of natural capital. The central reason to focus on nature’s unassisted productions is because the former is a distinguishing feature of natural capital. No instance of manufactured capital has this status. From this vantage point, we can see that, for the Physiocrats, nature or land is special insofar as it is required for the inimitable role it serves in producing wealth (which subsequently animates the three classes of society). Nevertheless, unassisted nature or land alone is insufficient for generating the wealth that circulates throughout society. For the Physiocrats, labor and land are jointly necessary and sufficient for economic production, a species of activity that is only manifested by the Farmers.

NATURAL CAPITAL AND LINNAEUS’ *OECONOMY OF NATURE*

If unassisted nature *qua* producer of economically valuable goods and services cannot be unequivocally aligned with the Physiocrats, then where else might one look for a nascent category of natural capital? This section argues that the idea of nature as an unassisted producer for human agents has roots in the writings of the eighteenth-century theorist, Carl Linnaeus (1707–1778), who believed

that the whole Earth and its productions were to be managed for maximum output and adapted to the human economy.

Linnaeus had devised his own system of plant classifications, *Systema Naturae*, describing it as the Creator's magnificent arrangement. Linnaeus' writings, particularly his *Oeconomy of Nature* ([1791] 1977), held significant sway over not only nineteenth-century naturalists, such as Charles Darwin and the geologist, Charles Lyell, but also classical political economists, such as Adam Smith (Koerner, 1999; Pearce, 2010). Robert Stauffer states, "the importance of Linnaeus in the evolution of ecology is very great, and it is striking that among the naturalists writing after Linnaeus and before Darwin, it is the geologist Charles Lyell who shows the clearest grasp of Linnaeus' ideas on the economy of nature and who makes the fullest use of them in his work" (1960, 238–239). Indeed, Darwin not only deployed the Linnaean terms of "polity of nature" and the "economy of nature" in his own works with great regularity and gleaned the notion of reciprocal dependence between organisms from Linnaeus' *Oeconomy of Nature*, but also his deep admiration for Linnaeus is on full display in a famous letter written to his friend William Ogle, where Darwin refers to the Swedish botanist, along with the French naturalist and zoologist George Cuvier, as one of his "gods" (Gotthelf, 1999; Koerner, 1999, p. 15).

In her *Natural Origins of Economics*, Margaret Schabas (2005, p. 30) argues that Linnaeus was one of the most important economic theorists of the Enlightenment and, furthermore, that Linnaeus' "oeconomy of nature" depicts in *Oeconomy of Nature* is the first genuine depiction of an economy (a claim that flies in the face of orthodoxy since it is generally presumed that the Physiocrats were the first economic theorists to depict an economy). Even among those who would dispute this claim, and question the status of Linnaeus as a bona fide economic theorist, there can be no question that Linnaeus held economic theorizing in the highest regard. As Lisbet Koerner recounts in her *Linnaeus: Nature and Nation*, Linnaeus' support for economic science is unquestionable when he states: "no science in the world is more elevated, more necessary and more useful than Economics, since all people's material well-being is based on it" (1999, 103).

For Linnaeus, "Oeconomy" is the art of household management or *oikonomikê* in the Aristotelian sense. Recall from Book 1 of his *Politics*, Aristotle grapples with the topics of wealth and household management, and investigates whether money-making and *oikonomikê* is the same thing (DesRoches, 2014). He responds in the negative, arguing that "it is easy to see that the art of household management is not identical with the art of getting wealth, for the one uses the material which the other provides" (*Pol* 1256a9–11).⁸ For Aristotle, natural wealth-getting involves the master of a household acquiring and administering those useful objects of wealth that constitute "true wealth" or "true riches" in order to meet the needs of all household members, including the master, his wife, children, and slaves. While Linnaeus has less to say about the relation between wealth and household management than Aristotle, he extends Aristotle's concept of *oikonomikê* to designate the whole oeconomy of nature. As Trevor Pearce (2010, p. 496) explains, during the

seventeenth century, the word “*oeconomia*” still had its Aristotelian meaning: the ordering of things pertaining to one’s household; its usage was metaphorically extended to nature as a whole, animal bodies, and human bodies. Linnaeus simply adopted Aristotle’s notion of *oikonomikê* and extended “the physiological idea of the animal economy to nature in its entirety. In [Linnaeus] eyes, the economy of nature deserved a description as detailed and rational as that of the animal economy” (Pearce, 2010, p. 497). In *Oeconomy of Nature*, Linnaeus states, “By oeconomy of nature we understand the all-wise disposition of the creator in relation to natural things, by which they are fitted to produce general ends, and reciprocal uses.”⁹ In short, Linnaeus believed that the oeconomy of nature was God’s great household, a household that was to be managed for human ends.

For Aristotle, good *oikonomikê* involves becoming economically self-sufficient (lacking in nothing or getting enough) mainly to avoid the constraints imposed by other people and nature (Meikle, 1995). Linnaeus, too, emphasized self-sufficiency as the proper goal of *oikonomikê*. Indeed, with his strong camera-list leanings, Linnaeus had devised a grand scheme for an autarkic Sweden whereby nonindigenous species of fruits and vegetables were to be domestically grown in greenhouses (Koerner, 1999; Schabas, 2005).

Linnaeus’ *Oeconomy of Nature* presents a static portrait of the geobiological interactions in nature with only one kind of change: a cyclical pattern that, inexorably, returns to the beginning (Worster, [1977] 1994, p. 34). He envisions all of the Earth’s species of plants and animals as purposefully and perfectly arranged, living in mutually dependent relations with one another. Nature, for Linnaeus, also possessed self-regulating properties (Koerner, 1999, p. 82). Each and every creature plays an important and specific function or “allotted place” in nature’s economy (Pearce, 2010). All creatures were assigned a part in the great unfolding *oeconomy of nature*, each with its own foodstuff, geological range, limits to appetites, and minimum and maximum rates of reproduction (Worster, [1977] 1994). It is critical to recognize that Linnaeus’ *oeconomy of nature* not only included the plants and animals but also humans and the entire atmosphere.

Indeed, for Linnaeus, the whole world was a “terraqueous globe” that consisted of three distinct and yet mutually interdependent kingdoms: the fossil (or the crust of the Earth), the vegetable, which “adorns the fact of the Earth and draws the great part of its nourishment from the fossil kingdom,” and the animal kingdom, which is sustained by the vegetable kingdom (Linnaeus, [1791] 1977, p. 40). In relation to these three distinct kingdoms, we are told that “man’s activities are seamlessly joined to those of plants and animals, even to the Earth’s crust and atmosphere” (Schabas, 2005, p. 30). Linnaeus describes all such interdependencies when he states:

Everything arranged by the omnipotent Creator on our globe is performed in such a wonderful order that there is not one thing that is not dependent for its existence on the support of another [...] The earth becomes the food of the plant, the plant that of the worm, the worm that of the bird and the bird often that of the beast of prey [...] Man who turns everything to

his needs, often becomes the food of the beast or bird or fish of prey or of the worm and the earth. So all things go round.¹⁰

For Linnaeus, the whole of nature was imbued with purpose and nature was incapable of producing waste. Just as Aristotle had famously argued that “nature does nothing in vain,” Linnaeus wholeheartedly agreed with this sentiment since he believed that each and every creature was fully engaged in the *oeconomy of nature* (*De Incessu Animalium* 2, 704b12–17). Even the dead and fallen tree, for example, does not go to waste but is, without delay, efficiently eliminated by a wide variety of creatures that depend on such items for their continued existence, such as liverworts, mushrooms, beetles, caterpillars, and woodpeckers (Pearce, 2010, p. 498). Similarly, as Donald Worster suggests, “all of animate nature is [...] bound together in common interest by the chains of sustenance that link the living to the dead, the predator to its prey, the beetle to the dung on which it feeds” ([1977] 1994, p. 35). Linnaeus, emphasizing the obvious benefits of this state of affairs explains that:

The whole earth would be overwhelmed with carcasses, and stinking bodies, if some animals did not delight to feed upon them. Therefore, when an animal dyes [sic], bears, wolves, foxes, ravens, &c. do not lose a moment till they have taken all away. But if a horse, e.g. dyes near the public road, you will find him, after a few days, swoln [sic], burst, and at last filled with innumerable grubs of carnivorous flies, by which he is entirely consumed, and removed out of the way, that he may not become a nuisance to passengers by his poisonous stench. ([1791] 1977, p. 121)

While it is true that, according to Linnaeus, human beings are part and parcel of the *oeconomy of nature*, these creatures still occupied a special role in this system since the whole contrivance was designed for mankind by the hand of God. This divine *oeconomy of nature* was an idea absorbed by Linnaeus who was under the influence of Robert Boyle and John Ray (Koerner, 1999, p. 82). While Linnaeus believed that human beings were fully integrated into the *oeconomy of nature* and, like other species, are living as subordinate parts of the divine order, non-human nature remains merely an apparatus for the purposes of mankind (Worster, [1977] 1994). Indeed, Linnaeus maintained that all things were made for the sake of man, an exceptional species that he describes as “the Lord of the animals”; the purpose of the whole *oeconomy of nature* was, ultimately, to make human lives more convenient and pleasant than they would be otherwise (Koerner, 1999, p. 85). Linnaeus states:

we follow the series of created things and consider how providentially one is made for the sake of another, the matter comes to this, that all things are made for the sake of man; and for this end more especially, that he by admiring the works of the Creator should extoll [sic] his glory, and at once enjoy those things, of which he stands in need, in order to pass his life conveniently and pleasantly. ([1791] 1977, pp. 123–124)

Worster has argued that Linnaeus’ *Oeconomy of Nature* ([1791] 1977) is the first complete system of the *oeconomy of nature* that envisioned human beings to be at the center of the system. The role of human beings in the *oeconomy of nature*, which is worth recognizing, resembled that which had been encouraged by Francis Bacon in his *Novum Organum*. Bacon’s dream was “to extend man’s

empire over nature” and “to the effecting of all things possible.”¹¹ Linnaeus recognized humans as living among other creatures, all of which were a part of a divine order; however, man must vigorously pursue his assigned work of utilizing his fellow species to his own advantage. This responsibility must extend to eliminating the undesirables and multiplying those that are useful to him, an operation “which nature, left to herself, could scarcely effect.” Created to praise and emulate the Creator, men fulfill their obligations not only by choosing to be “mere idle spectators” but also by making nature’s productions accrue to the enrichment of the human economy” (Worster, [1977] 1994, p. 36). Indeed, as Koerner (1999) argues, there is little doubt that Linnaeus held a sunny prelapsarian view of nature, judging the Earth to be a world that must be managed for maximum output; domesticating the wilderness to serve human purposes meant restoring it to an Edenic state.

The ideal of envisioning the whole of nature as an original and self-generating production process to serve human agents, a vision that is presumed by contemporary economists who deploy the concept of natural capital, has a clear forerunner in the writings of Linnaeus who depicted the whole Earth and all of its productions as God’s great *oeconomy of nature*. While no one denies that resource economists today have stripped nature’s productions from the theological and teleological clothing in which Linnaeus originally dressed them, the all-encompassing view of nature *qua* independent producer is on full display in Linnaeus’ *Oeconomy of Nature* ([1791] 1977).

OTHER ASCRIPTIONS OF ORIGINALITY AND SELF-GENERATION?

To be clear, the claim being made here is not that Linnaeus was the only economic theorist to ascribe originality and self-generation to natural factors of production. On the contrary, many theorists, including Adam Smith, John Stuart Mill, and Karl Marx, all had a distinctive class of production in mind that denotes nature’s independently generated products.

In Book I, Chapter XI of *Wealth of Nations*, Adam Smith ([1776] 1976) refers to nature’s unaided productions as the “spontaneous productions of the Earth” (I, XII, 112), including the kelp that is not augmented by industry nor harvested directly by man. Moreover, there are unmistakable vestiges of Physiocratic thought in Smith’s *magnum opus*, particularly in those passages that refer to agricultural production specifically. Here, nature’s (albeit assisted) productivity is displayed prominently when Smith states:

in agriculture [...] nature labours along with man; and though her labour costs no expence [sic], its produce has its value, as well as that of the most expensive workmen. The most important operations of agriculture seem intended, not so much to increase, though they do that too, as to direct the fertility of nature towards the production of the plants most profitable to man. ([1776] 1976, 363)

Agricultural production is a special case of production for Smith, one that is distinct from the manufacturing process; however, the distinctiveness that Smith

attributes to agricultural production is not identical to that argued by the Physiocrats as was detailed earlier. While sustaining the view that agricultural production is unique, Smith also departs from what he perceived to be the antiquated Physiocratic view of manufacturing and artisanal activities as “sterile” This claim is evidenced by Smith’s insistence that, when it comes to the manufacturing sector, nature does nothing and man “does all” (a view that would eventually be rejected by later classical political economists, especially J.S. Mill ([1848] 2006, p. 26) who, in his *Principles of Political Economy*, argues that nature’s powers are not merely to be found in agricultural production but in *all* physical objects, including the manufactured commodities that are bought and sold in the marketplace).

Insofar as Mill was aware of nature’s unassisted productions, his view on the matter more or less coincides with that of Turgot; Mill, however, is slightly more generous when recognizing the specific instances of nature’s unassisted productions. Toward the very beginning of his *Principles of Political Economy*, in the short but important chapter entitled “Of the Requisites of Production,” Mill clearly recognizes a limited number of nature’s unassisted productions, describing them as the “natural products” that “grow up spontaneously” in a manner that is quite independent of human agency. He states,

It is to be remarked, that some objects exist or grow up spontaneously, of a kind suited to the supply of human wants. There are caves and hollow trees capable of affording shelter; fruit, roots, wild honey, and other natural products, on which human life can be supported; but even here a considerable quantity of labour is generally required, not for the purpose of creating, but of finding and appropriating them. In all but these few and (except in the very commencement of human society) unimportant cases, the objects supplied by nature are only instrumental to human wants. ([1848] 2006, p. 25)

In *Das Kapital*, Karl Marx ([1867] 1954) echoes Smith when he explicitly recognizes nature laboring along with man. We are told that in the “virgin state,” nature supplies man with all of the necessities and means of subsistence and that labor is a process in which both man and nature participate. Nature’s productions can be located in a “pure state” and can be brought “out” of this wholesome and uncontaminated realm by human agents that are involved in the laboring process. Marx clearly identifies ready-made means of subsistence such as fruits that are produced by nature’s labor but, for the most part, human industry is required to appropriate nature’s productions and to modify them so that they are made into a form adapted to his or her own wants. In Chapter 1, Section 4, of *Das Kapital* entitled, “The Fetishism of Commodity and The Secret Thereof,” Marx makes the same point and thus unequivocally agrees with the other classical political economists described above when he states, “it is as clear as noonday, that man, by his industry, changes the forms of the materials furnished by nature, in such a way as to make them useful to him.”¹² For Marx, laboring necessarily involves opposing oneself to nature by using the natural forces of one’s body. With this scheme, Marx draws a clear distinction between the spontaneous productions of the Earth that are produced in a manner that is relatively detached from human agency, however, from the raw

materials, also produced by nature but that are required to undergo further manufacturing and processing to satisfy human fancies. Marx states:

All those things which labour merely separates from immediate connexion with their environment, are subjects of labour spontaneously provided by Nature. Such are fish which we catch and take from their element, water, timber which we fell in the virgin forest, and ores which we extract from their veins. If, on the other hand, the subject of labour has, so to say, been filtered through previous labour, we call it raw material; such is ore already extracted and ready for washing. All raw material is the subject of labour.¹³

Classical political economists and their immediate predecessors recognized nature's productions, particularly their use value, but they generally viewed such productions as capricious and manifestly deficient for human purposes. Nature's unassisted productions were certainly not produced *for* human beings and, therefore, it is unsurprising that they almost always fell short of the standards set by humanity's predilections. Most of the goods and services that were bought and sold in the marketplace bore the stamp of human labor, either directly or indirectly through manufactured machines. Thus, it is for good reason that, when it came to economic production, economic theorists, such as Smith, Mill, and Marx, almost always focused on the goods and services directly produced by human agency in combination with other factors of production, such as land and capital. Given the spontaneity of nature's productions, along with the underlying supposition that such productions could always be improved by labor, it is unsurprising that this category of production was expelled from economic discourse altogether.

Be that as it may, Smith, Mill, and Marx all had a distinctive class of production in mind – one that denotes nature's independently generated products. However, unlike Linnaeus, these theorists presented no systematic vision or account of nature's unassisted economic productions. The main claim of this article – that the central and distinctive features of natural capital are rooted in Linnaeus' systematic vision of nature as an original and self-generating producer – still stands. Unlike the Physiocrats and classical political economists, Linnaeus alone held a truly global and systematic vision of the whole Earth and its original productions as a great *oeconomy of nature* – one that could (and should) be subjugated for human purposes – an ideal that is arguably upheld by many contemporary resource economists today.

CONCLUSION

The resource economist Partha Dasgupta recently claimed that, “we economists see nature, when we see it at all, as a backdrop from which resources and services can be drawn in isolation” (2009, 2). With few exceptions, nature has – historically – been depicted as a repository of sorts, one that is located in a realm beyond human agency, where there exists a collection of items that, to be rendered useful, are transformed to serve human ends. This warehouse image portrays nature as merely furnishing the raw and inert materials that are to be subsequently used as inputs in human-directed, technological forms of economic production.

The concept of natural capital subverts this orthodoxy. No longer is Nature merely regarded as a collection of inert materials to be improved by human labor and manufactured capital or one that is subject to human-centered technological production processes alone; rather, nature is, to an increasing extent, taken to be a blind or mindless producer of economically valuable goods and services. Instances of natural capital are capable of producing a wide variety of goods and services in a manner that is relatively detached from human agency. This concept denotes a rich diversity of unproduced “natural mechanisms” or “natural machines” that are found and then frequently subjugated to serve human ends.

This article began by claiming that there are at least two features that distinguish natural capital from manufactured capital: originality and self-generation. Instances of manufactured capital are never original or self-generative since they are a produced means of production that depend on the investment decisions of economic agents; moreover, manufactured capital goods are incapable of producing autonomously, completely free from human agency. Simply because natural capital is distinct from manufactured capital, however, does not entail that the characteristics which make it so are without historical precedent.

While one might have supposed that natural capital would have had a clear forerunner in the writings of the Physiocrats, it was argued that, for the Physiocratic model of economic production, land had to be animated by human labor first. For the Physiocrats, land was certainly unique and necessary, but ultimately land alone was insufficient for the production and circulation of wealth in a given society.

Instead, it was argued that the image of nature as a systematic producer for human agents has roots in the writings of Linnaeus who depicted the whole Earth and all of its productions as the *oeconomy of nature*. For Linnaeus, it was shown that the Earth was not only perceived as a world to be managed for maximum output and human beings had the obligation to make nature’s productions accrue to the enrichment of the human economy, but that such production processes could transpire in a manner that was relatively detached from intentional human agency. Nature *qua* independent producer is on full display in during the eighteenth century with Linnaeus’ *Oeconomy of Nature* ([1791] 1977). Thus, while natural capital is a relatively new concept among contemporary resource economists, the distinguishing features which make it so are not as novel as some may have supposed.

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NOTES

1. See, for example, Edward B. Barbier (2011) and Partha Dasgupta (2008, 2009, 2010).

2. For recent histories of natural capital, see Åckerman (2003) and Missemmer (2018); for a related history of “ecosystem services,” see Gómez-Baggethun et al. (2010).

3. See, for example, Turner and Daily (2008) and Barbier (2011).

4. Manufactured capital is universally depicted as a factor of production that we humans produce, one that invariably depends on the *ex-ante* savings decisions of economic agents.

5. Quesnay’s original manuscript can be found in *Bibliothèque Nationale (Acquisitions Nouvelles Françaises*, no. 1900). See Meek (1962, p. 96).

6. Quesnay’s original manuscript entitled *Extract from ‘Corn’* can be found in I.N.E. D., II, 495–510. See Meek (1962, p. 82) for a translation.

7. While there is some confusion in Turgot’s writings, the source of this confusion may arise from the nature of his dual system, which consists of two spheres: a sphere of production, in which nature is the original source of wealth, and a sphere of distribution, in which wealth circulates from the Husbandman to other economic agents.

8. All references to Aristotle’s *Politics* refer to Benjamin Jowett’s translation found in Jonathan Barnes’ ([1984] 1995) edited volume *The Complete Works of Aristotle*. It is worth noting that while Jowett’s canonical work translates *oikonomikê* as an art, others have considered *oikonomikê* to be a practical science that aims at good action (see, for example, Miller, 1995).

9. Linnaeus ([1791] 1977), p. 31) is quoted by Pearce (2010, p. 497).

10. Linnaeus quoted by Schabas (2005, p. 30).

11. Bacon is quoted by Worster ([1977] 1994, p. 343).

12. Marx (1867 [1954], p. 76).

13. Marx (1867 [1954], p. 76).

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