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# Aristotle on Species Variation

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The whole numbers and the chemical elements vary *discretely*: 5 is the next number to 4 and there is no number between them; silver is next to gold in the atomic table and there is no element between them. On the other hand, colours vary *continuously*: between red and yellow there is another colour, orange, between orange and yellow there is another colour, and so on. Between any two colours, no matter how close, there is an intermediate colour—indeed, an infinite number of intermediate colours. A surface may change gradually over time from red to yellow, assuming all the colours in between. Or again, a surface may be red at one edge and yellow at the other, changing gradually (over space) and assuming all the colours in between.

This article will consider whether Aristotle admitted or denied the possibility of continuous variation in the category of substance, that is, the possibility that there should be two species with an infinite gradation of species in between. (Here 'species' is used in the Aristotelian sense of 'natural kind', and so is not confined to biological species.) It will be concluded that he asserted that continuous variation between species was not only possible but in fact occurred in an important case.

The question is interesting for two reasons. Firstly, the scholastic version of Aristotelianism received one of its most telling criticisms on precisely this point. Locke attacked the scholastics' realism about universals on various *a priori* grounds, but the principal *observable* phenomena which he adduced as incompatible with their theory were examples of continuous variation between (supposed) species. He argued, for example, that intermediate forms such as fishes with wings, amphibious animals, mermaids and so on show that there are no real boundaries between species, and concluded that things are sorted by us only according to our own ideas of them.<sup>1</sup> Hence, he thought, there were no real species. In the case of the human species, in particular, he believed that the existence of 'like-men' with language and reason, but with hairy tails, showed that the boundary of the species is arbitrary, so that what we decide to call men depends not on any real essence but 'only our abstract ideas'.<sup>2</sup> But these considerations would not count

<sup>1</sup> John Locke, *Essay concerning Human Understanding*, III.vi.12.

<sup>2</sup> Locke, *Essay*, III.vi.22. See M. J. Ayres, 'Locke versus Aristotle on Natural Kinds', *Journal of Philosophy* 78 (1981), 247–272.

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against just *any* realist theory of universals (since one could be perfectly realist about, say, colours, while admitting continuous variation between them). So it is of interest to see whether Aristotle's own version of realism incorporated the feature to which Locke objected.

A similar, though more general, criticism appeared in Kurt Lewin's influential article on 'Aristotelian' and 'Galilean' modes of thought.<sup>3</sup> Lewin saw a supposed Aristotelian preference for the discrete as retarding the advance of science in many fields, with a Galilean emphasis on continuous gradations supplying a remedy. He did not refer to the text of Aristotle or any Aristotelian, so it would be interesting to confirm one's suspicion that Aristotle, at least, was not guilty of this fault.

There is a second reason for pursuing the topic. Opinions on the discreteness or continuity of biological species had important consequences for the development of evolutionary theories. It is well known that Linnaeus's system of classification owes much to scholasticism.<sup>4</sup> In that system species are discrete and immutable, with variations within a species attributed to accidental causes like climate or soil. Some writers on evolution have asserted that Aristotle held the same opinions, and hence that he was responsible for delaying the appearance of the theory of evolution.<sup>5</sup> Conversely, Darwin's nominalism has been thought to have helped him.<sup>6</sup> It is certain that the problem of possible gradations had considerably exercised Darwin's mind. He wrote, concerning the advantages of his theory for classification:

Systematists will be able to pursue their labours as at present; but they will not be incessantly haunted by the shadowy doubt whether this or that form be in essence a species. This I feel sure, and I speak

<sup>3</sup> K. Lewin, 'The Conflict Between Aristotelian and Galilean Modes of Thought in Contemporary Psychology', *Journal of General Psychology* 5 (1931), 141–177, repr. in K. Lewin, *A Dynamic Theory of Personality* (New York: McGraw-Hill, 1935), 1–42, at pp. 4, 10.

<sup>4</sup> J. Sachs, *History of Botany*, trans. H. Garnsey (Oxford: Clarendon Press, 1890; repr. New York: Russell & Russell, 1967), 42–43, 85–91, 99–101; A. G. Morton, *History of Botanical Science* (London: Academic Press, 1981), 136, 263.

<sup>5</sup> O. Reiser, 'The Concept of Evolution in Philosophy', in J. S. Huxley *et al.*, *A Book That Shook the World* (Pittsburgh University Press, 1958), 38–47, at p. 41; D. R. Oldroyd, *Darwinian Impacts* (Sydney: University of NSW Press, 1980), 9; E. Mayr, *Animal Species and Evolution* (Cambridge, Mass.: Belknap Press, 1963), 5; A. J. Cain, article, 'Classification, Biological', in *Encyclopaedia Britannica*, 15th edn (1974), Vol. 4, 684; D. L. Hull, 'The Effect of Essentialism on Taxonomy—Two Thousand Years of Stasis' (I), *British Journal for the Philosophy of Science* 15 (1964–65), 314–326.

<sup>6</sup> F. F. Centore, 'Neo-Darwinian Reactions to the Social Consequences of Darwin's Nominalism', *Thomist* 35 (1971), 113–142.

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after experience, will be no slight relief. . . . Hereafter we shall be compelled to acknowledge that the only distinction between species and well-marked varieties is, that the latter are known, or believed, to be connected at the present day by intermediate gradations, whereas species were formerly thus connected. . . . In short, we shall have to treat species in the same manner as those naturalists treat genera, who admit that genera are merely artificial combinations made for convenience. This may not be a cheering prospect; but we shall at least be freed from the vain search for the undiscovered and undiscoverable essence of the term species.<sup>7</sup>

Darwin also quoted the old maxim, *natura non facit saltum*, as supporting his theory that there had been gradation between species.<sup>8</sup> It is clear that the metaphysical thesis of the necessary discreteness of species was an obstacle to the reception of the theory of evolution in Darwin's own mind, and presumably even more so in the minds of his readers. The observation that the higher species are in fact discrete is one of the most striking facts of biology, though now it is simply a consequence of a developed theory of evolution (or should be—it is not entirely clear that the theory of evolution as it now stands explains this fact). It has been suspected that Aristotle's metaphysics was unduly influenced by this fact. Again it is of interest to see whether Aristotle did hold with Linnaeus that species were discrete, or with Darwin that there could be continuous variations between them.

The question is in fact easily resolved by quoting the following two passages from Aristotle's biological works. From *Historia Animalium* 588b4–14:

Nature proceeds little by little from things lifeless to animal life in such a way that it is impossible to determine the exact line of demarcation, nor on which side thereof an intermediate form should lie . . . Indeed, as we just remarked, there is observed in plants a continuous scale of ascent towards the animal. So, in the sea, there are certain objects concerning which one would be at a loss to determine whether they be animal or vegetable.<sup>9</sup>

From *De Partibus Animalium* 681a10–15:

The Ascidiæ differ but slightly from plants, and yet have more of an animal nature than the sponges, which are virtually plants and

<sup>7</sup> C. Darwin, *On the Origin of Species*, 1st edn (London: Murray, 1859), 484–485.

<sup>8</sup> *Op. cit.*, 194.

<sup>9</sup> Aristotle, *Historia Animalium*, trans. D'A. W. Thompson (Oxford: Clarendon, 1910).

nothing more. For nature passes from lifeless objects to animals in such unbroken sequence (*metabainei sunechōs*), interposing between them beings which live and yet are not animals, that scarcely any difference seems to exist between two neighbouring groups owing to their close proximity.<sup>10</sup>

These ideas became part of the theory of the *scala naturae*, or Great Chain of Being, studied by Lovejoy in his famous book.<sup>11</sup> The continuity between species was always an element of that tradition, as expressed very clearly by Leibniz<sup>12</sup>—appropriately enough, since he was one of the founders of calculus, the science of continuity.

These two passages would be decisive in determining Aristotle's view, except for the possibility that he might have said the opposite somewhere else. The main passage that could suggest that he did is *Metaphysica* H3 1043b33–1044a11. The passage gives four ways in which substances are like whole numbers:

It is also obvious that, if substances are in a sense numbers, they are so in this sense and not, as some say, as numbers of units. For a definition is a sort of number; for (1) it is divisible, and into indivisible parts (for definitory formulae are not infinite), and number also is of this nature. And (2) as, when one of the parts of which a number consists has been taken from or added to the number, it is no longer the same number, but a different one, even if it is the very smallest part that has been taken away or added, so the definition and the essence will no longer remain when anything has been taken away or added. And (3) the number must be something in virtue of which it is one, if it is one (for either it is not one but a sort of heap, or if it is, we ought to say what it is that makes one out of many); and the definition is one, but similarly they cannot say what makes it one. . . . And (4) as number does not admit of the more and the less, neither does substance, in the sense of form, but if any substance does, it is only the substance which involves matter.<sup>13</sup>

Points (1) to (3) discuss not directly substance (*ousia*) but the definition (*horismos*) of a species (emphasized in (1) by speaking of the formulae (*logoi*) of definition). That is, the parts of a definition (e.g. 'sentient', 'animal', 'rational') are compared with the units which make

<sup>10</sup> Aristotle, *De Partibus Animalium*, trans. W. Ogle (Oxford: Clarendon Press, 1912).

<sup>11</sup> A. O. Lovejoy, *The Great Chain of Being* (Cambridge, Mass.: Harvard University Press, 1936).

<sup>12</sup> Quoted in Lovejoy, 145.

<sup>13</sup> Aristotle, *Metaphysica*, trans. W. D. Ross (Oxford: Clarendon Press, 2nd edn 1928).

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up a whole number (e.g. the three ones which make up three). Aristotle does not, however, attempt to compare the relation between different species to the relation between different numbers. Since he has just been careful to say that substance is not like number in all ways, (1043b33–34), there is no justification for extending his analogy to include the thesis that, since whole numbers cannot be infinitely close, species cannot be either.

Point (4) appears to be more relevant. The assertion that ‘substance, in the sense of form, does not admit of the more and the less (*to mallon kai hēttōn*)’ could mean that substance cannot vary continuously. But there are good reasons for thinking the passage does not mean this (apart from the difficulty of reconciling such an interpretation with the biological works). Since (4) follows (1), (2) and (3), which all speak about a particular substance, rather than a range of substances, continuous or discrete, it would be preferable to find an interpretation of (4) in terms of a single substance. Such a reading is provided in *Categoriae* 3b33–4a10, which close parallels in language suggest is an expansion of the thought of (4):

No substance, it seems, has degrees or admits of a more and a less. I do not mean here that one substance may not be more truly called substance, less truly called substance, than others; indeed, we have said that it may. But I mean that no substance as such can admit of degrees of itself. For example, the same substance, man, cannot really be more or less man as compared with himself or another. This man is not more than that, as one white thing is more or less white than another white object may be or, again, as one beautiful object has more or less beauty than others. The same quality in the same object may vary at times in degree. For example, a body, if white, is called whiter just now than it was or, if warm, is called more or less warm. But a substance is not more or less of whatever, *qua* substance, it is. For a man is not more of a man than he was at some time in the past. And so of all substances else. Therefore, substance can have no degrees.<sup>14</sup>

This, then, makes it clear that ‘the more and the less’ means ‘more or less some particular substance’, such as man. This says nothing about whether there can be continuous variation *between* substances; one could make the same comment about pure colours—vermilion is close to orange, but vermilion is not ‘less orange’, it is just fully vermilion. (Aristotle’s remark that one white thing can be more or less white than another seems to imply a somewhat Platonist distinction between pure

<sup>14</sup> Aristotle, *Categoriae*, trans. H. P. Cook (Loeb edn, London: Heinemann, 1962).

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colours and real or 'dirty' colours. Aquinas draws such a distinction explicitly in commenting on the above passage from the *Metaphysica*: 'But more and less occur from the matter participating more or less perfectly in the form. Whence also whiteness does not admit of more and less, but the white thing does.'<sup>15</sup> This distinction is not relevant to the present purpose.)

There are a few other passages in Aristotle that could suggest, though less strongly, that he might have believed in the discreteness of all species. Without actually saying so, Aristotle occasionally gives the impression in *Physica* Book VI, on continuity, that continuous variation is possible only in quantity, time and (local) motion (and hence impossible in, say, substance or quality).

Thus at *Phys.* 231b19–20:

The same reasoning [on continuity] applies equally to magnitudes, to time and to motion.

This might suggest that continuity only applies to these three. Another of the examples of continuity in the same book, however, makes it clear that this is not what is meant. At *Phys.* 234b10–20:

Everything that changes is divisible . . . in a process of change from white the goal will be grey.

That is, the changes that can be continuous are not confined to local motions, but may be changes of quality.

(It would be of interest to know Aristotle's thoughts on continuous variation of colour. His awareness here that colour can vary continuously over time does not imply that he consciously considered variation of colour over a surface or continuous variation 'in the sense of form'. The latter at least, however, seems to be referred to in *Top.* 123b26–28:

. . . in the case of white and black; for 'colour' is the genus both of these and of all the intermediate colours as well.

It is hard to believe that anyone, much less Aristotle, should have considered the range of colours between white and black and believed that there was only a finite number of them.)

The only other element of Aristotle's thought likely to conflict with the possibility of continuous variation between species is his theory of logical division. Plato, in the *Sophist* and *Statesman*, had advocated dichotomous division as a method of classification (so that 'sophist' is defined by dividing 'makers' into 'divine' and 'human', 'human makers' into 'human makers of real things' and 'human makers of images', and

<sup>15</sup> Thomas Aquinas, *In Met.* n. 1727.

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so on, and then defining the 'sophist' as 'human maker of images ...'). It is clear that if species are the end points of chains of dichotomous divisions, then they must be distributed discretely, since a finite number of divisions can produce only a finite number of species. In the *Topica*, an early work, Aristotle certainly followed Plato in recommending a method of division in classification. It is not clear, though, that his method has the discreteness of species as a consequence. He rejected Plato's requirement that each step of the division be into only two branches, and gave examples of divisions into more than two branches<sup>16</sup> (as did the other major contemporary classifier, Theaetetus<sup>17</sup>). He continued to oppose dichotomous division in the *Analytica Priora* and *De Partibus Animalium*.<sup>18</sup> Although he did not explicitly countenance the possibility of dividing a genus into infinitely many species, his remark quoted above, to the effect that 'colour' is the genus of all the intermediate colours between white and black, suggests that he had no objection to this possibility.

It is, furthermore, well known that Aristotle's classification of living things in his biological works does not follow the method of division proposed in the *Topica* but uses a multi-characteristic scheme which gives some kind of 'natural' classification.<sup>19</sup> His discussion of the need for this occurs in a passage which is, explicitly, a criticism of dichotomous division, but the latter part of the passage (*Part. An.* 643a35–644a10) in fact consists of arguments which hold against *any* method of division. He proposes instead the use of many characteristics as in popular classifications.

It can, then, be asserted that the thesis of discreteness of species is not attributable to Aristotle.

The survival of division methods of classification does explain why this thesis became part of the later Aristotelian tradition. In medieval education, the standard introduction to Aristotle's works was via Porphyry's *Isagoge*, and division entered the educated consciousness in the form of 'Porphyry's Tree'. It is not clear that Porphyry himself, in the relevant passage,<sup>20</sup> went any further than Aristotle in recommend-

<sup>16</sup> *Top.* 143b1–3.

<sup>17</sup> Euclid, *Elements*, Book X, especially Definitions II after Proposition 47 and Definitions III after Proposition 84.

<sup>18</sup> *An. Pr.* 46a31–b39; *Part. An.* 642b5–644a10.

<sup>19</sup> G. E. R. Lloyd, 'The Development of Aristotle's Theory of the Classification of Animals', *Phronesis* 6 (1961), 59–81; D. M. Balme, 'Aristotle's Use of Differentiae in Biology', in *Articles on Aristotle*, Vol. 1, J. Barnes, M. Schofield and R. Sorabji (eds) (London: Duckworth, 1975), 183–193.

<sup>20</sup> Porphyry, *Isagoge*, trans. E. W. Warren (Toronto: Pontifical Institute of Medieval Studies, 1975), 34.



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ing division. But his brief comment was developed into the Tree by medieval logicians. It appears in William of Sherwood's *Introduction to Logic* and is given the name 'arbor Porphyrii' in the most popular medieval logic, Peter of Spain's *Summulae Logicales*.<sup>21</sup> Linnaeus's system of static and discrete species was simply the result of filling in the abstract Tree with the names of actual species.<sup>22</sup>

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<sup>21</sup> N. Kretzmann, *William of Sherwood's Introduction to Logic* (Minneapolis: University of Minnesota Press, 1966), 54; Peter of Spain, *Summulae Logicales*, I. M. Bocheński (ed.) (Turin: Marietti, 1947), 17–18.

<sup>22</sup> I am grateful to Dr Denyse Rockey for some useful suggestions.