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# PRE-THEORETICAL ASPECTS OF ARISTOTELIAN DEFINITION AND CLASSIFICATION OF ANIMALS: THE CASE FOR COMMON SENSE

We must trust perception (*aisthesis*) rather than theories (*logoi*) and theories, too, so long as what they show agree with the *phainomena*.
Aristotle, *De Generatione Animalium* III, 10.760b31 – 33

## Introduction

HISTORIANS and philosophers of biology are, for the most part, in accord with the view that 'essentialism' has been the principal source of sin in systematics, and the cause of centuries of stagnation. In contrast to the 'scientific revolution' which began in the natural philosophy of the sixteenth century, natural history supposedly continued to wallow in what Popper has described as 'the empty verbiage and barren scholasticism' of 'the Aristotelian method of definition'.[1] Following Popper, for whom essentialism reflects a confusion of word meanings with an explanation of how their denotata actually came to be,[2] Hull argues that:

> The conflict between reality and theory was largely ignored by early taxonomists both because they did not understand the logic of Aristotelian definition very clearly and because even scientists have a way of not noticing what conflicts with their philosophical presuppositions.[3]

It is not so much that later taxonomists did not understand what Aristotle had to *say* about definition, they just were not aware of the fact that Aristotle himself had confounded the statement of the truth-conditions for the proper application of a term with a principled account of the existence of its referents. It is this intellectual myopia which is taken as 'responsible for taxonomists

[1]K. Popper, *The Open Society and Its Enemies* (Princeton: Princeton University Press, 1950), p. 206.
[2]K. Popper, *Conjectures and Refutations* (New York: Harper and Row, 1963), p. 20.
[3]D. Hull, 'The Effect of Essentialism on Taxonomy — Two Thousand Years of Stasis', *The British Journal for the Philosophy of Science* 15 (1965), 316.

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retaining what is loosely called a static species concept, which in turn is responsible for species being divested of reality'. This is supposedly so even though 'the names of taxa cannot be defined in terms of essential characters without falsification on a scale which should have been evident even to the most uncritical investigator with only a limited knowledge of the organisms being classified'.[4] Indeed, Simpson, in his brief history of systematics, goes so far as to warn the reader of Aristotle's pernicious effect on the mind:

> I tend to agree with Roger Bacon that the study of Aristotle increases ignorance. Nevertheless, the founders of taxonomy were themselves students of Aristotle and Aquinas (among many others of that lineage) so that the subject is to some extent necessary for my purpose.[5]

Also citing Popper, Mayr contends that Aristotle, like Plato and 'all essentialists', betrayed both common sense and the true course of science, by ignoring the obvious variations in nature for the sake of discovering 'the hidden nature or Form or essences of things':

> All these methodological essentialists also agreed with Plato in holding that those essences may be discovered and discerned with the help of intellectual intuition [*i.e.* analysis, logic]; that every essence has a name proper to it, the name after which the sensible thing is called.[6]

Essentialism, then, is a philosophy of marked discontinuity. It is thus resistant to change both as a means of representation:

> Presented with the welter of diverse forms to be classified, a taxonomist can greatly simplify his task if he pretends that certain properties are "essential" for definition,[7]

and in regard to what is represented:

> This philosophy, when applied to the classification of organic diversity, attempts to assign the variability of nature to a fixed number of basic types at various levels. It postulates that all members of a taxon reflect the same essential nature, or in other words that they conform to the same type. This is why the essentialist ideology is also referred to as typology. Variation, consequently, is considered by the typologist

[4] *Ibid.*

[5] G. Simpson, *Principles of Animal Taxonomy* (New York: Columbia University Press, 1961), p. 36n. Actually, Bacon thought Aristotle a great, if flawed, philosopher. The Stagirite's suggestions about optics led Bacon (as well as Grosseteste) to attempt a mathematical analysis of nature; however, Bacon's natural history, unlike Aristotle's, admitted magical forces.

[6] E. Mayr, *Principles of Systematic Zoology* (New York: McGraw – Hill, 1969), pp. 66 – 67; Popper, *The Open Society and its Enemies*, p. 34; *cf.* A. Cain, 'Logic and Memory in Linnaeus's System of Taxonomy', *Proceedings of the Linnaean Society of London* **169** (1958), 146.

[7] Hull, 'The Effect of Essentialism on Taxonomy', p. 316.

as trivial and irrelevant. The constancy of taxa and the sharpness of the gaps separating them tend to be exaggerated.[8]

For my part, I have so far failed to find any natural historian of significance who ever adhered to the strict version of essentialism so often attributed to Aristotle. Nor is any weaker version of the doctrine which has indiscriminately been imputed to Ray, Tournefort, Linnaeus and Cuvier likely to bear up under closer analysis. Most often, it is invoked against one's own rival school: the back pages of the technical journals are filled with pheneticists and phylogeneticists accusing one another of being reactionary throwbacks to an outworn tradition — their theoretical baggage filled with vestiges of statically contrived types and artificially fixed orders.

Notwithstanding this tendentious use of history, contemporary arguments are frequently decided on strict scientific grounds, not by doctrinal allegiance. The case is otherwise for historical figures who may be remembered, or forgotten, only as 'precursors' with regard to problems which currently agitate systematics; for, the historical past often appears merely as an imperfect prelude to the modern present. The problems were there all the time, only they were viewed cockeyed through filters of traditional ignorance, prejudice and superstition.

Forgotten in this Whiggish view of history are the facts: the elaboration of the distinction between the biological species and genus, the advent of the family concept and, ultimately, the ascendancy of the notion of phylum. All of these developments, though, are embedded in the gradual and profound shift from common sense understanding of local, everyday experience, to ever more reflective attempts to cope with world-wide novelty: from the layman's spontaneous treatment of what is rare and strange in the world in terms of the readily visible and familiar patterns of the phenomenal order of things, to the naturalist's progressive effort to deal with unceasing discovery in terms of the hidden causes and nonphenomenal processes of biology.

To reduce this all to 'two thousand years of stasis' is to trivialize a monumental movement in human thought — a movement which, by the eighteenth century, was at least able to offer up the whole of the living world, including man, as an object of study and insight. For all intents and purposes, it was Aristotle who began this movement; though it was for others to carry it through in ways which he could not have imagined. Such a movement was possible at all, however, only because access was assured by a common sense appreciation of the living world shared not only by Aristotle and Linnaeus, but by ordinary folk everywhere.

[8]Mayr, *Principles of Systematic Zoology*, p. 67.

## I

Common sense, as here understood, basically refers to universal aspects of propositional (*i.e.* truth-valuable) understanding of the environment. This includes statements pertaining to what is likely to be an innately grounded, and species-specific, apprehension of the spatio-temporal, geometrical, chromatic, chemical and organic world in which we, and all other human beings, live their everyday lives. G. E. Moore puts the matter this way:

> What is meant by saying that so-and-so is a feature or item in "the Common Sense view of the world"? Something like this: That it is a thing which every or very nearly every sane adult, who has the use of all his senses (*e.g.* was not born blind or deaf), believes or knows (where 'believes' and 'knows' are used dispositionally). Does one need to add: And of which, for many centuries, it would have been true to say this?[9]

Put simply, we are all (innately) disposed to believe, or know to be true, that the world of everyday experience is composed of natural chemical and biological kinds whose exemplars manifest definite colors, change in time and are locally distinguished by their relations in (Euclidean) space. The actual realization of these cognitive dispositions, including the particular contents of such beliefs, depends, of course, on the local, fragmentary experience available to us. But such experience does not so much shape our beliefs as 'trigger', or occasion, the 'automatic' extension of fragmentary instances to an integrated set of complexly related instances: to be able to divide the world into cats and dogs, one must experience cats and dogs; but it is our prior cognitive disposition to categorize animals with animals and species members with species members that allows us to distinguish such experiences as cats and dogs, rather than as flotsam and jetsam.

As such, common sense is not to be confounded with the 'good common sense', or *sensus communis,* of the Roman orators; that is, the mental capacity for exemplifying proper judgment, as when we say of a wise man that he shows good common sense in his choices, or of a handy man that he knows his ass from his elbow. That kind of willful (or pragmatic) and culturally relative judgment is not in question here. What is of concern is equally accessible to the sage and the ignoramus, the skillful and the hare-brained, no matter what his or her culture; it is part of our evolutionary heritage. No speculation can possibly confute the grounds for this common sense view of things, since all speculation must start from it. There just is no other place to begin to think about the world.

[9]G. Moore, *The Commonplace Book of G. E. Moore* (London: Allen and Unwin, 1962), p. 280.

Speculative reason (Cartesian *bon sens*) is thus unable to cut the umbilical cord which binds it to common sense, and so undermine it. Still, one can go beyond our ordinary ways of thinking about things. Speculation can reveal the bounds of common sense and thereby prevent common sense from exceeding its proper authority; for, common sense remains valid only so long as it is restricted to the manifestly visible dimensions of the everyday world, that is, to *phenomenal* reality. Studied reflection and measured experimentation, however, can lead to knowledge of another, nonphenomenal, world — a world of astronomical, microscopic and evolutionary dimensions — which can only be vaguely perceived, if at all, with the self-evident intuitions of common sense. Common sense, then, is an indubitable source of truth for knowledge of the readily experienced local world, but fallible as a means of insight into the scientific universe. This, opines Peirce, is what such eighteenth century common sense philosophers as Reid and Stewart did not fully appreciate:

> The Scotch failed to recognize . . . that the original beliefs only remain indubitable in their application to affairs that resemble the primitive mode of life. It is, for example, quite open to reasonable doubt whether the motions of electrons are confined to three dimensions, although it is good methodeutic to presume they are until some evidence to the contrary is forthcoming. . . . The Scotch school appears to have no such distinction concerning the limitations of the indubitability and the consequent limitations of the jurisdiction of original belief. . . . Modern science . . . with its entirely new appliances of life, has put us in quite another world; almost as much so as if it had transported our race to another planet. Some of the old beliefs have no application excepted in extended senses, and in such extended senses they are sometimes dubitable and subject to criticism.[10]

Considered in this way, common sense does not preclude, but neither does it include, any magical, mythico-religious, metaphorical or other 'symbolic' elaboration of the empirical world. Such symbolic elaboration is by nature non-propositional; that is, it can be assigned no fixed meaning (not even a context relative one) which can be appraised for its logically consistent entailments; neither can it be ascribed a determinate factual content with verifiable consequences that experience may either readily confirm or definitely disconfirm.

Symbolic elaborations of common sense are to be accepted on faith. Literally they are not meaningful, but vague. Their purpose is to incite evocation rather than to determine the facts. But in order to be effective, they require a factual basis, namely, common sense. They are, as Kant would say, quasi-schematized 'symbolic cognitions' for which 'no intuition commensurate with them can be given'.[11] What happens here is, roughly, that one seeks some empirically

[10] *Collected Papers of Charles Sanders Peirce*, Vol. 5, C. Hartshorne and P. Weiss (eds.) (Cambridge, Massachusetts: Harvard University Press, 1934), pp. 438 – 57; 505 – 25.

[11] Kant, *Critique of Judgment*, section 59.

intuitable situation which can serve as a model by reference to which the idea can be made comprehensible (*e.g.* God putting Nature in order on the model of a father disciplining his family); but the fact that the model is underdetermined with respect to its structure leaves many of its features in the dark: 'No isomorphism between the model and the modelled can be cogently supposed and hence the question of truth does not arise, not even vicariously'.[12]

This does not mean that there can be no preferred line of interpretation, or that there might not be greater factual content in one interpretation than in another. It only means that there is no consistent sequence of propositional entailments of the form 'if *p*, then *q*' simply because no symbolic utterance, *s*, is ever completely nailed down. Because such utterances are never completely fixed as to propositional content, they can be entertained as 'eternal truths' which are nonetheless adaptable to a changing appreciation of the world of facts.[13]

Such symbolic reconstruals of the world, however, are by no means explanations of the facts. It is this insight, argues G.E.R. Lloyd, which distinguishes the Greek *physiologoi* from the *magoi,* and the Hippocratic doctors from the purifiers (*kathartai*):

> Mythological 'aetiologies' are explanations only in a quite restricted sense. To attribute earthquakes to Poseidon is, from the point of view of an understanding of the nature of earthquakes, not to reduce the unknown to the known, but to exchange one unknown for another. While Poseidon's motives can be imagined in human terms . . . *how* an earthquake occurs is not thereby explained nor indeed at issue. If there is no question of assigning an historical origin to an interest in causal explanations of *some* kind, the deliberate investigation of how particular kinds of natural phenomena occur only begins with the philosophers: it was they who first attempted to explain what thunder, lightning, eclipses and the like are in terms of more familiar phenomena and processes.[14]

True, Greek scientific speculation, like symbolic reconstrual, was occasionally inspired by observational analogies which initially could not be falsified by experience; but the meaning of such speculation was fixed enough for the argument to be logically consequent and thus subject to specific challenge by a rival speculation.

According to Popper, for example, Thales's explanation of earthquakes in terms of the movement of the earth upon the water it supposedly rides is 'at least inspired by observational analogy'.[15] Nevertheless, such analogies are not

[12]A Margalit, 'Open Texture', in *Meaning and Use*, A. Margalit (ed.) (Jerusalem: Magnes Press, 1979), p. 145.

[13]D. Sperber designates such symbolic cognitions 'semipropositional representations' in *Le Savoir des Anthropologues* (Paris: Hermann, 1982), p. 69.

[14]G. E. R. Lloyd, *Magic, Reason and Experience: Studies in the Origins and Development of Greek Science* (Cambridge, U.K.: Cambridge University Press, 1979), pp. 52 – 53.

[15]K. Popper, 'Back to the Pre-Socratics', *Proceedings of the Aristotelian Society* **59** (1958 – 1959).

a *logical* requirement of early scientific speculations which often 'have nothing to do with observation'. Thus, avers Popper, Anaximander's theory of the earth's free suspension in space contains 'no analogy whatsoever in the whole field of observable facts'. Accordingly, Popper concludes that observational experience and common sense cannot be considered logically necessary *sources* of (the growth of) scientific knowledge.

This much seems right in Popper's analysis. But he goes on to argue that common sense can actually be a hindrance to the progress of science. Take the case of Anaximander: his speculation on the free suspension of the earth was presumably a properly scientific theory in that it was both a direct criticism of a previous theory (Thales's) and a direct antecendent of modern scientific findings; however, he was misled by 'common-sense theory' into supposing that the earth was flat like a column-drum.

Admittedly, assertions such as 'the earth is flat' or 'the earth rides on water like a ship' are compatible with common sense, in that sheer intuition about what is self-evidently true cannot, by itself, falsify such claims. Yet, such assertions are not claims *of* common sense, nor are they logically 'based on' common sense; for, if common sense can provide no intuitions to falsify such claims, neither can it provide the intuitions to verify them. Such intuitions lie beyond the natural, innately determined, phenomenal bounds of common sense. Moreover, neither the free-suspension theory nor the theory that the earth is a sphere are *incompatible* with common sense; indeed, in *de Caelo* Aristotle points to the readily apparent character of the horizon in defense of the earth's sphericity, while the idea of free-suspension in Anaximander is supported by the visibly fixed distance of the stars.[16]

Even more significant is the fact that the resolution of problems connected with the spatio-temporal position of the heavenly bodies depends upon a correct appreciation of the scope and limits of common sense. The shape of the earth, the position of the sun, etc. are determined by calculation; however, such calculations (which were partly developed as aids to navigation) are based on the assumption that various other objects *are* how and where they commonsensically appear to be. It is only because we start by equating the physical positions of the things around us with the observed positions of standardized referents that our more sophisticated methods of locating objects like the sun, and projecting the curvature of the earth, can lead to confirmable results. And such standardized referents, taken together with their apparent spatio-temporal position, are precisely those things around us with which we

[16]As to Popper's notion that 'there is the most perfect possible continuity' between Thales and Anaximander and modern science, this seems Whiggish at best — at least until it is shown that the relevant ontologies and allowable inferences of these thinkers are reducible to those of modern science without loss of generality.

are most intuitively familiar.[17]

For Popper, the perniciousness of too slavish a devotion to common sense is even more apparent in the *episteme* of Aristotle 'and all other essentialists' wherein the self-evident definitions of the terms of ordinary language can be presumably taken as true principles of the organization of reality.[18] It is this undiscriminating view of common sense and essentialism which I wish to challenge, as it applies to Aristotle's biology.

## II

Aristotelian speculation about nature began with an inquiry into the general aspects of the ordinary Greek's everyday knowledge of the wordly things around him: of those self-evident sorts manifest in common parlance, and spontaneously accepted by most everyone. Thus, for any particular state of affairs, one might ask: What is it? What-like is it? What size is it? Where is it? How does it look? How does it lie? In what is it? *etc.*[19] The set of terms which would provide sensible (not necessarily true) answers to these and other similar fundamental questions are said to belong to the same 'category'.

> For example, animal and knowledge: footed, winged, aquatic, two-footed, are differentiae of animal, but none of these is a differentia of knowledge; one sort of knowledge does not differ from another by being two-footed.[20]

[17]In reply to Popper, G. S. Kirk asserts that: 'gross departures from common sense were carefully avoided by the Presocratics. . . Naturally many of the conclusions of the early Presocratics were contrary to common sense; but they were not gratuitous departures from it . . . since they appeared to be entailed by arguments which themselves depended on observation and common sense': 'Popper on Science and the Presocratics', *Mind,* **69** (1960). Consider Thales: According to Kirk, Thales's idea of a water-supported earth was 'borrowed' from the myths of the riverine civilizations. These myths, in turn, were 'natural ideas' which were 'firmly based . . . upon observation and experience' (p. 327). That is, they derived from common sense notions which were themselves 'inductive' in the sense of being 'based on an indefinite number of particulars', although the inductions could be 'intuitive' and 'sub-conscious' (p. 321). From this it follows that Thales's theory (and science in general) is ultimately 'inductive'.

Unfortunately, each line in this chain of reasoning is flawed. The intuitive inductions of common sense could *not* be based on an indefinite number of particular observations, anymore than our intuitive induction of triangles could be 'based upon' particulars which are not initially apprehended as triangles. Experience merely occasions the conclusion of an intuitive induction, it does not — and logically cannot — produce or justify it. Nor is Thales's idea of a water-supported earth 'borrowed' from the riverine myths of Greece and Egypt, anymore than these myths themselves are 'natural ideas' which are 'firmly based . . . on observation and experience' (p. 327). What makes Thales's theory different from myth is that it can be criticized (and ultimately refuted) because of its definite propositional content. Myths, however, have no definite propositional content. Because they have no definite propositional content they can in no sense be 'firmly based' either on reason, studied observation or common experience.

[18]Popper, *Conjectures and Refutations,* p. 20.

[19]*Cf.* G. Ryle, 'Categories', *Proceedings of the Aristotelian Society* **38** (1938 – 1939), 189 – 206.

[20]*Cat.*1b16. (Note: all titles to Aristotle's works are abbreviated in accordance with the Liddell – Scott – Jones Lexicon).

What can be sensibly said of animals cannot be sensibly said of knowledge, and vice versa, because animals and knowledge belong to different categories.

Thus, whatever can be truthfully said of one kind of animal can be sensibly predicated of all other kinds of animals, even if the predication is false (*e.g.* it makes sense to ask whether or not fish, quadrupeds, insects are winged even though most are not). But not everything that can be sensibly predicated of animals can be sensibly predicated of plants (*e.g.* it is literal — though perhaps not metaphorical — nonsense to ask whether animals have roots and leaves, or whether plants sleep and have babies). Still, there are predicates which can be sensibly applied to plants as well as animals, such as 'live' and 'die'. This means that plants and animals, although they have different ontological status, nevertheless must belong to the same ontological category (one which can be described, in part, by the predicates which can sensibly be applied to both plants and animals). The categories, then, represent those ontological domains which sensibly share no predicates, and no manner of existence, with one another, such as substance, quality, quantity, place, time, etc.

The most important category in the Aristotelian scheme is that of substance (*ousia*). The contents of this category are not produced by *a priori* reasoning, but by an abstractionist use of common sense intuitions. Here, one begins with the sensible *phainomena* of everyday experience, especially visible phenomena.[21] The primary objects of knowledge are those sensible things which *can* be named in ordinary speech. Although different languages might have different sounds for denoting things, the things denoted, as well as the mental representations of those things, are pretty much common to humankind:

> Now spoken sounds are symbols of affections in the soul, and written marks symbols of spoken sounds. But what these are in the first place signs of — affections of the soul — are the same for all; and what these affections are likenesses of — actual things — are also the same.[22]

Owing to our innate mental make-up, these things are represented to us first as sense impressions, then as memories.[23] If the experience is sustained, a thing is named and represented in our minds as a non-material form; that is, the sense organ receives the form of the object perceived without its matter. The sense organ, which always has the potential for actually assuming the forms of objects, thereby becomes the object. Thus, 'knowledge that exists in actuality is identical

[21] 'All men desire by nature to know. An indication of this is the delight we take in our senses; for even apart from their usefulness they are loved for themselves; and above all others the sense of sight. . . The reason is that this, most of all the senses, makes us know and brings to light many differences between things'. (*Metaph.* 980a21 – 27).

[22] *Int.* 16a3.

[23] *APo.* 99b – 100a.

with its object'.[24] So, to know the true nature of an object is to have that object represented in the mind; for, the non-material intellectual form of the object actually is of the *essence* of the object. In the limiting case, that is, at first sight, the form (*morphe*) is simply the exterior morphological aspect of the object (*externa figura ac forma*).[25] This is the usual, pre-Socratic sense of the term *eidos*.[26]

In effect, the constituents of this initial level of analysis correspond to what psychologists call 'basic object' terms. Such terms apparently represent the initial referential groupings of very young children, the named groupings to which adults primarily assign objects and the first groupings to be assigned a lexical lable in a given semantic (categorical) domain in the evolution of a language. The objects which fall under the extension of these terms seem to share gross perceptual and/or functional features. These terms presumably divide the world of objects into maximally distinguishable sets of entities, and constitute the most inclusive groupings for which a concrete image of a class of objects can be formed. In this sense dogs and chairs, for example, are more basic to the domains of living kinds and artifacts, respectively, than, say, mammals (quadrupeds) or dalmations and furniture or high-chairs. Basic-object terms thus represent the most intuitively accessible level of object categorization.[27]

From this basis one continues the analysis of substance by 'induction':

> there is a primitive universal in the mind (for though one perceives the particular, perception is of the universal — *e.g.* of man but not of Callias the man); again a stand is made in these, until what has no parts and is universal stands — *e.g. such and such* an animal stands, until animal does. . . . Thus it is clear that it is necessary

[24] *de An.* III, 5.

[25] *Metaph.* 999b16.

[26] See A. Taylor, 'The Words EIDOS and IDEA in Pre-Platonic Literature', in *Varia Socratica* (Oxford: Parker, 1911). Aristotle uses the terms *schema, idea* and *morphe* as non-technical synonyms of *eidos*; in *PA* 640b24 – 28, for example, he uses all four terms to denote the shape of a bed. According to L. Bourgey, it is this 'popular' conception of *eidos* which is present in the Hippocratic Corpus: *Observation et expérience chez les médecins de la collection hippocratique* (Paris: Vrin, 1953), p. 34.

[27] E. Rosch, C. Mervis, W. Gray, D. Johnson and P. Boyes-Braem, 'Basic Objects in Natural Categories', *Cognitive Psychology* **8** (1976), 382 – 439. Aristotle's appreciation of basic-level intuitions is actually more nuanced than that of Rosch *et al.* inasmuch as he makes a categorical distinction between apprehension of basic-level *artefacta* and basic-level 'natural kinds', while Rosch *et al.* do not. It is not merely that 'there is much greater finality and beauty in the productions of nature than in those of art' (*PA* 639b21). Finality is altogether different for artifacts and living kinds: in the former, finality is directed by the transcendent purpose of the artisan (*Metaph.* 1041a25 – 30); in the latter, finality is merely directive and immanent in the material nature of the organism. For artifacts, the efficient agent of genesis is the *skill* of the artisan; for living kinds, it is the motion imparted to female residue by male semen. More significantly for the modern psychologist and epistemologist is Aristotle's denial of 'underlying natures' to artifacts (*Ph.* II,1). Artifacts are the way they are by virtue of the functions they serve in the artisan's mind (*Metaph.* 1032b1); but living kinds are as they are 'by nature' (*physei*), that is, in virtue of an essential and underlying physical constitution (*physis*) which is shaped and developed by an intrinsic 'soul' (*PA* 640b24 f.).

> for us to become familiar with the primitives by induction (*epagoge*), for perception too instills the universal in this way.[28]

This process of induction, however, is not to be confused with enumerative induction or abstraction by omission of irrelevant content. It is, rather, 'an intuition that will apprehend the [general] principles'. Peirce has dubbed this freely speculative inference by which one is led to intuit the general principle, 'abduction'. Abduction, or hypothesis formation, is meant to account for the plausibility of Aristotelian syllogism.[29] It is an intuitive inference from a given result of a possible deduction and a proposed general premiss to the contingent (minor) premiss of the syllogism:

> The form of inference, therefore, is this: The surprising fact, C, is observed; But if A were true, C would be a matter of course. Hence, there is reason to suspect that A is true. Thus, A cannot be abductively inferred, or if you prefer the expression, cannot be abductively conjectured until its entire content is already present in the premiss, "If A were true, C would follow as a matter of course."[30]

At first glance, Aristotelian induction seems to be no more than a means of tapping the layman's intuitions about his usual linguistic ontology. In this respect, psychologists have been able to show that even very young children recognize well-bounded ontological divisions of various levels of generality. These are delimited both in terms of predicate spanning (*i.e.* the set of predicates that can be sensibly applied to a division),[31] and in terms of inductive projections (*e.g.* if one is told that two unrelated animals possess some unknown property then one is likely to predict that all and only animals possess that property).[32] With these means of testing ordinary intuitions one eventually arrives at various ontologically distinct levels, or domains (*e.g.* animals vs plants, chemical substances vs artifacts, living kinds vs inanimate substances). Ultimately, one ends up with substance itself.

The category, and each distinct sub-level, represent criteria of identity; for,

[28] *APo.* 100a – b.

[29] *APr.* 68b15 – 37.

[30] C. Peirce, *Collected Papers* Vol. 6, (Cambridge, Massachusetts: Harvard University Press, 1935), pp. 522 – 8.

[31] F. Keil, *Semantic and Conceptual Development: An Ontological Perspective* (Cambridge, Massachusetts: Harvard University Press, 1979). Keil's experiments are designed as psychological confirmations of F. Sommers, 'The Ordinary Language Tree', *Mind* **68** (1959). Keil gives compelling evidence for the distinctive (plausibly innate) character of such ordinary ontological categories as SUBSTANCE, ARTIFACT, LIVING KIND, PLANT, (NON-HUMAN) ANIMAL AND HUMAN. However, his attempt to arrange all (common sense) ontological types into a rigid hierarchy following Sommers is seriously open to criticism. Moreover, it does not seem to be the case that all the predicates of natural language span a definite ontological type (for example, 'fly' is a predicate which spans artifacts, but not chemical substances, and animals, but not plants).

[32] *Cf.* S. Carey, 'The Child's Concept of *Animal*'. Paper presented to Psychonomic Society, San Antonio, Texas, 1978.

without them, there is no way on earth to limit the otherwise limitless inductive possibilities for assessing similarities.[33] They are fundamental regions of object-giving intuitions which are psychologically prior to, and necessary for, learning which objects go together in the world. Ever since Kant, the categories, and often their subordinate levels as well, have been appreciated more for their epistemological, or even merely syntactico-semantic, priority than for their alleged ontological primacy. For Aristotle, though, there is no crucial distinction between the world as we know we see it, and the world as it is (or as science tells us it may be).

The principal task of Aristotelian philosophy and science, or metaphysics, is to determine the essential nature of this common sense ontology so as to reveal these different pieces of the world as instances of, or more justly, as teleological tendencies *to,* order and beauty. As a result, Aristotelian speculation goes beyond simple common sense; that is to say, those intuitively obvious aspects of common sense which are visibly manifest and iterated in ordinary language constitute necessary, but not sufficient, conditions for a determination of how the world is structured. Speculation aims to connect intuitively separate and dissimilar features of the everyday world (distinct relations, qualities and substances) into a harmoniously integrated universe. In it, each thing will be shown to have its proper place relative to every other in the economy of nature. Accordingly, the determination of essences involves a mixture of commonsensical and aesthetic criteria. Because such a determination is not strictly manifest, true natures are partially hidden from immediate, sensible intuition. The discovery of these partially invisible, essential truths is the goal of a properly 'scientific' knowledge (*episteme*) of nature (*physis*).[34]

In this respect, Aristotle's attempts to analyze world-structure differ significantly from the pre-Socratic physical philosophers. In their efforts to find

[33]Locke, *Essay on the Human Understanding*, II, 27, sections 1 – 6. Locke argues, *per impossibile*, that these general criteria of identity arise from the particular fragmentary experiences of everyday life. Frege more plausibly views these criteria as prior to, and necessary for, knowledge of objects: M. Dummett, *Frege: Philosophy of Language* (London: Duckworth, 1973), pp. 75 – 76. In line with Kant, A. Pap ('Types and Meaninglessness', *Mind* **69** (1960), 41 – 54) considers our ordinary ontological categories to be 'synthetic *a priori* insights' which may be in part ordered hierarchically (e.g. ANIMAL is in some psychologically unexplained way subordinate to LIVING KIND; LIVING KIND is subordinate to SUBSTANCE, *etc.*).

[34]Although Aristotle provides *physis* with a technical sense (*i.e.* the principle of movement and rest), that sense is grounded in the more popular sense of the term as it is applies to living kinds (*viz.* as an innate program for development). According to A. Lovejoy ('The Meaning of PHYSIS in the Greek Physiologers', *The Philosophical Review*, **18** 1909), the sense current in Greek philosophy and literature before Aristotle closely parallels 'the commonest and most familiar colloquial sense of our word 'nature',' namely, 'to be of such and such a sort by birth' in virtue of 'qualitative character', 'make-up', 'essential nature'.' Concerning the Hippocratic Corpus, Bourgey (*op. cit.*, 1953, p. 34) notes that '*physis* rarely designates Nature in general, rather it indicates the particular constitution of a being'. For example, in what is likely a late fifth-century treatise, *On Regime I, physis* designates a 'state of physical composition' or 'state of mixture'. To know the nature of man, therefore, is to know 'from what things he is originally composed'' as embodied in the soul (*psyche*) and seed (*sperma*). Therein lie principles (*archai*) and causes (*aitia*) of development.

a reality-principle which would unify the diverse phenomena of mind and body, and the various kinds of inanimate and animate objects, the pre-Socratic physiologers opted for a materialistic aetiology which effectively denied to each living kind (and to living kinds in general) their specific natures. Empedocles, for example, held the common sense presumption of such natures to reflect an unwarranted projection of ordinary language onto the ontological plane.[35] Kirk seems justified, then, in insisting that Aristotle's robust sense of experiential reality led him:

> to react against the excesses of idealism and restore the phenomenal world to something like its proper place in man's schematism of his experience . . . at last Aristotle re-directed knowledge towards the common-sense world of our experience.[36]

Still, the problem remained for Aristotle, as for his predecessors, of unifying the apparent variety which common sense presents. This is the problem which articulates Aristotle's biological investigations: 'that of the unity of phenomenal diversity, in both the technical and popular (*vulgaire*) sense, of living forms'.[37] It is a problem which common sense alone cannot resolve.[38]

The revelation of nature's underlying order proceeds by showing how, and why, the sundry common-sense kinds of phenomenal substance lawfully connect as true 'natural kinds'. As Gaukroger notes: 'Natural kinds are self-differentiating, but this does not mean that our everyday speech automatically exhibits these kinds: this is part of the reason why demonstration is needed'.[39] A taxonomy, or hierarchically ordered division (*diaeresis*), is the instrument (*organon*) that makes apparent the rationale (*logos*) inherent in the process to order and beauty. It displays the process as a system of definitions *per genus et differentiam* (*sive differentias*) beginning with the category substance (*genus summum*), and ending with the last species (*infimae species*). It is not simply a mechanical procedure, like dichotomization, but is ontologically principled.[40] If induction is to prove demonstratively, it is necessary to know all the species that fall under the genus;[41] nonetheless, the study of instances merely provides

[35] *On Nature* fr. 8.

[36] G. Kirk, 'Sense and Common-Sense in the Development of Greek Philosophy', *The Journal of Hellenic Studies* **81** (1961), 113–115.

[37] P. Pellegrin, *La Classification des Animaux chez Aristote* (Paris: Belles Lettres, 1982), p. 195.

[38] 'The things that stand out as plain and obvious at first glance are confused mixtures, whose elements and initiating principles become known only on subsequent analysis. Accordingly we must proceed from the general character of a thing to its constituent factors; for what the senses discern most readily are concrete wholes, and a thing's general character is a kind of concrete whole, embracing as it does a number of constituent factors or aspects. (*Ph.* I,1).

[39] S. Gaukroger, *Explanatory Structures: Concepts of Explanation in Early Physics and Philosophy* (Atlantic Highlands, New Jersey: Humanities, 1978), p. 95.

[40] *C.f.* G. Granger, *La Théorie Aristotelicienne de la Science* (Paris: Aubier, 1976), p. 241. Aristotle's disallowance of dichotomy as an arbituary and empty formalism is duly noted, but his allowance for *real* division is not.

[41] *APr.* 68b27.

one with knowledge 'that a thing is so' (the fact) but not yet 'why a thing is so' (the understood fact).[42] To know why a thing is so is not only to know that it is, but also from whence it came, how it came, and because-of-what it came to be. Aristotle soon realized, however, that, at best, division can only *show* the essential nature of things, but cannot *prove* it.[43] In addition, he also tacitly acknowledged that there was no sure-fire method of *epagoge* for determining how to actually come by necessary universals and essential relations. For each field, or "genus," of science discovery of the right method would be a matter of trial and error, though guided by intuition (*nous*) of first principles.

## III

Ontological definition was not to be achieved through an analysis of the linguistic meaning of species terms, as Hull implies, that is 'by properties connected conjunctively which are severally necessary and jointly sufficient'.[44] Aristotle is explicit: 'Definition is a unitary discourse, not by simple conjunction (*syndesmos*) . . . but by the essential unity of its object'.[45] Definition is meant to reveal those existence-determining principles (*archai*) responsible for the unitary career of an object, that is, for its identity through changes in space and time. Since any definition must reveal the generative principles responsible for the existence, or coming-into-being (*genesis*), of a thing it could not be purely descriptive, but must carry existential import. In addition to the individuals and properties with which modern logic deals there are also natural kinds whose relations to individuals are not the same as the relations between individuals and properties.

As Moravcsik aptly notes there are two reasons why natural kinds cannot be defined in terms of necessary and sufficient discursive conditions: 'on account of the Aristotelian instantiation requirements, but also on account of the naturalness conditions assumed by statements describing the nature and potentialities of species. *E.g.* 'a tiger (normal, healthy, etc.) is a four-legged animal' '.[46] It is the latter condition which also precludes defining natural kinds in terms of their token extensions; for it could turn out that no exemplars of tigers are actually four-legged, even though all tigers are quadrupedal 'by nature'.[47]

[42] *APo.* 99b – 100b.
[43] *APr.* 46a31 – 46b11; *APo.* 91b14 f.
[44] Hull, 'The Effect of Essentialism on Taxonomy', p. 318.
[45] *Metaph.* H, 6.
[46] J. Moravcsik, 'Aitia as a Generative Factor in Aristotle's Philosophy', *Dialogue* **14** (1975), 635 – 6.
[47] But given the instantiation requirement it could not turn out that no tigers actually exist, as Plato might have allowed.

This requires some explication. Let us first make the following rough distinctions. Of the whole set of synthetic attributes of a given natural kind, there is a subset which is natural to that kind and a subset which is accidental to it. For example, if it were true that tigers are large, striped felines seen only on Tuesdays, then being a feline and being striped would be among the natural properties of tigers and being seen on Tuesdays would be accidental to tigers.

The natural attributes of a living kind come in two grades, one more essential, but less well known than the other. The essential nature (*e.g.* the peculiar felinity of tigers) 'underlies' the better known perceptible properties (*e.g.* being large and striped); that is the perceptible properties of a natural kind are *presumed* to be (proper) natural consequences of the essential nature of that kind, even if the essential nature is largely unknown and perhaps effectively unknowable. This understanding of the meaning of natural kind terms as determined, in part, by their presumed underlying natures is not peculiar to Aristotle. As I have argued elsewhere, it seems to characterize our own common sense appreciation of natural kind terms, as it does for peoples in all other cultures.[48]

Being a natural consequence is dependent on a *ceteris paribus* clause. When an exemplar possesses a set of traits essentially, *e.g.* when Tio the tiger has its peculiar felinity essentially, then *all other things being equal,* it will necessarily manifest the perceptible properties of its kind. It is possible, however, to envisage situations where all other things are not equal, where some external event has broken the putative natural chain which physically links Tio's having a peculiar essential nature and Tio's being large and having stripes. Shaving Tio, or Tio being a naturally deformed dwarf would be examples of such interference. We ordinarily cope with such situations by marking a distinction between semantic properties of the kind and perceptible properties of particulars. We say of the shaven Tio that it has no stripes, but that it is 'naturally striped' or 'striped by nature'.

To say of a three-legged tiger that it is 'quadrupedal by nature' is not to say that it actually possesses four phenomenal legs. Rather, it is to say that a three-legged tiger *should* perceptibly manifest, or actualize, the whole of the phenomenal configuration which typifies 'tiger-ness' (including four legs) and that it would have done so, in fact, had all other things been equal. So, given a semantic property of the mental dictionary, *S,* which is prescinded from the phenomenal configuration, *P*;[49] given an underlying nature which is (partially)

[48]S. Atran, 'The Nature of Folkbotanical Life-forms,' *American Anthropologist,* **87** (forthcoming).

[49]Semantic properties, such as 'quadrupedal' and 'striped' are prescinded from the phenomenal configuration in which our concept of tiger is grounded, that is, from the (eidetic) imaginal figure. They are not identical with the phenomenal configuration, though they are derived from it. In other words, we do not (and we cannot) conceive of the four-leggedness of tigers without attaching four legs to a complex, partially non-discursive intuitional configuration; but we can use the abstract discursive marker 'quadrupedal' in order to predict the lexical (dictionary-related) entailments of any sentence in which the term appears.

represented by a theory, $T$, in the mental encyclopedia; and given a natural kind exemplar, $x$; then, to entertain (1):

1. $S(x)$ is true by nature

is to bear in mind (2):

2. $P(x)$ is necessarily expected in virtue of $T$

And to bear in mind this expectation is to commit oneself to believing (3):

3. $x$ is physically disposed to perceptibly realize $P$ because it has the essential nature it does.

The common sense locution 'by nature', when fully analyzed, thus yields the ontological relation, *because of*. This is a relation of reductive physical identity which holds between the perceptibly realized correlates of $P$[50] and an underlying nature. In other words, the perceptibility realized correlates of $P$ are assumed to be ontologically indistinguishable from that underlying nature which is presumably responsible for them. Of course, there remains the epistemic distinction between phenomenal properties *per se* and underlying traits (although, as we shall see, that distinction is minimal in Plato).

The essential role of possibly unknown underlying structure is to permit variation, and even change, in reference without a change in the corresponding archetypical (eidetic) concept from which linguistic meaning (*i.e.* Fregean sense) is prescinded. In this way, we are able to accommodate unusual aspects of the physical world to our conceptual system without comprising our basic stock of ordinary knowledge about everyday matters.

Usual token variation from the conceptual type is spontaneously handled by the mind. This is possible because the phenomenal archetype is not itself any given exemplar or empirical prototype; rather, it is an imaginal archetype whose intuitive nature is undetermined by any actual specimen. For example the imaginal notion which most of us have of a tiger includes the idea that it has stripes; however, the exact width, number, length and texture of those stripes is not fixed with respect to any actual or possible token. This is not because the imaginal type is itself vague, but because the truth-valuation (verification – exemplification) process of matching token to type is, as Kant emphasized, fairly abstract.[51]

When the deviance between the perceptual token and the phenomenal type begins to border on the 'monstrous', though, or when exotic organisms are introduced into the local scene, explanations are sought. Often these explanations

[50]A *phenomenal* property is an imaginal attribute, not a physical one; however, it is a property such that if it is actualized, that is, empirically identified, then it is readily *perceptible*. For a phenomenal property to become perceptible, there must be a relationship of physical causality established between the observer and that in the world which is perceived. On this view of "phenomenal" as an attribute of intuition, rather than experience as such, see P. Strawson, *The Bounds of Sense* (London: Methuen, 1966), p. 282.

[51]Kant, *Critique of Pure Reason*, B – 181.

are empirically straightforward; other times they are 'mystical' or 'mythical', that is, non-propositional,[52] or simply assumed to be true. For folk in pre-literate societies, this way of dealing with the disparity between token and type suffices; for the Greek physical philosophers it did not. They wished to know the empirical nature of presumed underlying natures in order to account for deviance; so that they could better know what 'went wrong' with nature and thereby anticipate what could go wrong.

The pre-Socratic physiologers thought to resolve the problem of deviance between token and type (*i.e.* between experience and concept) by dissolving all underlying natures into a general Nature. Nature was ultimately to consist only of one or more of the material 'elements' (earth, fire, air and water) together with their qualitative 'potential' (*dynamis*) or 'powers' (hot, cold, wet, dry) as *arche*.[53] Although in the *Phaedo* the young Socrates tells us that he was first seduced by this maneuver, he came to view it as an affront to reason and common sense.

To resolve the problem of the ontological relation between token and type, Socrates argues that material explanation will not do. Material happenstance cannot explain why it is that exemplars should conform to specific types, nor how and to what degree exemplars actually do so conform. To understand *how* exemplars are actually generated in accordance with their underlying natures is to grasp the teleological *aitia,* argues Socrates. For the Platonic Socrates, as for Aristotle, the presentation of *aitia* corresponds to those 'because' clauses which answer *dia ti* questions of 'how' and 'why' things come to be as they are. Socrates says that although he has not found the teleological *aitia* responsible for genesis (including material development) he has found the essential, or 'formal', *aitia* which account for why there is conformity to type at all.

These formal *aitia*, or 'Forms', are but projections of conceptual types onto the timeless and spatially unextended ontological plane. A Form is an immutable, incorporeal and eternal *eidos* which cannot be known by sense experience, but only by 'recollection' (*anamnesis*). We do not recollect that we actually possess such forms within us. Rather, we discover 'in us' an innate appreciation of them; what is in our minds is thus the characterization of the Form as a 'namesake'. Although these Forms are not themselves responsible for genesis (material existence), it is nevertheless the case that: 'each of the Forms exists and it is in virtue of participating in them that other things are named after [these Forms]'.[54] More precisely:

4. For any true phenomenal characterization, *P,* of an exemplar, *x,* there

[52]S. Atran, 'Rendons au sens commun', *Le Genre humain,* 7–8 (1983).

[53]*Cf.* P. Kucharski, 'Anaxagore et les idées biologiques de son siècle', *Revue philosophique* **154** (1964).

[54]*Phaedo* 102A10-B2; *cf. Republic* VII, 507A.

exists a (homonymous) Form, P-ness, such that $P(x)$ is true if, and only if, $x$ participates in P-ness.[55]

Although Plato thus reinstates the common sense notion of 'natural kind' as an ontological entity with an underlying nature, his doctrine does not account for the mechanics of participation, that is, for natural causality.[56] There is no account of how tokens come to resemble one another 'for the most part' and yet remain undeniably different. Moreover, Plato's belief that token exemplars are somehow less real than their corresponding Forms is plainly contrary to common sense realism; for we really do experience them. Accordingly, in an effort to preserve common sense realism and the Greek conception of ultimate unity, Aristotle sought an explanation of the common sense notion of natural causality for natural kinds[57] which not only saves the phenomena, but also systematically accounts for the fact that in this world it is *for the sake of the best possible material advantage* that phenomena conform by nature to specific types under given circumstances.

## IV

Aristotle's four sorts of *aitia* are as follows:[58] the material cause, or brute and formless matter of the thing (*e.g.* man's flesh and bones); the formal cause which gives matter its specific identity or unity (*e.g.* man's upright figure together with his thinking); the efficient cause which determines how form is actually imposed upon matter (*e.g.* the biological act of generation whereby 'man begets

[55]See G. Vlastos, 'Reasons and Causes in the *Phaedo*', *Philosophical Review* 77 (1969), 301: "'participation' here designates the one-way relation of ontological dependence between temporal things and eternal Forms." That is, no exemplar, $x$, could actually exist in space and time and be characterized by $P$ unless $P$-ness existed; however, the existence of $P$-ness does not guarantee instantiation.

[56]The generative factors, or *aitiai*, responsible for coming-into-being have been historically referred to as the four 'causes'. Recent commentators, such as Vlastos (1969) and Moravcsik (1975), have inclined to view the term 'cause' as a misnomer and to consider the doctrine of *aitia* in Plato and Aristotle as a program for understanding in general. On these accounts an *aitia* is a 'reason' for something, be it logical consequence in a mathematical proof, the justification of one's actions or an explanation of a fact of nature. Nonetheless, there is ample evidence in Aristotle's physical and biological works that *aitia* applied to natural kinds is a doctrine of physical consequence with respect to underlying nature. As such it seeks to explicate the common sense notion of natural causality and to systematically extend that notion to unfamiliar objects and events for which no self-evident common sense intuitions exist.

[57]The common sense notion of 'natural consequence' (or 'natural causality') should not be confused with modern technical notions of Humean causality or nomological necessity. Applied to living kinds, the common sense conception of natural necessity differs from the Humean idea of contingent temporal consequence much as nomological necessity does (*e.g.* one does not say tigers are contingently disposed to be quadrupeds). But natural consequence differs from nomic cause in that the former alone imposes epistemically necessary conditions. Thus, it is possible that two nomic kinds share *all* phenomenal (readily perceptible) features, but nevertheless differ essentially. This is not possible for the phenomenal kinds of common sense.

[58]*Ph.* II, 3.

man'); and the final cause which prescribes why form should thus be imposed upon matter (*e.g.* to function rationally). Taxonomy only exhibits material and formal cause, although it presupposes the operation of efficient and final cause.

Since "there is an identity between the [formal] nature of the thing [*i.e.* the 'what'] and why it is [*i.e.* the 'because-of-what']",[59] the part of overall appearance that is truly essential to something naturally identifies the underlying cause of its being. Thus, for man, an erect gait, and all which that essentially implicates (*i.e.* footedness, vertebrateness, animality, living kindhood, substantiality), exist only 'for the sake of' man's nature, that is, his rational soul. Man essentially functions in an erect, motile fashoin *so as* to be able to properly exercise his thinking, *e.g.* to make tools.[60]

Within a natural kind taxonomy each generic level represents a kind of matter relative to the next, more specifically formed, level. The more specific level, then, represents a transformation of its generic matter which is effected in accordance with nature's plan. In such a taxonomy the only actual substance is the last species (*atomon eidos*), since it alone divides into real individuals. The process by which this transformation of matter into substance is effected is not exclusively the result of action upon the intrinsic properties of the generic matter, but of the interaction of these with other sources of movement and matter, such as the sun and earth. Nature, being structured as it is, will always tend to transform a certain kind of matter in a specific way under given material circumstances. Taxonomy merely records the steps in this process, but neither demonstrates nor describes the process itself.

In view of the existential nature of the causal process underlying taxonomy, it follows that the differentiae which essentially distinguish and form the various species of a genus cannot be determined by a necessary and sufficient (*a priori*) analysis of logical properties, nor by empirical abstraction. Such a determination requires a causal analysis which is at once material and logical. It is logical to the extent that the determination of form from the highest genus to the lowest species implies what Balme describes as a 'progressive quantification of matter': 'the movement from general to particular should not proceed by adding new differentiae but by determining more and more precisely the forms with which the division began'[61] (*e.g.* motile, footed, bipedal). Quantification ends when further difference can only split intuitively familiar natural kinds (*e.g.* color and sex in the case of living kinds).

It is empirical to the extent that each quantification must correspond to a sensibly apparent, and constant, qualification of the last species. As A. C. Lloyd notes: 'a differentia which is an essential property is to be distinguished from

[59] *APo.* 90a14.
[60] *PA* IV, 10.
[61] D. Balme, 'Aristotle's Biology was not Essentialist', *Archiv für Geschichte der Philosophie* 62 (1980), 6.

an accident by observation and experiment'.[62] But constancy is not enough: the constant features must be logically, because causally, related. The fact that appendages of most animals come in symmetrical pairs is less significant than the fact that they are motile; for the former fact is true only in virtue of the latter fact (and not vice versa) which is essentially bound up with the search for food.

The essential trait or difference, of a species of animal is a part of its typical, morphologically complete, and normally functioning adult state (*acme*), as that end state is the complete being.[63] It is the part which points to the cause of that, rather than some other, species' coming-into-being. It is the 'functional form' to which the flow of movement and matter leading to a mature member of the species is directed. All animal species must eat and defend themselves in order to develop, but it is owing to their essential structure (which is potentially present in the male seed) that species actualize the same animal matter, following the same animal 'cause' (*i.e.* the need to eat and survive), in fundamentally different ways.

*Epagoge,* then, is required to do much more than simply yield *de facto* universals. It must distinguish what properly and necessarily belongs to a given kind of organism from what belongs only accidentally (*e.g.* the dog's having a long snout and its sniffing behavior in the hunt from its getting wet or sick); and it must distinguish what essentially belongs to a kind of organism (*e.g.* the dog's canines) from what belongs to it only properly and necessarily. It is in virtue of its canines that the dog is able to hunt; and it is because it has canines to tear its food and defend itself that it does not require the defensive horns of other animals nor the extra stomachs needed to complete mastication.[64]

Those properties which are necessary and proper do not figure into the definition of a kind because they belong to the kind to which they are attached as realizations of nonessential dispositions. This is so whether the kind in question be an 'eternal' kind, such as a mathematical object, or a 'sublunary' and 'perishable' kind such as an organism. For example, one proper consequence of man's being rational follows from his 'having the disposition to learn grammar': 'because if *A* is a man, then he is capable of learning grammar, and if he is capable of learning grammar, then he is a man'.[65] Although proper

[62]A. C. Lloyd, 'Genus, Species and Ordered Series in Aristotle', *Phronesis* 7 (1962), 87: 'in order to . . . be able to distinguish an appropriate differentia from a unique characteristic which belongs to the genus . . . it is necessary to observe more than the static facts, namely the [causal] connection between them'. Lloyd argues that the causal process itself is also to be observed in nature; however, this 'observation' is by no means intuitively obvious. The description of such a process is invariably conjectural and the mechanism thus described partially inscrutable to visible verification.

[63]*PA* 641b31.

[64]*PA* II, 2.

[65]*Top.* I, 5. Another proper consequence of being rational is that one thereby has the 'capacity to receive science'. (*Top.* VI, 3).

consequences of a kind may be unique to that kind, they are, in a sense, incidental to nature's plan.

Thus, the proper consequence that the angles of a triangle sum to two right angles is only an 'essential accident' of triangles, because this fact does not help to define (the differences) between the essential natures of all *other* geometrical figures.[66] Similarly, to characterize man as capable of learning grammar fails to capture the reality of man as a *species*. Because a species is a substantial unity of genus and differentia, the differentia must be as appropriate to the genus as to the species itself. If the attribute is merely unique to the species, however, there is no guarantee that it is also pertinent to the genus; that is, each of the other species of the genus must have as a differentia a complementary, or co-ordinate, feature taken from a feature-dimension which spans the whole genus.

Although the proper consequences of both eternal and sublunary kinds are necessary, they are necessary in different ways. In the former case necessity is absolute and cannot be otherwise.[67] In the latter case necessity is merely hypothetical and follows only 'for the most part'.[68] In other words, necessity is conditional upon the end state actually coming about. Thus, on the hypothesis that the mature organism will fully develop, then what is proper to that organism will fully come about only because the 'best possible' end state has been achieved. There is, however, no guarantee that the best possible end state will be achieved in fact, although under normal circumstance the best possible end state does tend to come about 'for the most part'.[69] In the case of eternal kinds, the best will always come about inasmuch as eternals are intrinsically divine and beautiful.[70]

Among the realizations of non-essential dispositions are all the readily visible parts (*moria*) common to animals which do not directly point to substance (*e.g.* feet, feathers, scales, tails, hair etc.) because life is possible without them.[71] Even though living kinds are initially distinguished by similarity of overall morphology, including similarity of essential accidents[72], such features cannot

[66]As would, say, 'three sided plane figure' which would distinguish triangle from quadrangle, *etc.* (*Metaph.* 1025a30). *Cf.* A. C. Lloyd, *loc cit*: 'One can say that in [ordinary class algebra] there is no criterion for distinguishing an essential or definitory differentia of a species from any unique characteristic'.

[67]*Metaph.* 1015b7, 1026b27.

[68]*Metaph.* 1027a f. Although in *PA* 639b21 Aristotle uses the coming into being of artifacts to illustrate hypothetical necessity, the hypothetical necessity which attaches to living kinds is fundamentally different. In the case of living kinds, the hypothesis that the end will in fact come about reflects the best possible outcome, and one which naturally comes about for the most part. However, the hypothesis that a statue or house will come into being is a *mere* possibility which depends on the whims of human will, desire or convention.

[69]*GA* 731b20 f.

[70]*Ph.* 199b34.

[71]*PA* 645b5.

[72]*PA* 644b7.

enter into the definition inasmuch they do not point to the causes of their presence in the organism.[73]

Nonetheless, essential accidents play a crucial role in science for two reasons:[74] First, they provide the principle means of access to the problem of underlying causes; for the common sense awareness of pattern — an awareness which makes no distinction between essential trait and essential accident — is the most reliable indication that nature is being systematically organized. Second, explanation of essential accidents, once their causes have been discerned, is necessary to a principled understanding of why the common sense realism of ordinary humankind is valid. Such understanding certifies that we need not hold to common sense merely on trust, nor need we fear that we mistake appearance for reality; for the world we readily apprehend is, for good reason, the world that is.

There are, in addition to the essential traits and the proper essential accidents,[75] nonessential accidents such as the color and health of organisms of a kind. But even these accidents are necessitated in virtue of biological ends. That an eye has this or that color owes to the fact that this particular part of the body is (essentially) required to serve some biological function, and there (incidentally) just happens to be this or that clump of matter available as a vessel for efficiently fulfilling that function. The matter which forms the eye of an animal must have *some* color (because all matter is colored); but the color that eye does have is not essential for sight. An explanation of these accidents does not form part of the subject matter of biological science because science concerns only what is best always or for the most part.

Essential traits point to underlying natures which are the *sources* of all those attributes that can be properly attributed to an organism. Nevertheless, *all* of the typical features of a sublunary kind, including the essential traits, flow from the underlying natures of the individuals of a kind merely 'for the most part'. True, if the essential traits did not appear, then the proper attributes wouldn't either. But even the essential traits develop, if at all, out of material necessity. This is not to say that the essential and proper traits of animals come into being wholly in virtue of their material constituents; rather, their material constitution is determined by the ends which those traits serve: a hand comes to have the

[73] *PA* 645b14.

[74] Demonstration must reveal essential accidents (*APo.* 75a39). Knowledge of these form an indispensable part of the natural philosopher's understanding of those consequences of the soul which make an animal what it is (*PA* 641a21).

[75] There are also essential accidents which are not proper to any species, but are appropriate to the genus: *e.g.* having a male or female sex is appropriate to being an animal, but not to being a horse or cow (*Metaph.* 1058b22 ff.). A somewhat different case is that of 'biped' which appears to be an essential trait of man when he is considered under the genus of footed vivipares (*i.e.* mammals), but is actually an essential accident because it is not a trait which is unique to man among the animals (birds have it) (*APo.* 75a18; *PA* 643a3).

shape and constitution it does in virtue of a function determined by nature.[76] Still, essential traits depend upon matter for their existence. And since it is essential traits which figure into the definitions of natural kinds, then such definitions cannot be of pure essences; they can be only of the 'mixed products'[77] of material and formal causes.

Unlike in the realm of mathematical intuition, no pure forms actually exist in the living world: 'For the objects of natural science, while distinguishable ideally from the matter in which they reside, are not actually separable: man generates man but the sun does too'.[78] The only forms that exist in the sublunary realm are actualized, individualized forms. These are composites of form and matter. They are not intensional classes which exist apart from, or before, the objects which fall under their extension, like Platonic *universalia ante rem*. They exist *sub specie universalitatis*, as particular realizations of global rules, or principles of nature, which cause matter to develop, *i.e.*, to change and yet persist for a time in identifiable form.

Accordingly, the actualized forms which instantiate these universals need realize not only potential for form (inherited from the father), but also compatible material potential for the effectuation of form (in part inherited from the mother, in part determined by the material composition of elements in the surrounding environment). Natural kinds must thus consist of those general and specific *ranges* of formal and material potentials pertinent to teleological explanation. Such explanation must account for what is intrinsically purposive, in the sense of adaptive, and not purposeful, in the sense of intentional. It is in this account of genesis, that is, in the material realization of potential for form in animals, that one comes to realize that species are neither eternal nor statically fixed in space and time, and that the demonstrations applied to living kinds can only be hypothetical.[79]

[76] *Metaph.* 1036b30, 1041b25 ff.

[77] *Cf.* M. Loux, 'Form, Species and Predication in *Metaphysics* Z, H and Θ', *Mind* **88** (1979).

[78] *Ph.* II, 2; cf. *Metaph.* 1036a24 – 29.

[79] In *Metaphysics* Z.7 Aristotle states: 'Everything that comes to be (a) *by something* and (b) *from something*, and it comes to be (c) *something*.' The first item is the efficient agent, the second is matter and the third is the form of the thing that comes to be. In *Historia Animalium* I.6, Aristotle sketches the relevance of this passage to the study of animals. First, 'it is necessary to take separately each kind of animal and examine its nature (*physis*) separately'. This, as Aristotle makes clear in *de Partibus Animalium* I.4, is the task of common sense. Then, one must go into greater detail, in order to grasp the attributes which distinguish and unite kinds, 'according to those difference which pertain to form, to excess to analogy, to opposition'. This is the study of material cause; for 'the matter for animals is their parts' (*GA* I, 1). It is the subject of *Historia Animalium*. Afterwards, one must attempt to discover the *aitia* of these differences and similarities, that is, those essential parts which define the kind, and point to its essential nature (*PA* 645b f.). This is the study of formal cause and is the object of *de Partibus Animalium*. So, 'one must first take the *phainomena* of each *genos* of animal, and only then go on to speak of their *aitia*, then their *genesis*' (*PA* 640a14). Thus, study of the actual, efficient process of genesis for different kinds of animals completes our essential knowledge of animal nature. This is the topic of *de Generatione Animalium*. Such, then, is 'the natural order of investigation once knowledge of each [kind of] animal is acquired. By this method the object and the premisses of demonstration will most clearly appear.' (*HA* 491a7 f.)

A major source of error in the interpretation of the course of natural history is thus due to a misleading analysis of Aristotle. By and large, interpretation has been influenced by the idealism of some of the Oxford scholars, most notably H. W. B. Joseph.[80] Such analyses tend to gloss over the subtle, though significant, differences between Aristotle's interpretation of Logical Division in the *Organon* and that of the Platonists. Furthermore, these analyses disregard the fact that by Book Z of the *Metaphysics* the purpose of definition by genus and species is to exhibit and determine the nature of material substances whose species and essence are quite clearly distinguished from one another. Essence *per se* is thus no longer a proper object of definition, at least for living kinds and all natural substances, because in such cases essences cannot be considered apart from the matter which instantiates them and upon which their generation depends.[81]

## V

If commentators on the development of natural history tend to downplay the differences between Plato and Aristotle,[82] some of the more recent classical scholars incline perhaps too greatly to Werner Jaeger's thesis[83] that Aristotle's biological works represent the maturation of his declining Platonism,[84] if not increasing empiricism.[85] On G. E. R. Lloyd's account, for instance, Aristotle gradually proceeds in the *Organon* from an uncritical acceptance of Platonic division to a more discretionary appreciation which is elaborated in the *Metaphysica*. The biological works then continue the process: beginning with a half-hearted attempt to use division in the *Historia Animalium*, Aristotle goes on to criticize and abandon it in *de Partibus Animalium*, and eventually propose his own method of classification by degrees of perfection of the offspring in *de Generatione Animalium*. To my mind, the claim that Aristotle *ever* rejected division is either ambiguous or false; nor is there compelling evidence to suggest that Aristotle ever held that classification by degrees of perfection was *sufficient*.[86]

[80]H. W. B. Joseph, *Introduction to Logic* (Oxford: Clarendon, 1916).

[81]*Metaph.* 1036a24 – 29.

[82]For example, in H. Lehman, 'Classification and Explanation in Biology', *Taxon* **20** (1971).

[83]W. Jaeger, *Aristotle: Fundamentals of the History of his Development* (Oxford: Oxford University Press, 1948).

[84]G. E. R. Lloyd, 'The Development of Aristotle's Theory of Classification of Animals', *Phronesis* **6** (1961).

[85]L. Bourgey, *Observation et Expérience chez Aristote* (Paris: Vrin, 1955), p. 124 n. 5.

[86]The sequence proposed in *GA* 733a is: (a) those animals which are hot and wet and bring forth their young in a perfect (man), or near perfect (the other vivipara) state; (b) those which are hot and dry and have a perfect egg (scaly reptiles and birds); (c) those which are cold and wet and externally viviparous, but internally oviparous (vipers and cartilaginous fish); (d) those which are

In Plato's *Phaedrus*, Socrates warns against those rhetoricians who would 'make the same things appear to his hearers like and unlike'. Instead, one ought to inquire into the 'real nature of everything' by a 'regular division'. The proper execution of such a division involves two complementary processes: 'first, the comprehension of scattered particulars in one idea'; second, 'division into species according to their natural formation, where the joint is, not breaking any part as a bad carver might'. Socrates then offers a very rudimentary sketch of dichotomous division which is more fully elaborated in the *Sophistes* and *Politics*.

In the *Analytica Priora*, Aristotle argues contra the Platonists that division, as against syllogism, is powerless to demonstrate: nevertheless, syllogism combines those terms established by division.[87] In the *Analytica Posteriora*, he further contends that division, which itself employs terms established by *epagoge*, while never apodictic is still the only method for exhibiting essence by definition that is known to be valid.[88] Division, then, is the indispensable midwife for converting the universals isolated in common sense by *epagoge* into terms appropriate for syllogistic demonstration. Aristotle never had the least cause to alter this appreciation of division; although he would come to reject the dichotomous division of Plato's later works, throughout his career he would continue to hold with his teacher that: 'I am myself a great lover of these processes of division (*diaresis*) and assembly (*synagoge*)'.[89]

In *Historia Animalium* I, Aristotle does follow some shallow dichotomies

cold and dry and produce an imperfect egg (scaly fish, crustacea, cephalopods); (e) those which are simply cold and produce not an egg, but 'larva' (insects); (f) and those which are almost lifeless and reproduce spontaneously (testaceans). However, (b) and (c) are reversed in 733b, and it is this latter sequence which Lloyd holds to.

But there is indirect evidence that the former is the correct one. For Aristotle, those animals which are most perfect are hot and wet; but heat is the fundamental life-giving force. Life-giving heat, which is more akin to the heat of the sun and stars than that of fire and friction, is conveyed by pneuma (which is carried in sperm). When the blood is thus 'pneumatized' a pulse appears as the heat is borne from the lungs to the heart, and then to the blood vessels (*PA* 667a29). It is because the generative heat transmitted by the pneuma and blood varies in value that the soul can be conveyed in varying degrees according as a higher or lower animal is generated (*GA* 736b30 – 36). Since the mark of natural heat is the lungs which are full of blood (*GA* 732b31), it follows that 'lung possessors' are more perfect beings than animals which do not possess lungs (*PA* 669b9). Thus, it is not surprising that 'the exterior parts of fish are still more deformed' than the parts of birds (*PA* IV, 13).

This sequence is fundamentally no different from that based on the order of complexity of reproductive parts in *HA* 539a10: (a) viviparous and oviparous land animals, (b) birds, (c) (ovo)viviparous and oviparous fish, (d) crustaceans, cephalopods and insects, (e) testaceans. Moreover, the fact certain groupings seem to split ordinary kinds (*e.g.* fish and snakes are split into those which are oviparous and those which are ovoviviparous) does not imply the abandonment of common sense kinds. All that is implied is that no single functional system, whether it be reproduction or locomotion, is enough to determine the underlying nature of ordinary kinds. Reproduction is only one factor in the actual genesis of kinds; it is necessary but not sufficient.

[87] *APr.* 46a – b; *cf.* P. Pellegrin, 'Division et Syllogisme chez Aristote', *Revue philosophique*, 171 (1981).

[88] *APo.* 91b.

[89] *Phaedrus* 265C9 f.

(*e.g.* animals may be aquatic or not; of the aquatic animals there are those that live by absorbing water and those that do not); but this work, far from endorsing dichotomy, is implicitly a practical lesson on how such such divisions are both incomplete (shellfish neither absorb air nor water) and cross-cutting (crabs walk like terrestrial animals). In *de Partibus Animalium* I, he explicitly attacks dichotomous division. The most vulgar version of dichotomy, is that which pretends to unite a pair of opposites on the order of possession – privation (*e.g.* substance vs non-substance; of substance, animal vs non-animal, etc.). Such division is not real because the negative partner must lack the matter which the positive partner possesses; however, division can only apply to *eide* which *share* the matter common to their *genos*.[90]

Another problem with dichotomy is that it merely seeks to distinguish things from one another so that they cannot be confused. In this sense dichotomy can only aspire to the status of an identification key which neither supports inductions nor lawful demonstrations; nor, therefore, can it distinguish essential accidents from essential traits. Finally, dichotomy leads to much 'splitting and dislocation' of natural groups, because it assumes, *a priori* that all living kinds naturally fall under the divisions of a single logical dimension.[91]

In the *Organon* Aristotle clearly outlines the process of division which will go on to characterize his biological works:

> It is important to choose partitions and divisions. The method of selection consists of positing the genus that is common to all of the subjects studied: for example, if they are animals, then those which are the properties of all animals. Once this is

[90] *Metaph.* 1055b3 ff. Bourgey (*op. cit.*, 1953, p. 39 n.4) notes a single instance of the logical use of *genos* and *eidos* in the Hippocratic Corpus. The passage from *On Nutrition* I, which may be contemporary with Aristotle, is roughly as follows: 'there exists an *eidos* of food, as there exist several; there exists a food which corresponds to a *genos*, [and] one distinguishes the [kinds of] *eidos* of food by their liquid and solid character'.

[91] It is obvious that these criticisms also extend to polytomous divisions which hold along a single *fundamentum divisionis*. Yet, Aristotle himself appears to suggest in his logical and metaphysical works that division along a single *fundamentum* is the ideal means for achieving a proper definition:

> A genus is always divided by differences which are coordinated in terms of a division; for instance, animal is divided by the pedestrian, the winged, the aquatic, and the biped. These must be contrasting terms. (*Top.* VI, 6)
>
> The division can thus only be this: 'of that which possesses feet', there is 'that which has a split hoof', and 'that which does not', because these are differences of feet: the character 'split hoof' is a manner of being a foot. And this process continues until one arrives at undifferentiated species; at that moment one will obtain as many species of 'footedness' as last differences, and the [different kinds of] species of animals possessing feet will be equal in number to the difference [of footedness]. If this is so, the last difference will be the substance of a thing and its definition. (*Metaph.* 1038a)

It is not at all evident, though, that Aristotle meant these examples to be more than merely illustrative of a novel logical technique, namely, division by *genos* and contrasting *eide*. This is not to say that Aristotle did not view logical division as the best, or only, means to achieve a proper definition of natural kinds. It is only to suggest that division along a single *fundamentum*, rather than along multiple *fundamenta*, did not represent an important distinction for the purposes of illustrating a logical technique.

> achieved, next in turn is the first class [of subgenera] remaining. One asks what are the necessary attributes which belong entirely to this class: for example, if it is the bird, then those which are the properties belonging to every bird; and so on down the line.
> . . . we have just taken examples from among those things which have received a common name, but we must not restrict our investigation there: if we have observed some other common attribute, then we must, after having grasped it, go on to see to which species it applies and which properties belong to it. For example, in the animals which have horns, we reveal as common properties [of all horned animals] the fact of possessing a third stomach and only one row of teeth. The question which then poses itself is: of which species is the possession of horns an attribute? For one sees in virtue of what the properties in question belong to these animals [*viz.*] it is by the fact of having horns.
> Finally, there is another method, and that is choice by way of analogy: it is not possible, in effect, to find one and the same word to designate cuttle-bone, fish-bone and bone properly speaking; nevertheless, all these things possess properties which belong to them as if such things were of one and the same nature.[92]

The object of a division, then, is to rigorously cut nature at its joints by carving the material *genos* into more precisely formed component *eide*. This is already intimated in the *Categoriae*. Thus, the animals may be divided into:

> beast and bird and fish — and none of them is prior or posterior; and things of this kind are thought to be simultaneous by nature. Each of these might itself be further divided into species (I mean beast and bird and fish); so there, too, those resulting from the same division of the same genus will be simultaneous by nature.[93]

The *Metaphysica* further clarifies the matter: 'Everything which differs, differs either according to the *genos* or according to the *eidos*: according to the *genos* when there is no common matter or generation from one to the other'.[94] Still, there are groupings which do seem to share a common nature, yet are not the same by *genos*; for example, birds, fish and sea mollusks all seem to have bone-like structures, even though these groupings correspond to different *gene*.[95]

Thus, although common sense provides clear-cut groupings of animals which may be systematically analyzed in terms of the resemblances and differences of their readily visible parts, common sense does not obviously provide the means to systematically compare and contrast the largest groupings (*megista gene*), such as the quadrupeds, birds, fish, and the several invertebrate groups. Even so, such groups evidently share a material nature, namely, animality.

[92] *APo.* II, 14.
[93] *Cat.* 14b24.
[94] *Metaph.* 1027b27.
[95] Empedocles (*On Nature*, fr. 82) also discusses morphological analogies, though not in such a way as to reveal their systematic import.

Aristotle's solution to the dilemma is implicit in the passage from the *Organon*: there must thus be 'another way' to divide and assemble the natural realm than by *genos* and *eidos*, and that other way is *analogos*. This is not to say that division by analogy is a process which is logically distinct from division according to *genos* and *eidos*; rather, analogy is the only way to *complete* a division by the analysis of structures not readily apparent. From a logical point of view, groupings which differ as *megista gene* are but *eide* of Animal, which is the same by analogy.

The *Historia Animalium* further makes explicit the notion of a complete division to be established in accordance with 'induction' from common sense:

> There are animals which resemble one another in all their parts; there are others which differ. Certain parts are the same specifically (*eidei*); for example, the nose and eye of one man resemble the nose and eye of another man; the flesh and bone of one resemble the flesh and bone of another. It is the same for the horse and other animals of which we say they are the same specifically (*eidei*); because they are identical not only with respect to the whole body, but also each of their parts. . . When other parts are the same, but differ from one another by more or less, they belong to animals of the same *genos*. By *genos*, I mean, for example, bird or fish; because each is separated from the other by a difference according to *genos*, and there are many *eide* of fish and bird. . .
> There also exist animals whose parts are neither the same by *eidos* nor by more or less, but by *analogian*.[96]

Again, in *de Partibus Animalium:* 'bird differs from bird by the more or by degree (one is long-feathered, another is short-feathered), but fish differs from bird by analogy (what is feather in one is scale in another)'.[97]

Accordingly, such a division would not only define each kind of organism which common sense makes apparent, but would systematically unify all kinds by defining (animal) *life* itself. This is the import of the oft ignored or misunderstood passage in the *Politica*:

> We should first have to answer the question "what is essential for every animal to have in order to live?" And among those essentials we should have to include some of the sense organs, the organs for digesting food, and for taking it into the body, e.g. mouth and stomach, and in addition to these, the organs of locomotion. If these were all that we had to consider, there would be variations in them (I mean several sorts of mouth, of stomach, of sense organs, and of locomotion), and the number of ways of combining these will necessarily make a number of different kinds of animals. For it is biologically impossible for one and the same species of animal to have different kinds of mouth or ears. So that when all possible combinations of these parts have been arrived at, they will comprise the species of animals, and the

[96] *HA* 486a – b.
[97] *PA* 644a19 – 22.

> number of forms of animal life will be equal to the number of collocations of essential parts.[98]

The first division of Animal life would thus include all and only those organ-systems upon which animal life depends: digestion, locomotion and sensation.[99] To this list could be added reproduction, although digestion and reproduction really form one functional system.[100]

Each of these functional organ-systems would then be analyzed in terms of its constituent functional parts, and the analogous character of each of these parts would be ascertained for each of the vertebrate and invertebrate *megista gene*; this is the task begun in *Historia Animalium*. Within each of the *megista gene*, quantitative differences of 'more or less' in each part would be analyzed for every one of the subordinate groupings of organisms; this is the process initiated in *de Partibus Animalium*. The sum of the differences in parts for any given subordinate grouping would thus define that grouping. Each common sense kind would thus be shown to be uniquely constituted as a complex of vital function-parts. Yet, simultaneously, the connection of each kind to every other kind by specific degrees would become manifest, since all kinds share vital organs analogously, if not more or less.[101]

If one considers that each of the essential organ-systems of animals corresponds to a character-dimension, or *fundamentum*, then a logical division of animals is preserved by multiple differentiation. The functional parts comprising each organ-system would thus correspond to essential divisions of the *fundamentum* which characterizes that system. Each species would then be delineated as the complex product of simultaneous, parallel divisions (*i.e.* with a specific kind of digestive apparatus, and way of sensing, and manner of locomotion); that is, each species would be defined by multiple differentiae. Consider the *fundamentum* 'organs of digestion'. According to Aristotle, there are digestive organs which all animals share[102] either by

[98]*Pol.* 1290b21 f.

[99]*PA* 647a24.

[100]*de An.* II, 1; *HA* 589a13. On the one hand, Pellegrin (*op. cit.*, 1982) argues that reproduction, unlike locomotion, is not essential to Aristotle's scheme because some animals do not reproduce, but are spontaneously generated. Nevertheless, reproduction *is* essential to every animal which *does* reproduce. G. E. R. Lloyd (*op. cit.*, 1961), on the other hand, contends that locomotion, unlike reproduction, is not essential since some animals do not move by themselves. But the same argument can be made for locomotion as for reproduction, *viz.*, that it is essential to the being (and distinction) of every *motile* kind of animal.

[101]Even analogical differences appear to be ultimately quantitative. Thus, Aristotle seems to say that the differences between terrestrial and aquatic animals is reflected in a quantitative change in their parts which results from the accomodation of those parts to material nutriment in the course of their genesis and development (*HA* 590a2); *cf. PA* 653b3 and 655a33 where bone and cartilage are spoken of as being analogous and differing by the more and less.

[102]*PA* 655b29.

identity (*eidos*),[103] degree or analogy:[104] the mouth (by which nutriments are absorbed), the anus (by which residues are discharged) and the stomach (from which nutriments are absorbed into the body). The character of these organs are described for each of the *megista gene*. Thus, the quadrupeds, like man, have mouths with many teeth and a tongue, but 'birds have for a mouth what one calls a beak'.[105] As for the cephalopods, they 'have two teeth around that part which one calls their mouth; and in this mouth there is, in the place of the tongue, a fleshy appendage'.[106] Similar considerations apply to the *fundamenta* of locomotion, sensation and reproduction.[107] All other functional organs of animals are ultimately to be explained as being 'for the sake of' these primary function-parts.[108]

Once each of the *megista gene* is marked off by an analogous complex of vital function-parts, each part of the complex can then be differentiated in parallel, and by degrees of 'more or less', as one descends the hierarchy of subordinate kinds. For example, since all birds are winged and beaked, hawks may be partially defined as that kind of bird which has long and narrow wings and a sharply hooked beak. Division ends when all of the *infimae species* have been completely defined in this way.

Such a division should work because 'nature does nothing in vain, but it acts always by seeking the best that is possible, so safeguarding the essence of each being and its particular end'.[109] Consequently, 'we must recognize that if a small source is disturbed, many of the things after the source usually change with it'. In this way 'nature seeks out that which is adapted'.[110] It is, therefore, 'biologically impossible for one and the same species to have different kinds of mouth or ears'. It is also biologically impossible for different species, living

[103]The notion of readily visible identity of the parts and whole structure of all the organisms which fall under a species, or 'observational homology', is still the intuitive means by which species are initially discerned by zoologists today: See W. Inglis, 'The Observational Basis of Homology', *Systematic Zoology* 15 (1966).

[104]*HA* 589a13.

[105]*PA* III, 1.

[106]*PA* IV, 5.

[107]Take the *fundamentum* 'organs of locomotion'. One of the divisions of this *fundamentum* is the function-part which corresponds to 'foot' in some animals, 'wing' in others, 'fin' in still others. (*IA* 713a9) Among certain of the invertebrates this function-part is 'called tentacles' (*HA* 524b). As for 'organs of sensation', all animals have similar or analogous parts for smell, hearing, sight, and taste, except for the testaceans where hearing and sight is 'neither sure nor evident' (*HA* IV, 8). Concerning the 'organs of reproduction', all vertebrate females have a uterus, although the arrangment of uterine parts differs for each major grouping (*GA* 718a35 – b5). The invertebrates, too, have uterine parts (*GA* 720b2). This is clearly evident in all of the cephalopods (*GA* 720b20); while in female insects there is a part 'analogous to the uterus' (*GA* 721a21). For other insects 'too small to observe' (*GA* 721a25), and for the testaceans, about which 'there is no certainty' (*GA* 720b), there may be no uterine parts because these animals may reproduce not by coupling, but spontaneously or by budding. Like considerations apply to male testes; for instance, fishes and snakes lack testes, but analogously possess two spermatic channels (*GA* 716b15).

[108]*PA* 645b22.

[109]*IA* 708a9.

[110]*HA* 615a25.

under different material conditions, to have the same kinds of mouth or ears; for 'nature always aims to realize that which is the best possible under given conditions'.[111] This is why each distinct kind of animal just *is* the uniquely integrated complex of its function-parts: *e.g.* birds of chase and prey have keen sight, strong and large wings, thick legs, curved claws and a curved beak.[112] Such are the ontological presuppositions of real division.

Aristotle repeatedly emphasizes that such a division is *not* deductive, at least in the sense of yielding demonstrations. Furthermore, despite the aspect of quantification and implication, it would be a mistake to view division as a deductive exercise meant to enable the number and kinds of last species to be *inferred*, or predicted. Rather, division can succeed only if preceded, or accompanied, by a survey of each and every basic sort 'like sparrow or crane and such'.[113] Division thus aims to reveal the essential natures of natural kinds which have been *independently* apprehended on the basis of overall morphological aspect and habits of life.[114] It does this by reducing the habitual structures of pre-theoretical kinds to characteristic formulae, that is, by mentioning only those minimal aspects of overall morphology which serve to functionally distinguish each kind from every other kind.

Accordingly, Aristotle did not endeavor to deduce the basic kinds of the living world, only to order what was antecedently held by ordinary common sense. In this regard, he sharply differed from Linnaeus and the other classical systematists who sought to tabulate the existence of unknown kinds. True, there are striking similarities between the method outlined in the *Politica* and *de Partibus Animalium* and Linnaeus's *Systema Naturae*.[115] In fact, Linnaeus went further than anyone else in attempting to convert the method of multiple differentiation into a complete classification of the animal kingdom; he also insisted, as did Aristotle, that division not violate common sense. But by, *e.g.*, shifting attention from kinds of mouth to numbers of teeth, and explicitly excluding consideration of stomachs and all internal organs, Linnaeus clearly showed himself more interested in computing the visible order than in defining its (causal) nature.

It is not that Aristotle rejected such an approach. He simply had no need of it. With only 30 or so exotic species to worry about, and less than 600 indigenous species to survey, his situation was fundamentally no different from that of local folk the world over.[116] In such a circumstance, there is no concern with reconciling the partial orders of many different local

[111] *GA* 716b4 – 5.
[112] *PA* III, 1; IV, 12.
[113] *PA* 644a25 – 33.
[114] *PA* 1, 4.
[115] Linnaeus, *Systema Naturae* (Leiden: Theodorum Haak, 1734).
[116] *Cf.* P. Raven, B. Berlin and D. Breedlove, 'The Origins of Taxonomy', *Science* 174 (1971).

environments scattered over the various corners of the earth. There is, therefore, no warrant to systematically fill in the lacunae. Consequently, Aristotle did not endeavor to predict a single, world-wide order in which all organisms, known and as yet unknown, would naturally fall into place.

## VI

There is, it appears, a universal tendency of folk-biological classification to exhaustively partition the local fauna and flora into mutually exclusive basic types along a *fundamentum relationis*. Aristotle uses the term *atomon eidos* to refer to these basic kinds.[117] Each type is readily distinguished from every other type at a glance according to its overall morphological aspect — what the European herbalists would come to call its *habitus* (*primo intuitu ex facie externa*). This feature may well owe to an innate disposition of the human mind to structure all, and only, living kinds in this way.[118] It is the pre-theoretical fact of a complete series of well-bounded natural sorts which makes the common sense living world the paradigm for Aristotelian science, and the prime candidate for a real division.

First, it fulfills the logical pre-condition on scientific explanation, namely, that *all* the species of a natural domain must be known for proper induction of the general principle.[119] Second, it holds speculation to the epistemic constraint that one must 'first take the appearances in respect to each kind, and only then go on to speak of their causes'.[120] Third, it provides the *prima facie* evidence that the substantive requirement of natural science can be met, *viz.*, that it can be shown how and why: 'the *for-something's-sake* is present in the works of nature most of all, and the end for which they have been composed or have come to be occupies the place of the beautiful'.[121]

In the *Politica*, Aristotle says that plants are for the sake of animals, and animals are for the sake of men.[122] Consistent with scholastic and biblical tradition, the usual interpretation of the statement is that plants exist *for the*

[117]According to Louis, 'Aristotle . . . gave to *eidos* the precise sense of species'. As for *genos*, this could apply to 'all groups other than species': *La découverte de la vie. Aristote* (Paris: Hermann, 1975), pp. 154–55. Yet, in Louis's own translation of the passage in *GA* where Aristotle discusses the relation between reproduction and basic kinds, the word 'species' (*espèce*) translates *eidos, genos* and even *phylon*: *De la génération des animaux* (trans. P. Louis) (Paris: Belles Lettres, 1961), 746a30–746b10. Moreover, Aristotle acutally applies the term *eidos* to higher-order groupings (*e.g.* the *eide anonyma*), and not only (but then also) when they are considered in the formal mode. The term *atomon eidos*, however, *is* used to refer to a basic kind whenever it refers to something other than an individual.

[118]See S. Atran, 'Natural Classification', *Social Science Information* **20** (1981).

[119]*APo.* 68b27.

[120]*PA* 640a14.

[121]*PA* 645a24–26.

[122]*Pol.* 1266b16.

*purpose* of providing animals sustenance, and that animals, in turn, exist so as to provide food and service to men. Against this Balme argues:

> Aristotle's comments on natural economy in fact refer . . . not to a general economy of nature. . . Aristotle means only that *A* is for the sake of *B* in the sense that *B* cannot happen without *A*. Man depends upon animals for food, and animals upon plants; if the latter were not present, the former could not be.[123]

In other words, Aristotle's teleology implies no hypostasization of nature. Nonetheless, it is precisely the *pre-theoretical* conception of a 'general economy of nature' which provides the plausible grounds for such a teleology:

> All things are ordered together somehow; but not in the same manner — fishes, birds, plants; and the world is not such that one thing has nothing to do with another, but they are connected: because everything is ordered with respect to a single end . . . all beings must dissolve into their elements . . . by which all conspire to a harmony of the ensemble.[124]

In this conception, the living world appears as an integrated whole of interacting parts. Here no one kind exists solely for the sake of another. As a result, and contrary to most historical opinion, so-called 'primitive' classification is never primarily utilitarian. Take the rather typical case of the Pinatubo Negritos of the Philippines. Not only do they recognize hundreds of kinds of plants and animals, but they also have a detailed knowledge of the habits and behavior of each. The natives, it seems, classify animals and insects of no apparent benefit or danger because of their intimate connection with plant life. Conversely, they 'are also interested in plants which are of no direct use to them, because of their significant links with the animals and insect world'.[125]

Plants and animals thus seem to be classified in preliterate societies within a totalizing framework wherein the reciprocal roles of all readily perceptible plant and animal groupings in the economy of nature are appreciated. Bulmer refers this totalizing aspect of folk-biological classification to an 'ecological' perspective:

> These continuities are particularly obvious where they occur in plants and animals which operate at an ecological scale approximately equivalent to that of man. . . . When I say an ecological perspective is vital to interpreting folk systems of

[123]See D. Balme's notes to *Aristotle's De Partibus Animalium I and De Generatione Animalium I* (Oxford: Clarendon Press, 1972), p. 96.

[124]*Metaph.* 1075a.

[125]R. Fox, 'The Pinatubo Negritos: Their Useful Plants and Material Culture', *The Philippine Journal of Science* **81** (1953), 187.

> classification of plants and animals, I want to stress that . . . a vast amount of apparently accurate knowledge is possessed about aspects of the integration of plant and animal communities — of the topographic, soil and climate conditions required by wild as well as cultivated plants, of the kinds of plants and their parts which provide food or refuge for different kinds of animals, of which animals prey upon other animals, and the role of birds and mammals in the propogation and dispersal of plants.[126]

As a rule, the basic folk kind is an ecological species in that it is restricted to a particular niche.[127] Its morphological constitution, as well as its courtship behavior, is usually well correlated with ecological strategies.[128] But ecological strategy is the limiting material factor in the determination of kinds, and *not* reproduction of like from like.[129] In short, these basic folk-biological sorts denote morphologically, behaviorally and geographically well-bounded groups of organisms. More often than not, they correspond within very predictible limits to local, 'nondimensional',[130] or 'morphogeographical',[131] biological species, that is, species viewed within the confines of an ecosystem bounded by a human habitat,[132] and over the space of but a few generations. This is most clearly the case for those organisms which are visibly manifest, including most vertebrates and flowering plants.

These basic types, however, also exhibit features of the (taxonomical) genus inasmuch as they are recognizable from their gross morphological '*aspect*, without recourse to technical characters not readily visible to the naked eye'.[133] This state of affairs underlies much of the confused, and seemingly inexhaustible controversy over whether the species or the genus constitutes the

[126]R. Bulmer, 'Folk Biology in the New Guinea Highlands', *Social Science Information* **13** (1974), 12.

[127]R. MacArthur, *Geographical Ecology: Patterns in the Distribution of Species* (New York: Harper and Row, 1972).

[128]*Cf.* E. Hunn, 'A Measure of the Degree of Correspondence of Folk to Scientific Biological Classification', *American Ethnologist* **2** (1975), 320; J. Diamond, 'Zoological Classification System of a Primitive People', *Science* **15** (1966), 1104.

[129]It is this circumstance which may well lie behind Aristotle's acceptance of the following account, and not any inclination to pay heed to fabulous stories: 'One says that the proverb pertaining to Lybia, according to which Lybia always produces something new, owes to the animals of different families (*phyla*) uniting: as water is scarce, they meet in the small number of places that have sources, and they couple, even if they are not of the same species (*eidos*)' (*GA* 746b611; *HA* 606b19). Thus, unusual environmental circumstances may create new kinds of animals, although once these kinds emerge they may then go on to reproduce themselves 'naturally', that is, by 'like being generated from like'.

[130]E. Mayr, *Principles of Systematic Zoology*, p. 37.

[131]P. Davis and V. Heywood, *Principles of Angiosperm Taxonomy* (New York: D. Van Nostrand, 1963).

[132]The partitioning of the local flora and fauna into mutually exclusive nondimensional species is only 'ideal' inasmuch as the frontiers of a human habitat do not always correspond to the natural ecosystemic boundaries of a set of sympatric species; and because, e.g., migrating birds may be only intermittently or vaguely represented.

[133]A. Cronquist, *The Evolution and Classification of Flowering Plants* (New York: Houghton and Mifflin, 1968), p. 30; G. Simpson, *Principles of Animal Taxonomy*, pp. 11 – 12, 23, 199.

historically primitive and primary natural grouping. The controversy, however, is a dead letter. This is because the species – genus distinction is not pertinent to a *local* understanding of the natural environment, that is, within the phenomenal dimensions of everyday human existence. Even the scientist has little need of the distinction in the field, since most local species are usually isolated from their congeners. This means that in any local environment, species and genus are, more often than not, extensionally equivalent. It is only with the post-Renaissance discovery of a baffling array of new organisms that the need arose to distinguish a privileged rank of mnemonically accessible taxa immediately superordinate to the species. Before Morison, or more surely before Tournefort, 'genus' meant *any* level above the basic level.[134]

Given this pre-theoretical array of basically distinct kinds in the local environment, Aristotle sought to investigate the 'causes' of their continuance over time, their diversity and ultimate connectedness in nature's overall plan. Since all life is perishable, continuance can only be renewal — a constant coming-into-being. The renewal of any particular kind is conditional upon three factors: the availability of the right sort of matter, the reliability of material forces, and the presence of a form-potential for combining matter in kind with the aid of material forces. The female menses is responsible for the first, the sun, wind, climate and available nutriments for the second, and the male seed for the third.

The third factor is determinant (*aitia kai archai*) inasmuch as it conveys the life-giving soul. The form-potential is invariably in the father's image; however, the actual form which is realized in the offspring can only be said to bear a species-likeness:

> Creatures produce others of their kind, animals producing animals and plants producing plants, in order that they may share, so far as their several natures allow, in the eternal and divine. That is the ideal for which all creatures strive, and which determines their behavior, so far as their behavior is natural. But since mortal things cannot share continuously in the eternal and divine (because nothing that perishes can preserve its identity nor remain numerically one), they partake of eternity and divinity in the one way that is open to them, and with unequal success; achieving immortality not in themselves, but vicariously through their offspring, which, though distinct individuals, are one with them specifically (*eidei*).[135]. . . That is why there is always a kind (*genos*) — of men and of animals and of plants.[136]

Thus, individuals strive to perpetuate themselves though sequences of ancestor generating descendant. The species arises as the product of this effort at serial immortality.

[134]Morison, *Plantarum Historiae Universalis Oxoniensis*, Vol. 1 (Oxford: Sheldoniano, 1680); Tournefort, *Elémens de Botanique* (Paris: Imprimerie Royale, 1694), pp. 13 – 14.

[135]*de An.* 415a26 – b1.

[136]*GA* 731b25 – 732a2.

Even so, there is no indication whatever that such a self-generating lineage is ever eternal or immutable in fact. It is not the case that kinds exist 'as Aristotle would have it, from all eternity . . . by the process of like generating like'.[137] The only 'kinds' which Aristotle mentions as even approaching eternity are the common sense ontological types: man, animal and plant. Never does Aristotle submit that 'natural species are unchanging' because he 'like most other Greek naturalists, firmly believed in the permanence of natural species as we know them'.[138] For Aristotle, species are not characterized by the genealogical progression of immutable forms from individual to individual; nor is any natural *genos* defined by kinship *per se*. Rather, natural groups are the result of resemblance in the process of *genesis* — a characteristic process marked by a *range* of active (male) form-potentials, passive (female) material-potentials and intrusive (environmental) element-potentials. The species qua universal is nothing more than potential.

Material happenstance (from insufficiency of coction to the heat of the South Wind) unavoidably deflects the unfolding of the causal process from its ideal course. As a result, the individual's actual form, that is, its spatio-temporal 'career',[139] is always somewhat different from its sire's. By default, the offspring tends to resemble the more weakly determined form of one of its ancestors. If no individual influence is dominant 'there remains only what is common': the species as a limit at which form and matter are compatible.[140]

Now, any actual combination of matter and movement is contingent upon the state of the world at any given time. Since the material state of the world is partially the result of chance (*automaton*), there is no guarantee that the causal process will always develop as it should; indeed, it may never do so. A species, therefore, can be nothing more than a lawful *tendency* in nature. It is not even the empirical ideal: that ideal is a perfect actual copy of the 'irreducible potential to form' inherited from the father.[141] Yet, even species-likeness may not be obtained. Hybrids are but the imperfectly formed matter of some higher genus (in which case the higher genus becomes the last species), and monsters may be so ill-formed (lit. 'amorphous') as to be recognizable only as Animal.

Species-likeness, however, is 'natural', whereas the generic-likeness of

[137]P. Sloan, 'John Locke, John Ray, and the Problem of Natural System', *Journal of the History of Biology* **5** (1972), 2.

[138]G. E. R. Lloyd, *Aristotle: The Growth and Structure of His Thought* (Cambridge, U.K.: Cambridge University Press, 1980), pp. 88 – 89.

[139]*Cf.* N. White, 'Origins of Aristotle's Essentialism', *Review of Metaphysics* **26** (1972), 78.

[140]*GA* 768b10. A nature is an ordered pair of compatible (species-specific) male and female potentials.

[141]A. Gotthelf, 'Aristotle's Conception of Final Causality', *Review of Metaphysics* **30** (1976). By 'irreducible' Gotthelf means that Aristotle believed the male influence in the process of genesis could not be reduced to the sum of contingent material processes. Given the poor state of chemistry at the time, this teleological effect was a plausible *empirical* supposition pending evidence to the contrary.

hybrids and monsters is not. The species is natural not because it is an eternally existing type. It is natural because it is the optimal morpho – behavioral career naturally available to an individual generated in the normal way, and raised in normal surroundings. It is a naturally occurring empirical 'necessity' — part of nature's ontological fold — which is nevertheless conditional upon an ideal constellation of material circumstances that may never, in fact, obtain. Nor must this necessity be eternal, since the normal conditions for generation and growth may shift and nature's optimal course along with them.[142]

Thus, 'certain animals became (*egeneto*) quadrupeds because their soul could not support their weight'; for, it was 'inevitable' that 'nature gave' to quadrupeds forelimbs, instead of hands and arms, so that they could be placed under the body for support.[143] This does not mean that Aristotle had a doctrine of 'natural selection', but he did believe that those kinds which do exist do so in virtue of their *materially* adapted nature.[144]

Even viewed as a typical pattern, the Aristotelian species does not entail the view that all variation is "trivial and irrelevant," as Mayr claims.[145] On the contrary, for Aristotle, the investigation of variation, or rather deviation, afforded a means of ascertaining the extent and efficacy of those causal factors which could reveal nature's underlying order and connection. Additionally, it is only because such standardized referents were posited that variation, and ultimately speciation, could be discerned.

[142]So far as I am aware, Cesalpino was the first to argue for the eternity of the species based on the principle of like propagating like by seeds: *De Plantis Libri XVI* (Florence: Marescot, 1583), pp. 1; 28. He considers individuals *sub specie aeternitatis*, and not merely *universalitatis*.

[143]*PA* 686b1.

[144]*HA* 615a25. Although Aristotle never embraces a doctrine of 'survival of the fittest', his biology is compatible with some versions of it, though *not* with Empedocles's. For what survived in Empedocles's scheme were not so much whole organisms which gradually succeeded in acquiring adaptive parts, but disconnected parts which managed to unite by chance into functioning complexes. (*On Nature* frs. 57 – 61)

[145]In his recent book, *The Growth of Biological Thought* (Cambridge, Massachusetts: Harvard, 1982), Mayr offers a more nuanced version of the role of essentialism in the history of biology. No longer is progress exclusively attributed to empirically minded thinkers hardly tainted by dogmatic typology; rather, it is the fact that within the thoughts of the great innovators the non-essentialist element eventually managed to prevail. Still, what counts as good in biological history is what has been purged of all 'essentialism'.

Take the case of Aristotle. For Mayr, 'the Greek philosophers, including Aristotle, were primarily rationalists' (p. 25). Nevertheless, Aristotle, 'far more than his predecessors, was an empiricist' (p. 88). Thus, although Plato and Aristotle entertained a notion of *eidos*, they 'defined it differently'. Aristotle's *eidos* is a 'teleonomic' principle which 'performed in Aristotle's thinking precisely what the genetic program of a modern biologist performs'. In contrast, Plato 'posited an outside force to explain the regularlity of nature and especially its tendency toward reaching complex goals'. But Aristotle also illegitimately applied his teleology 'to the universe as a whole': 'so much in the universe reflects seeming purpose that final causation must be postulated' (p. 50). As to classification, Aristotle proceeded 'in a very modern way' by a 'commonsense phenetic approach' (p. 151). Hence, it is 'not legitimate to designate [logical division] as Aristotelian', since Aristotle 'specifically ridicules the dichotomous division as a classifying principle'.

This account, though, seriously misconstrues the relationship between Aristotle and the subsequent history of systematics. First, Aristotle was neither rationalist nor empiricist, at least in any modern sense. He did not believe, as post-Cartesian rationalists do, that intuitive reason could provide the

## VII

Consider, now, the 'largest kinds' (*megista gene*): man and the viviparous quadrupeds, the oviparous quadrupeds and footless animals, birds, fish, cetacea (the sanguineous animals); cephalopods, crustacea, testacea, insects (the bloodless animals).[146] Aristotle implies that the listing of bloodless animals is complete.[147] As for the sanguineous animals, although the groups mentioned include most vertebrate forms, there are those which are 'intermediate' between these groups, such as the monkey and the bat. According to G.E.R. Lloyd, these groupings are the product of a complex and novel way of distinguishing natural groups by multiple criteria of function and form.[148] For anthropologists familiar with folk zoology, however, except for man and the bloodless groups, the *megista gene* are fundamentally no different from those major 'life-forms' found in folk zoological classifications everywhere.[149] Aristotle himself emphasizes that 'one should try to take the animals by kinds in the way already shown by popular distinction between *bird* and *fish* kind', inasmuch as they are 'natural' (*i.e.* should not be split) and 'rightly distinguished'.[150]

A salient characteristic of folk-biological life-forms, be they zoological or botanical (*e.g.* tree, herb, shrub), is that they seem to partition the conceptual

foundations of knowledge. Nor was he empiricist in the sense pheneticists tend to be; for pheneticists reject the idea that common sense intuition has any privileged say as to what counts as a significant empirical feature, or that common sense can provide a clue on how to go about assessing overall similarities. In their view, science advances only to the extent that it is able to avoid the prejudicial influences of 'non-operational' theories and ordinary intuitions. Furthermore, Aristotle did not use the empirical data to *test* the predictions of competing theories in the way modern scientists do; so that even the most liberal interpretation of 'empiricism' fails to apply to him. In brief, Aristotle's 'empiricism' is simply the commonsensism of ordinary folk, not modern science; though Mayr further confuses the point when he erringly asserts that the first kinds named by 'natives' are 'of course, those of immediate concern to man . . . or possessors of magical qualities' (p. 134).

Mayr's view of Aristotle's teleology is also unacceptable. True, one sense of *eidos* does refer to the individual as a pre-set hereditary program in *GA*. But this non-material program is as far from a genetic notion of program as Empedocles's 'survival of the fittest' is from natural selection, or as Epicurean atomism is from quantum physics. As to Aristotle's invocation of 'purpose' in nature, this is no more than a simile: 'Nature, like the mind, acts with reference to purpose (*heneka tou*), and this purpose is its end (*telos*).' (*de An.* II, 4) Yet, even the simile is nowhere to be found in his biological works. As for Plato, Socrates merely tells us in the *Phaedo* what teleological *aitia* should explain, but says he has not found them.

Finally, consider the matter of division and classification. Aristotle does not 'ridicule' dichotomous division as a classifying principle, nor is it correct to say that he rejected logical division as a method of classifying. What Aristotle most strongly objects to is not division, or even dichotomous division as such, but dichotomies which use only privative (negative) differentiae, and divisions which use accidents, instead of essential features, as differences.

[146] *HA* 490b7 f.

[147] *PA* 523b1; *GA* 720b2.

[148] Lloyd, 'The Development of Aristotle's Theory of the Classification of Animals', p. 73.

[149] *Cf.* C. Brown, 'Folkzoological Life-Forms: Their Universality and Growth', *American Anthropologist* **81** (1979).

[150] *PA* 642b10, 643b11, 644a15 – 16.

categories of living kinds (*i.e.* the category of plants or the category of animals) into a contrastive lexical field. The system of lexical markings thus constitutes a pre-theoretical *fundamentum divisionis* into features which are 'positive and opposed'. The opposition may be along a single perceptible dimension (*e.g.* size, stem habit, mode of locomotion, skin covering, *etc.*) or simultaneously along several dimensions. In the first case a single feature is diagnostic for each life-form, in the latter it is a Boolean function of features.[151]

Because life-forms are often pre-theoretically arranged along multiple *fundamenta*, it follows logically in such cases that any 'intermediate' form can be uniquely fixed by a conjunction of features with respect to all other life-forms. Their intermediate status is thus psychological, not logical, in that it owes to an appreciation of the substantive fact that life-forms usually tend be rather large groupings of equal scope (*i.e.* number and diversity of constituent species).[152] Within any given system of folk-biological classification, the choice of whether to include a grouping which diverges greatly from the other life-forms in terms of habits of life, but which is narrow in scope, depends upon the general disposition of fauna and flora in the local environment and the optimal mnemonic strategy for disposing such information.[153] Some cultures, for example, give the bat a separate life-form status;[154] others include bats with the bird.[155]

It appears, then, that Leblond is born out in his claim that Aristotle 'is inspired by common sense (*sens commun*) in choosing the largest genera'. Leblond goes on to argue, however, that Aristotle's use of life-forms owes, in part, to his appreciation of their 'complex reality' and, in part, to his 'habitually conformist attitude'.[156] It is this latter factor which supposedly encouraged Aristotle's theoretical timidity and prevented him from offering a bold new approach to classification once he had rightly criticized the Platonist tendency to lose touch with reality. Yet, there is hardly a trace of 'conformism' in Aristotle's attitude towards common sense: for Aristotle explicity argues that common sense should be used only where manifestly correct,[157] and even then it is not, by itself, adequate to the task of the scientist.[158] Moreover, his introduction of man among the life-forms, and his elaboration of the invertebrate life-forms, represent momentous alterations in traditional ways of

[151]S. Atran, 'Natural Classification', section 10.

[152]B. Berlin, D. Breedlove and P. Raven, 'General Principles of Classification and Nomenclature in Folk Biology', *American Anthropologist* 75 (1973).

[153]S. Atran, 'Natural Classification', sections 10–11.

[154]E. Hunn, *Tzeltal Folk Zoology* (New York: Academic Press, 1977).

[155]R. Bulmer, 'Folk Biology in the New Guinea Highlands, *Social Science Information* 13 (1974).

[156]J. Leblond, *Aristote: Philosophe de la Vie* (Paris: Aubier, 1945), p. 176 n.116; *cf.* Leblond, *Logique et Methode chez Aristote* (Paris: Vrin, 1939), pp. 295; 298.

[157]*PA* 644a16.

[158]*Ph.* 1, 1.

apprehending living nature — changes whose effects continued to be vigorously debated (and with specific reference to Aristotle) by the likes of Linnaeus, Buffon, Lamarck and Cuvier.

For most folk, man is the standard for a comparative appreciation of the animals, but is not himself an object of such comparison. The Rangi of Tanzania are rather typical in this respect:

> To Rangi, the resemblance between '*vanyama*' [mammals] and people is most strikingly seen in their having blood, in their genitals and in their manner of giving birth. However, to say that they are more like people than are, say, *ndee* [birds] or *makoki* [bugs] is not to say that people are '*vanyama*'. That would be insulting to Rangi, as such comparisons usually are in other societies. The category *vantu* [people] is separate from the [other life-forms]. Implicitly, *vantu* are the subjects who do the classifying, not the objects which are classified.[159]

Perhaps the most striking characteristic of this anthropocentric view of the animal kingdom is that while the vertebrates are distinguished into major life-forms, the invertebrates usually are not; rather, they are thrown together under the single 'residual' life-form 'bug' (or something of the sort). This is because any readily visible analogs to the morphological and behavioral standards of man and his vertebrate cousins lack resolution. For example, among the Hill Pandaram of South India, *puchi* is 'a residual category . . . which includes insects, crustaceans and several other categories'.[160] Similar considerations apply to the categories *agbiro* in Zandeland,[161] *makoki* in Rangi and *remes* (or *sheretz*) for the ancient Hebrews.[162] Generally speaking, whereas the vertebrate life-forms often constitute distinct classes within a single phylum, the invertebrate life-form 'is distinctly heterogeneous, demonstrating little criteria clustering',[163] often including representatives of many different classes and even phyla.

Although Aristotle never completely abandoned this anthropocentric telescoping of the animal kingdom, he greatly enhanced its resolution. First, he included man as an object along with the other animals.[164] In Aristotle's

[159]J. Kesby, 'The Rangi Classification of Animals and Plants', *Classifications in Their Social Contexts*, R. Ellen and D. Reason (eds.) (New York: Academic Press, 1979), p. 44.

[160]B. Morris, 'Whither the Savage Mind? Notes on the Natural Taxonomies of a Hunting and Gathering People', *Man* **11** (1976).

[161]E. Evans-Pritchard, 'Notes on Some Animals in Zandeland', *Man* **63** (1963).

[162]*Genesis* I, 1; *Leviticus*, XI.

[163]Brown, 'Folk Zoological Life-Forms', p. 806.

[164]In the *Gorgias* Plato asks whether or not man is an animal and answers affirmatively. In the *Politics* he takes the young Socrates to task for dividing the animals into human and non-human, and in the *Republic* (596A3) he refers to 'men and the other animals'. There is also evidence in the Hippocratic tradition which places man among the animals (*cf. On Regime I*, para. 25), as there is in pre-Socratic philosophy: for example, in Xenophanes's attempt to reduce anthropomorphism to absurdity (fr. 15).

scheme, man is to serve as the standard of reference for a comparative functional morphology of the animal kingdom. The choice of man is justified, not only because man is 'the best known' of the animals,[165] but because his functional morphology is the most 'complex',[166] 'natural'[167] and 'perfected'.[168] All the functions and parts of the other animals are less finished and apparent — this lack of perfectedness being measured by 'small differences' down the ladder of being which commences with man and ends with the testaceans.[169]

Thus, while it would be a mistake to view Aristotle as the precursor of Cuvier and the initiator of a general functional anatomy which compares animals to one another, he does provide at least the first comparative morphology which allows one to systematically cross-check other animals with man. Indeed, it is this systematic effort to exhaustively compare the structures and functions of other animals with man that led Aristotle to introduce the concept of analogy to unify all of life. Henceforth it would be possible not only to scrutinize the hitherto inscrutable invertebrates, even plants could ultimately be incorporated into the same systematic framework.[170]

The importance of this procedure for the development of natural history can hardly be overestimated, although its effects were intermittent for the better part of two millenia. Not until Linnaeus managed to defy charges of heresy and re-introduce man into his classification of animals could their be further advance in understanding the organization of animal kinds.[171] As late as the middle of the eighteenth century, Buffon felt compelled to defend Aristotle and insist that: 'the first truth which comes out of a serious examination of nature, is a truth perhaps humiliating for man; it is that he must order himself within the class of animals'.[172]

It was Lamarck, however, who first grasped the systematic import of Aristotle's concluding remarks to the theoretical discussion of systematic zoology in *de Partibus Animalium*: 'we must avoid a childish distaste for examining the less valued animals. For in all natural things there is something wonderful'. Although Swammerdam, Réaumur and others had taken up the study of invertebrates, there was to be no significant improvement in understanding their diversity relative to the vertebrates before Lamarck.[173] In

[165] *HA* 491a19.

[166] *HA* 539a4.

[167] *PA* 656a10; *IA* 706a19, 706b9.

[168] *HA* 608b4.

[169] *HA* 588a19 – b21. The idea of a *scala naturae* is suggested in Plato's *Timaeus*.

[170] *PA* 686b35, *GA* 717a21, 741b35; *de An.* II, 1.

[171] Linnaeus, *Systema Naturae*. See also *Philosophia botanica* (Stockholm: G. Kiesewetter, 1751), section 153: 'A natural instinct teaches us to know first those objects closest to us, and at length the smallest ones; for example, Man, Quadrupeds, Birds, Fish, Insects, Mites, or firstly the large Plants, lastly the smallest mosses'.

[172] Buffon, *Histoire naturelle*, Vol. I (Paris: Imprimerie Royale, 1749), p. 12

[173] Buffon and Daubenton failed to understand Aristotle's position on the invertebrates. (*Hist. nat.*, Vol. 4 (1753), 149) They thought that Aristotle's rejection of dichotomy implied that the division into blooded and bloodless groups was to be taken as unreal. This is clear from their critique of

the spirit of Aristotle, Lamarck believed that the study of invertebrates might yield 'still more enlightenments' that could eventually lead to that 'knowledge most important for arriving at the discovery of [nature's] laws and for determining its process (*marche*)'.[174]

Like Aristotle, however, Lamarck was also bound to an anthropocentric perspective using man as the standard of reference.[175] It was Cuvier who finally forsook the progressive scale of nature and thereby made conceivable the idea of a non-linear reticulate organization of the living world.[176] This he did by unhinging inquiry into living organization from anthropocentric visibility. He rejected common sense's overriding concern with the readily visible patterns of organization. He dismissed the notion of 'invertebrate' as a phenomenal residual of no biological consequence: the boneless, bloodless 'bugs' that were left over from the common man's concern with the vertebrates (*i.e.* the 'man-like' creatures of blood and bone). All the vertebrate categories would be united under one anatomical *embranchement* roughly corresponding to the modern phylum of vertebrates; and the invertebrates would be reconstituted as three distinct *embranchements*, as different from one another as each from the vertebrate phylum considered in its entirety. Cosmically, insects were raised to the level of man and man was reduced to an object on a par with the lowliest bug. The subjective goal of natural history — to explain the world *in relation to ourselves* — was replaced by the objective ideal of biology — to explain the nature of living things *in themselves*. The phenomenal order of things was thus overturned, and then reversed in Darwin's account of the humble animal origins of man. But it is only because the bugs became subject to the same systematic scrutiny as man himself, that such advances were possible at all. It is curious that so many natural historians before Darwin acknowledged this debt to Aristotle, but few after have done so.[177]

Ray's 'misuse' of the distinction in his effort to establish a classification of animals in *Synopsis Methodica Animalium* (London: Smith and Walford, 1693). But Aristotle only argues that bloodless, as non-matter, cannot be a differentia of animal. 'Bloodless', then, really refers to animals whose matter is analogous to blood (*HA* 532b7; *PA* 655a28 f., 678a31 – 34; *GA* 726b36; *cf.* Pliny, *Historiarum Mundi* XI, 2). As Lamarck rightly noted, Aristotle's bloodless group corresponds to the invertebrates. The fact that Aristotle chose to emphasize blood, rather than bone, owes to the blood's putative connection with life-giving 'heat'.

[174]Lamarck, *Philosophie zoologique* (Paris: Dentu, 1809), *Discours préliminaire.*

[175]*Ibid.*: 'in effect, what is more interesting in the observation of nature than that of animals; than the consideration of their organization with that of man'. Later, Lamarck adopted a reticulate zoological order: *Histoire naturelle des animaux sans vertèbres,* Vol. 1 (Paris: Déterville, 1815). But this was only after Cuvier had already done so.

[176]Cuvier, *Le Règne animal,* Vol. 1 (2nd edn.) (Paris: Déterville, 1829), pp. xx – xxij.

[177]Darwin's letter to Ogle is often cited as an indication of his debt to Aristotle: 'Linnaeus and Cuvier have been my two gods, though in very different ways, but they were mere schoolboys to old Aristotle'. But Darwin's appreciation came long after he had developed his theory of natural selection, and was based on a tendentious reading of 'a sketch of the principles of natural selection' into the Stagirite's works (see S. Byl, 'Le jugement de Darwin sur Aristote', *Antiquité classique* **42** (1973). Darwin's debt to Aristotle is more likely indirect, via Linnaeus and Cuvier.

## VIII

Given the pre-theoretical character of folk-biological taxonomy, Aristotle's problem of the reduction of habitual structures to their essential parts translates as the problem of reconciling the pre-theoretical divisional character of life-forms with the pre-theoretical relational character of basic kinds. Aristotle's solution was to *superimpose* one logical system, *i.e.*, the contrastive hierarchy, upon another, *i.e.*, the ranked taxonomy.

In pre-theoretical taxonomy each level, or rank, corresponds to a fixed level of reality: the *megista gene* apply to all and only life-forms, the *atomon eidos* to each and every basic kind: robin, cat, pike and gnat are all of the same rank (that of the *atomon eidos*), not because they stand in inclusion relations to the same *genos*, but because they partition reality in commensurable ways. In the logical division which applies to organ-systems and their respective function-parts, however, *genos* and *eidos* do not represent fixed ranks corresponding to distinct levels of reality. Rather, any *genos* may be an *eidos* to some higher level *genos*. In such a scheme there are no fixed ranks, only relative levels of inclusion and contrast. Each *eidos* of a given *genos* must stand in 'positive opposition' to every other *eidos* of that *genos*. Every functional-part, then, is a 'contrary' of another functional-part at the same level of inclusion: *e.g.* fins, wings and feet are contrary function-parts of the organ-system of locomotion; split-winged and whole-winged are contraries of winged, etc. In order to determine the logical relationship between groups in a ranked taxonomy, though, no reference to inclusion or contrast is required, and the taxa compared may be disjoint: *e.g.* robin, gnat and fish stand in a definite relationship by virtue of their respective ranks, not by virtue of inclusion or contrariety.[178]

Although these two organizational schemas are logically distinct,[179] their

[178]An appreciation of the difference between rank and level of inclusion and contrast may help to explain the seemingly contradictory status of man in Aristotle. In *Top.* 1013a14 and *Metaph.* 1016a27 man is referred to as an *atomon eidos* and is listed along with such *eide* of vivparous quadrupeds as the horse and the dog in *HA* 490b18. Yet, in *HA* 505b25 man is listed among the *megista gene*. The difficultly is resolved if one considers man to be a *monospecific life-form*. Considered as a life-form, Man is in direct contrast to the other *megista gene*. Considered as a basic kind (the only representative of the life-form Man) man is in *indirect* contrast with the basic kinds of other life-forms. In *Metaph.* I.4, Aristotle allows that two species (*e.g.* justice and injustice) are in (indirect) contrast even if they belong to different genera (vice and virtue) so long as those genera are themselves in (direct) contrast. Accordingly, man and horse are species in indirect contrast, because their respective genera, Man and Viviparous Quadruped, are in direct contrast. Aristotle may have viewed the ostrich in a similar way (*PA* 697b13 – 26).

[179]Leblond (*op. cit.*, pp. 9, 59 n.3) argues that the use of *genos* and *eidos* in Aristotle's Logic derives from his Biology. Thus the fact that living organisms naturally tend to form groups embedded within groups presumably leads to the idea of a logical 'subalternation' of concepts by genus and species. To the contrary, Balme holds that the logical distinction was introduced into the biological works, though never strictly followed: D. Balme, 'GENOS and EIDOS in Aristotle's Biology', *Classical Quarterly* 12 (1962), 98. Both arguments are misleading, though Balme's less so: The

logical product yields an integral classification of the animal world. When the ranked taxonomy of life-forms and basic kinds is overlain by the grid of organ-systems and their functional parts, the result is simultaneously a ranking of all functional parts (by analogy, degree and identity) and a division of all phenomenal kinds (by means of a componential analysis of their vital parts). The disjoint kinds of common sense are thereby systematically 'assembled' into life's functional manifold; and life's vital systems, in turn, are 'differentiated' into viable kinds specifically adapted to the various exigencies of actual, material existence.

Recently, however, Pellegrin has proposed an altogether different interpretation of the object of Aristotle's biology.[180] In his view, Aristotle's aim is supposedly never a classification of all the readily apparent groupings of animals; rather, he aims at a definition of animal *natures* — not species *per se* — in terms of function-parts, each distinct nature being defined by its constituent complex of vital function-parts. Thus, it is possible, even likely, that among the kinds distinguished by common sense, it may be shown that some share natures. In that case it would be useless to define separately all of the kinds distinguished by common sense. Moreover, the kinds of common sense would not necessarily correspond to natural kinds; since a nature might subsume several kinds which common sense had not thought to put together (*e.g.* the 'anonymous' grouping of horned animals). The discovery of such natures and their causes would thus be to provide the arguments for demonstrations about natures, not an understanding of common sense taxa as such. For example, according to Aristotle we find that:

> No animal which is polydactyl has horns. The reason is that the horn is the only means of defense and polydactyl animals have different means of defending themselves. To some [Nature] has given claws, to others sharp teeth. . . .[181]

Thus, if we are told of the discovery of a polydactyl animal, we can immediately demonstrate that it is horn-less on the premiss — arrived at by division — that all polydactyls are horn-less. We also infer — by inspecting the terms of the division — that polydactyls must have something in lieu of horns. The ultimate goal of division in biology, therefore, is to provide the premisses for syllogisms demonstrating a functional understanding of natures. It is not to provide a

technical distinction in Aristotle's Logic has a different logical character than biological ranking. Logically, a genus is a substantial unity. Biologically, a genus is a fixed level of reality containing any number of substantial unities. The technical genus and the biological genus thus belong to different logical types. Aristotle also applied the technical distinction in his Biology; however, he apparently did not intend it to apply to kinds, or taxa, *tout court*, but to organ-systems and function-parts.

[180]Pellegrin, *La classification des Animaux chez Aristote.*

[181]*PA* III. 1.

complete division and assembly of the kinds of common sense.

For my part, it seems that Aristotle does believe a complete division of the kinds of common sense to be a necessary, if not sufficient, condition for a demonstrative understanding of the biological world. As we shall see, this necessary step could not succeed, given certain constraints which Aristotle imposes on his project. The problem which he never solves, and whose resolution is requisite to a complete division, involves a reduction of habitual structures to their essential parts. But before such a reduction could be systematically engaged, a *complete* knowledge of habitual structure would be needed. Aristotle does not belabor the point, though; not because pre-scientific groupings are 'non-aetiological' and therefore devoid of scientific interest, as Pellegrin claims,[182] but because such groupings are simply too obvious to warrant elaboration. Such groupings would be self-evident not only to Aristotle and the ordinary Greek layman of the time, but to common folk across cultures the world over, and likely in all times. This is so not only for life-forms and basic kinds, but for the 'anonymous' groups as well.[183]

Pellegrin's case goes something like this: Aristotle's biological investigations aim at science (*episteme*); science proceeds by syllogistic demonstration; such demonstrations are demonstrations of what is eternally true; but phenomenal kinds are not eternal; therefore Aristotle's investigations do not aim at a comprehensive understanding of phenomenal kinds as such. A crucial part of this argument turns on Aristotle's alleged use of *a priori* reasoning when presenting biological generalizations, together with his use of *ad hoc* interpretation when faced with apparently conflicting experience.

Take Aristotle's claim that all sanguineous animals have four feet. Yet, birds have wings and men have hands as forelimbs instead of feet. Nonetheless, argues Aristotle, they still have four appendages for support.[184] What, then, of snakes? Well, 'the curves they make are alternately concave and convex', so they do have four points of *support*. In effect, this is just another way of saying they have four feet.[185] Or, consider the argument that

[182]Pellegrin, *op. cit.*, p. 180.

[183]According to Balme, (*op. cit.*, 1962, p. 91): "If *eide anonyma* means [species] having non [name], it cannot refer to [lion, red-deer, *etc.*]. It must refer to groups that contain these types and are themselves contained within [the viviparous quadrupeds]. What, for example, is the name of the group that contains the lion? We have one ('Cat'), but Aristotle has not. All that he has at this level are *ta lophoura* ['longhaired tails', *i.e.* the equids], and the rest are nameless, *eide anonyma* therefore denotes . . . groups intermediate between the main [*megista gene*] and the [basic] types visible in nature." For the most part, these 'intermediate general groupings' to which Balme refers correspond to biological families or orders which are only occasionally named (*e.g. ta selachi*, the cartilaginous fish including rays and sharks); *cf.* Bourgey, *Observation et expérience chez Aristote*, pp. 135–37. For reasons I have discussed elsewhere, such groupings are recognized by folk but rarely named (they only first explicitly appear in systematic fashion in the eighteenth century when they begin to replace life-forms as the principal intuitive access to a complete taxonomy: S. Atran, 'Covert Fragmenta and the Origins of the Botanical Family', *Man* **18** (1983)).

[184]*PA* 639b11, 687a7.

[185]*IA* 707b22.

nature limits secretions of residue so that an animal which secretes residue in one way secretes proportionately less in other ways: an animal with developed horns does not have developed teeth,[186] and a furry animal, like the bear, does not have abundant reproductive parts.[187] Nevertheless, the hare has both much fur and much sperm.[188] The discrepancy is ostensibly resolved with the reasoning that the hare has such a superabundance of residue that its secretions can be excessively varied.

Pellegrin, like Joly before him,[189] points to such reasonings as evidence that Aristotle uses observation merely to illustrate arguments which accord with pre-conceived doctrines. This is not to deny that experience plays an indirect role by providing tentative correlations which Aristotle would then arrange into fixed arguments; nor is to ignore Aristotle's insightful use of observation to criticize *rival* theories: *e.g.* 'certain physiologers have tried to say such a part forms after such another, but they did not have a perfect experience of the facts'.[190] Such a 'perfect experience of the facts', however, means only enough experience as it takes to readily confirm the right arguments, namely, Aristotle's own demonstrations about functional connections between parts.

While it is possible to agree with the opinion that Aristotle does not use observations and experiments in the way modern scientists do, this in no way indicates that Aristotle believes *a priori* arguments to be wholly acceptable. First, experience of various kinds is required to ensure that the phrasing of the argument will be correct: *e.g.* that 'having four feet' and 'having four points of support' are equivalent. Second, the experience must be 'conclusive'[191] so that the arguments are easily verified and irrefutable. To this, one might counter that the generalizations of modern science are neither verifiable nor immunized against refutation by experience. But Aristotle's generalizations differ from those of modern science in that they are restricted to what was commonsensically known to *already* exist; hence, Aristotelian generalizations are numerically verifiable because the relevant experience is in principle exhaustive. Third, and most important, any argument showing the connection between parts of animals must take into consideration the fact that all parts are material, and that their connection exists partly in response to material necessity. Such necessity, however, does *not* operate on parts as such, but on the whole organism-in-its-environment. It is for this reason that the only underlying biological natures, are those which specifically underlie all and only

[186] *GA* 728b14.
[187] *PA* 658b1.
[188] *GA* 774a30.
[189] R. Joly, 'La Biologie d'Aristote', *Revue philosophique* **158** (1968).
[190] *GA* 742a16.
[191] *GA* 741a34.

readily visible kinds. This is what Aristotle's definition and classification of animals aims to show.[192]

## Conclusion

Aristotle shared a commitment with pre-scientific folk in regard to common sense epistemology and its accompanying phenomenal realism: that we do know to exist most, if not all, of the things that ordinary people think they know exist.[193] This commitment to common sense does not reflect a simple confusion of conventional meanings with reality. True, the ontology of the everyday world includes intuitional entities to which discursively definite meanings are attached in ordinary language; however, the necessity which informs the corresponding terms does *not* derive from verbal convention, but from the way the mind spontaneously organizes environmental information.

Yet, it is only by extending common sense in ways which render it fallible and susceptible to falsification that knowledge of the world can possibly advance beyond self-evident experience. What is obvious and familiar is thereby reinterpreted so as to coherently incorporate the unfamiliar and unusual. Such extensions, however, require profound empirical insight

[192]Joly (*op. cit.*, 1968, p. 253) writes: 'As for the classification of animals, it must be remembered that it is really a question of successive and divergent efforts. Aristotle himself notes that he is not the first to address the problem, and the treatise *On Regime* effectively supposes a very similar attempt at classification.' But Aristotle's acknowledgement of previous efforts at classification refers only to the 'popular' kinds of common sense. Such popular notions were neither cumulative nor divergent.

Jolly cites Palm's study of the relevant passages in *On Regime* II as evidence of the existence of a 'zoological system' before Aristotle: Joly, *Recherches sur le traité pseudo-hippocratique du régime* (Paris: Belles Lettres, 1960), p. 207; A. Palm. *Studien zur hippokratischen Schrift PERI DIATES* (Töbingen, 1933), pp. 5 – 40. But leaving aside Jaeger's critique of the inferences which Palm draws from the data, there is no evidence of any *principled* system of classification. True, many of the basic kinds and life-forms found in Aristotle are also found in the Hippocratic treatise. There are also groupings of intermediate generality, such as the leguminous plants which are assembled and distinguished on the basis of their visible aspect. Yet, nothing in the treatise goes much beyond what was probably commonsensically known to the average layman of the time. There is no attempt at reduction of habitual structure to essential parts, or even a systematic attempt at comparing and contrasting morphologies. When principles are introduced to explain the distinctions between animals, the principles are usually materialistic and the distinctions often irrelevant to the interrelations among animals; for example, game animals are essentially distinguished from domestic animals by their freer movements which enable them throw off moisture and thus be dryer. (secs. 47, 49) For Artistotle, though, the distinction between domestic and game animals was not pertinent to classification (*HA* 488a29 ff.).

Joly notes other ostensible similarities between Artistotle's biological work and *On Regime*. Both are said to rely heavily on *a priori* reasoning and ordinary, run of the mill experience. But the approach to knowledge in *On Regime* seems to run directly counter to Aristotle: 'men confide in their eyes rather than in reason, although the eyes are bad judges, even in their own domain; for my part, it is through reliance on reason that I expose this doctrine'. (I, 4; *cf. GA* 760b31 – 33).

[193]*Cf.* R. Chisholm, *Theories of Knowledge* (Englewood Cliffs, New Jersey: Prentice – Hall, 1977), p. 120.

coupled with bold theoretical speculation, since common sense alone provides no intuitions to confirm or deny.

One of Aristotle's most significant contributions to the advance of science was to banish all mystical, magical, mythico-religious and other 'symbolic' endeavors to cope with those rare, deviant, or otherwise uncommon phenomena which were inscrutable, or partially inscrutable, to common sense. For example, in order to account for deviance from the type, Aristotle supposed that either the normal environmental circumstances conducive to the organisms's proper development were lacking, or some 'accident' had occurred in the normal process of generation, or both. As a result, both normal variation and radical deviance were assimilated to the same explanatory framework. It is to Aristotle's lasting credit, therefore, that he was able to provide such a 'mistaken' extension of common sense. Henceforth, the mechanics of reproduction and the configuration of environmental circumstance would serve along with comparative functional morphology as the principal means for empirically investigating possible extensions of 'natural kind' beyond the phenomenally obvious. The types of common sense would thus gradually dissolve, first in geographical space, and then in evolutionary time, as the underlying unity of nature became increasingly accessible to the inquiries of later natural historians.

This is not to say that Aristotle understood *episteme* the way we understand science today, as the attempt to 'explain the known by the unknown'.[194] For Aristotle, the task was rather to reduce the unfamiliar to the familiar. The kinds of common sense were not only psychologically primary, but ontologically primary as well. Aristotle sought merely to connect phenomenal types in a systematic way, not to uncover nomological laws which could apply to 'real essences' or kinds different in nature from those of common sense. Accordingly, the ontological problem of the relationship between phenomenal and nomic kinds (such as that between phenotype and genotype) did not arise.

Instead, the problem which most agitated Aristotle, and which he failed to solve, was how to select the essential attributes of a type from its necessary accidents. In requiring that morphological features be linked to anatomical functions in order to qualify as candidates for essential parts, Aristotle introduced a contradiction into the natural history of animals that was not really treated until Lamarck. For phenomenal analysis to work, a complete knowledge of the relation of phenomenal structures to underlying functions was presumably needed. But from Aristotle to Buffon, any thorough and independent consideration of internal function was rejected as falling outside the range of ready verification by sense experience. Accordingly, the fact that similar morphologies might have quite different functions was not properly

[194]Popper, *Conjectures and Refutations*, p. 102.

understood; for this means that a division of morphological similarities and differences, even if functionally based, need not necessarily reflect the essential distinctions between kinds.[195]

Furthermore, Aristotle never seemed to doubt that a *complete* survey of the basic types of the living world was possible. He recognized that there were kinds not present in his own familiar environment, but he had no idea that there were orders of magnitude of difference between what was locally apparent and what existed worldwide. Given the (wrong) assumption that a phenomenal survey of naturally occurring kinds was practically complete, Aristotle hoped to find an appropriate system of logical indexing by the trial and error method. That system would be the expression of the functional laws for generating phenomenal types from their essential parts.

As long as analysis could be restricted to the kinds of a single *fundamentum relationis* the enterprise would seem plausible. By admitting exotic kinds to equal status with local types as the quest for the unity of nature demanded, Aristotle undermined the common sense basis for supposing that a complete inventory was readily at hand; though it was not until the end of the sixteenth century, after the 'Age of Exploration', that the problem was recognized. Actually, it was only after this recognition that the Aristotelian method of division became a largely *a priori* affair. According to Aristotle, division could only be posterior to a complete survey of kinds. For Linnaeus and the other classical systematists, however, division represented a rational means of accessing hitherto unknown types; but such preoccupation with rational prediction had more to do with concerns shared by Galileo, Descartes and Leibniz, than by Aristotle.

In sum, Aristotle's primary ontological commitment was to common sense 'appearances', that is, self-evident phenomenal reality. He went beyond common sense in trying to systematically generate such appearances from their underlying existence-determining principles. By so doing, he sought to relate disparate phenomenal kinds to one another, thereby converting them into natural kinds which could be subsumed under unifying laws. In this, he was little different from the creative modern scientist who proceeds by conceptual

[195]Aristotle had little factual knowledge of internal anatomy. He knew nothing of the muscles, for instance, nor of the differences between arteries and veins. He even believed the brain to be an organ whose primary function was to cool the blood. When he did use analogies from internal anatomy (*e.g.* gills and lungs) it was only to determine the *existence* of function. Once the functions were discovered they could allegedly be used as a sufficient means for reducing mophological features to essential characters; but without morphological agreement, essential agreement was not possible. Classification, then, would be based on morphological divisions that could be functionally interpreted, and not on functions as such. For Aristotle, the animal is not fundamentally an agglomeration of functional systems *per se* (digestion, reproduction, respiration, circulation, etc.) as with Cuvier. Rather, it is a functioning morphological complex consisting of eyes, feet, stomachs, lungs, etc.: 'The active functions reside in the composite parts: *e.g.* mastication of food in the mouth, locomotion in the feet or wings or analogous members' (*HA* I, 4).

generalization, that is, by showing that phenomena initially perceived to be different, follow from the same principles (*e.g.* planetary motion and earth-bound projectiles).

Unlike the modern scientist, though, he did not seek to explain away the known world of everyday experience as the epiphenomenal manifestation of some deeper, unseen reality; for Aristotle, all natural kinds were phenomenal. Rather, he aimed to improve our understanding of the world as we ordinarily see it, and know it to be — not by refuting 'naive realism', but by simplifying it. Practically, this meant knowing just what properties of one intuitive kind could be generalized to another: to know how *A* and *B* essentially differ, is to know what aspects of their functional morphology must necessarily be shared by identity, by degree or by analogy.

The first order of business was, therefore, an unambiguous presentation of intuitive species. But Aristotle's reification of the species as an empirical 'natural necessity' hardly reflects an idealist strain in Aristotle's thought. Not only did Aristotle not allow idealization to encompass that which was not, or could not plausibly be expected to be, readily perceived (*e.g.* objects moving in the void), but he limited all idealizations in the sublunary realm to probability only. Thus, common sense types were not to be mythically preserved at all costs despite the observation of individual variation. On the contrary, they would be accepted as real only to the extent that they made factual sense of such observations.

In this sense, teleology was not some intentional design brought in by analogy from elsewhere (e.g. purposeful human action). For Aristotle, it was the best hypothesis to account for the apparent regularity of the living world given the obtainable experience. Had others been able to show that the development of even the simplest part could be produced from a chance encounter of material elements (or even an externally forced experimental encounter), then Aristotle might well have embraced a materialistic aetiology without compromising his fundamental interest in locating the principles underlying the unity of nature.[196]

Beyond this point Aristotle's scheme flounders. This is because his

[196]Kirk (*op. cit.*, 1961, pp. 116 – 17) sees teleology arising from the 'anthropomorphising inclination of the Greek mind', though the inclination is supposedly more pronounced in Socrates than in Aristotle. Joly (*op. cit.*, 1968, p. 249) sees Aristotle's teleology as a 'regression' from the biology of the Hippocratics. Yet, nowhere in Aristotle (or Plato for that matter) is there the slightest inclination to animism (which Kirk erringly judges to be compatible with common sense despite the fact that it violates the logical boundary conditions on ordinary ontological types). There is only the occasional metaphor linking the process of physical maturation and the realization of thoughtful purpose. But metaphor is hardly a commitment to anything at all. Symbolic speculation, however, differs from metaphor in that the former lays a claim to truth while the latter does not. Such symbolic speculation (*e.g.* belief that the structure of the macrocosm informs that of the microcosm via inscrutable affinities and action at a distance) is still rampant in numerous treatises from the Hippocratic Corpus, though not in Aristotle.

conception of induction of general, connecting principles from the phenomenal data was untenable. By restricting the domain of evidence to common sense, explanation as he meant it could not be achieved. First, the limitation of functions to the visible organs precluded an understanding of functional anatomy adequate to the task at hand, *viz.*, a determination of (functionally based) connecting principles. Second, as these principles were supposed to extend to organic nature at large, and not simply to segments of local fauna (and flora), the extended domain of evidence could no longer be certifiably complete; however, without completeness, division would not be possible.

Still, the idea of conceptual generalization, *i.e.*, lawful unification of disparate phenomena, did considerably benefit the advance of science, though in a somewhat paradoxical way. To better understand the common sense world, Aristotle introduced a science of organizing principles to go beyond it. But what began as a quest to simplify common sense, eventually turned to an anticipation of unknown and invisible evidence. In the end, that nonphenomenal realm would become the principal domain of scientific inquiry and philosophical speculation about ontology. Yet, this does not mean that philosophers and historians of science today can afford to ignore common sense as the outworn vestige of some 'Stone Age Metaphysics': the epistemologist must contend with the fact that common sense remains our primary means of intuitive access to the otherwise largely unintuitive world of science; while the historian need consider that science progresses in no small measure in response to the insufficiency of our ordinary ways of dealing with extraordinary facts. To understand the scientific enterprise, then, is, first of all, to understand the scope and limits of common sense.