Two Kinds of Mechanical Inexplicability in Kant and Aristotle

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KANT'S ANTINOMY OF TELEOLOGICAL JUDGMENT describes an apparent opposition between two maxims or principles of scientific investigation. According to the first, or mechanical, principle, "all production of material things and their forms must be judged as possible according to merely mechanical laws" (§70, 387).[1] According to the second, or teleological principle, "some products of material nature cannot be judged as possible according to merely mechanical laws (their judging requires quite another law of causality, namely that of final causes)" (ibid.). What necessitates this second principle is the existence of what Kant calls "organized beings," that is plants and animals. For these, Kant claims, cannot be mechanically explained by human beings. As he puts it in a famous passage, "it is quite certain that we cannot sufficiently get to know, still less explain, organized things and their inner possibility according to merely mechanical principles of explanation; so certain indeed that we can say boldly that it is absurd for human beings even merely to envisage such an attempt, or to hope that some day another Newton could arise who would make conceivable even so much as the production of a blade of grass according to natural laws which no intention has ordered" (§75, 400).

What does Kant mean by saying, in this context, that organisms are mechanically inexplicable? Some recent discussions appear to link the answer to a distinc-

[1] References beginning with an arabic numeral preceded by "§" are to Kant's *Critique of Judgment*; the number following indicates the page number according to the pagination of volume 5 of the Akademie edition of Kant's collected writings (*Kants gesammelte Schriften*, edited by the Prussian [now German] Academy of Sciences: De Gruyter, 1902–). References to other works by Kant cite volume and page number of the Akademie edition. Except where stated, translations are my own, but I have been helped by Werner Pluhar's translation of the *Critique of Judgment* (Indianapolis: Hackett Publishing Company, 1987) and by Paul Guyer and Allen Wood's translation of the *Critique of Pure Reason* (Cambridge: Cambridge University Press, 1997). In quoting Kant, I have omitted his emphases where these tended to obscure or distract from the point at issue.

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tion Kant makes between organisms and machines. Organisms, unlike machines, have a self-generating structure which is manifested in their capacity to grow, to reproduce their kind, and to regenerate or repair missing or damaged parts. Rather than being constructed out of antecedently existing components, they are composed of parts which depend for their existence on one another, in the sense that they are responsible for one another's production, development and maintenance. It is in virtue of this non-machine-like character, according to these recent discussions, that organisms resist mechanical explanation, and hence require appeal to teleology.[2]

I believe that this answer is mistaken, and that it obscures a distinction between two separate strands in Kant's thinking about organisms. It is quite true that Kant insists on the non-machine-like character of organisms; and this can certainly be regarded as entailing a kind of mechanical inexplicability. But the kind of mechanical inexplicability associated with the non-machine-like character of organisms is independent of the mechanical inexplicability which figures in Kant's argument for teleology. When Kant claims in the Antinomy that organisms cannot be mechanically explained by us, and must instead be regarded in teleological terms, he does not have in mind the impossibility of regarding organisms as machines. Rather, he has in mind another kind of mechanical inexplicability, which would remain even if the workings of an organism could be explained, like those of a watch, in terms of the properties of pre-existing parts.

In this paper I shall try to clarify the sense of mechanical inexplicability invoked in the Antinomy, and to show how it differs from the kind of mechanical inexplicability which we might attribute to organisms in virtue of their non-machine-like character. These two kinds of mechanical inexplicability, I shall argue, correspond to two separate aspects of Kant's view of organisms: on the one hand, his conception of organisms as purposes, that is, as requiring to be understood in teleological terms, and on the other hand, his conception of organisms as products of nature rather than divine artifacts. In order to bring out more clearly the distinction between these two kinds of mechanical inexplicability, as well as to underscore its historical and philosophical significance, I shall point out a paral-

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[2] The term "non-machine-like" is less than ideal both because of its clumsiness and because of its negative character, but I use it because it seems to me to be the least misleading of the available alternatives. One term which has been used for this character of organisms is "epigenetic;" see Clark Zumbach, cited in the next note, 26, and Henry Allison, cited in the next note, 35. But I am reluctant to use it because many writers in the eighteenth century endorsed the theory of epigenesis as a theory about the generation of individual organisms—and hence could have been said to have an epigenetic view of organisms—without committing themselves to the view that organism have what I am calling a "non-machine-like" character. That is to say, they held that an individual organism was naturally generated by its parent in a gradual process of development (as opposed to being supernaturally preformed) but without accepting the implications of the non-machine-like view, in particular that the parts of an organism are required for one another's maintenance once the embryo has developed into the fully formed plant or animal. Indeed, it is arguable that this is Kant's own position in the precritical *Only Possible Proof of the Existence of God* in which Kant defends an epigenetic theory of generation but without asserting, as he does in the *Critique of Judgment*, that the parts of an organism depend on one another and on the whole for their existence. Describing the character of an organism as "epigenetic," then, is at least *prima facie* compatible with regarding it as machine-like in the sense that the parts can exist independently of the whole. "Holistic" is a possible alternative, but this term is used in such a wide range of contexts that it carries potentially misleading connotations.

lel distinction in Aristotle. Aristotle invokes something very like Kant's notion of mechanical inexplicability in arguing for the teleological character of organic phenomena. But this has to be distinguished from another kind of mechanical inexplicability which is associated with his view of organisms as natural. As with Kant, we need to recognize the different roles played by these two kinds of mechanical inexplicability, and more specifically the way in which they correlate, respectively, with the "teleological" and "natural" dimensions of his natural teleology. Doing so, I shall suggest in conclusion, not only allows a better grasp of the logic of Aristotle's and Kant's accounts of organisms, but also enables us to see more clearly the ways in which their views must be rejected or modified in the light of modern biology.

The paper is structured as follows. Section 1 criticizes the identification of mechanical inexplicability as it figures in the Antinomy (Kant's "first kind" of mechanical inexplicability) with the non-machine-like character of organisms (Kant's "second kind" of mechanical inexplicability). Section 2 offers an alternative account of the first kind of mechanical inexplicability. Section 3 discusses the distinction between the two kinds of mechanical inexplicablity and Section 4 describes the corresponding distinction in Aristotle. Finally, and very briefly, Section 5 suggests how an appreciation of this distinction can help us to see the extent to which Kant's and Aristotle's conceptions of organisms survive recent advances in biological thinking.

1.

The idea that the mechanical inexplicability of the Antinomy corresponds to the non-machine-like character of organisms can be found in a number of interpreters, including Peter McLaughlin, Clark Zumbach, Henry Allison, and Paul Guyer.[3] McLaughlin, who motivates the idea most fully and on whose account I will focus, lays the groundwork for his view by criticizing the widely held assumption that "mechanism" as used in the third Critique means the same as "causality" as used

[3] Peter McLaughlin, *Kant's Critique of Teleology in Biological Explanation* (Lewiston, N.Y.: Edwin Mellen Press, 1990), especially 152–56, and "What is an Antinomy of Judgment?", in Gerhard Funke and Thomas M. Seebohm, eds., *Proceedings of the Sixth International Kant Congress*, vol. ii/2 (Washington, D.C.: Center for Advanced Research in Phenomenology and University Press of America, 1989); Clark Zumbach, *The Transcendent Science* (The Hague: Martinus Nijhoff, 1984), especially 79–80; Henry Allison, "Kant's Antinomy of Teleological Judgment," *The Southern Journal of Philosophy*, 30, Supplement (1991), especially 26–27 and 35; Paul Guyer, "Organisms and the Unity of Science," in Eric Watkins, ed., *Kant and the Sciences* (Oxford: Oxford University Press, 2001), especially 264–65. Even where these commentators do not explicitly identify the mechanical inexplicability of organisms with their non-machine-like character, they do so implicitly in holding that it is in virtue of their non-machine-like character that organisms must be understood in teleological terms. For example, Allison says that it is "because of their epigenetic features. . . that we can only represent. . . [organic] beings to ourselves as products of design" ("Kant's Antinomy of Teleological Judgment," 35). And Guyer, who takes Kant to offer three distinct arguments for a teleological view of organisms, interprets the first of these as the argument that "paradigmatic organic processes cannot be understood by our ordinary mechanical conception of causation," an argument that he spells out by saying that "we are incapable of explaining organic processes such as reproduction, growth and self-preservation simply as processes of combining antecedently extant, fully formed parts into a subsequent whole" ("Organisms and the Unity of Science," 264).

in the first.[4] According to this assumption, the principle of mechanism which figures in the Antinomy of Teleological Judgment is the principle of causal determination established in the Second Analogy of the *Critique of Pure Reason*.[5] It follows that when Kant says in the third Critique that organisms "cannot be judged as possible according to merely mechanical laws" he means to deny that organic processes can be regarded by us as causally determined. But this leads, McLaughlin says, to an unacceptable conflict with the first Critique. Specifically, while the causal principle in the first Critique is constitutive of experience, the principle of mechanism in the third Critique is described as a regulative principle. If we identify mechanism with causality, then, we have to read Kant as demoting the causal principle to a merely regulative status, and hence as "abandon[ing] . . . one of the fundamental pillars of his system" (144).

As an alternative, McLaughlin proposes a narrower construal of the notion of mechanism. Rather than identifying mechanical causality with causality as such, he claims, we should identify it with a particular species of causality: the causality whereby the parts of a thing determine the whole, rather than the whole determining the parts. Thus, he says, "a mechanical explanation means the reduction of a whole to the properties (faculties and forces) which the parts have 'on their own', that is independently of the whole" (153). A thing resists mechanical explanation if "the *parts* can have properties *in* the whole and *due to* their presence in the whole which they would not (did not) have independently of their existence in the whole" (ibid.).[6] This is not the case for a machine, whose parts "have precisely those properties in the machine that they had before they were put together to make the machine and . . . [which] do not lose any properties when the machine is taken apart." For example, "[r]igid gears and levers do not become elastic in the machine and springs and transmission belts do not become rigid." But it does appear to be the case for organisms, since, as McLaughlin puts it elsewhere, organisms seem to manifest "a causal relation in which the whole acts on the properties of the parts" (180). The implication, then, is that organisms are mechanically inexplicable in virtue of their non-machine-like character. Because

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[4] McLaughlin, *Kant's Critique of Teleology*, 140–44. Subsequent page references to McLaughlin will refer to this book and will be given in the text.

[5] What accounts for the prevalence of this assumption is that Kant uses the term "mechanism" in the second edition Preface of the *Critique of Pure Reason* and in the *Critique of Practical Reason* to refer to causal determination (as contrasted with noumenal freedom), and many commentators take for granted that it is used in the same sense in the *Critique of Judgment*. In addition to those commentators cited by McLaughlin, others who make this assumption include John H. Zammito, *The Genesis of Kant's Critique of Judgment* (Chicago: University of Chicago Press, 1992), 220, and Michael Friedman, "Exorcising the Philosophical Tradition: Comments on John McDowell's *Mind and World*," *The Philosophical Review* 105 (1996), 439n15 and 448. As indicated below, I agree with McLaughlin and Allison that the assumption is mistaken.

[6] Related formulations are found in Allison, who says that "mechanism" in the relevant context "refers to the explanation of wholes solely in terms of the causal interaction of their component parts" ("Kant's Antinomy of Teleological Judgment," 27), and in Guyer, who says that our "mechanical" conception of causation is one in which "the character of a composite whole is always explained by the character of its parts, which are in turn logically independent of and temporally antecedent to the whole" ("Organisms and the Unity of Science," 264). The account that I will go on to give in section 2 does not necessarily conflict with these formulations, but it does conflict with them if they are understood in the way these commentators appear to understand them: namely in such a way that organisms are mechanically inexplicable but machines are not.

of the way in which their parts depend causally on the organism as a whole, organisms cannot be "reduced" to the properties which those parts possess independently of the whole. And this, for McLaughlin, is precisely to say that they cannot be mechanically explained.[7]

Now I agree with McLaughlin that mechanism in the relevant context should not simply be identified with causality. But I believe that he goes astray in his characterization of mechanism, and specifically in taking the mechanical inexplicability of organisms to be a function of the causal influence of the whole organism on its parts. Even though Kant does believe that the parts of an organism depend causally on the organism as a whole, and that this sharply differentiates organisms from machines, this is not what leads him to claim that organisms are mechanically inexplicable in the relevant sense, that is, in the sense at issue in the Antinomy. For, to put the point very simply, the mechanical inexplicability of organisms in that sense is supposed to be a ground for regarding them teleologically: it is because organisms are, to us, mechanically inexplicable, that we must regard them as ends or purposes. But for Kant there is no less of a need for teleology in understanding a machine such as a watch, than there is in understanding an organism. And this means that—unless, implausibly, the need for teleology in the two cases stems from two quite different sources—it cannot be the non-machine-like character of organisms which makes them mechanically inexplicable. Rather, what makes them mechanically inexplicable has to be something they share with machines and other artifacts.

This can be seen from the context in which Kant distinguishes organisms from machines. Kant makes this distinction in the Analytic of the "Critique of Teleological Judgment," and more specifically in a pair of sections which together elucidate the concept of a natural end or natural purpose and argue that this concept applies exclusively to organisms (§§64–65). He begins §64 by focussing on the notion of a purpose *tout court*. To say that something "is possible only as a purpose" is to say that "the causality of its origin must be sought not in the mechanism of nature, but in a cause whose capacity to operate is determined through concepts" (369–70). And in order for a thing to qualify as a purpose, "it is required . . . that its form not be possible in accordance with mere laws of nature . . . but rather that even the empirical cognition of it . . . presupposes concepts of reason" (370). He illustrates this with the example of a regular hexagon found drawn in the sand in an apparently uninhabited land. If we were to come upon such a shape we would rule out as its cause such factors as the sand, the sea, the wind or animal footprints. For "the contingency of coinciding with such a concept . . . would seem so infinitely great that there might just as well be no natural law for it" (ibid.). We would rightly conclude that "the causality for such an effect

[7] I may be oversimplifying McLaughlin's position, since in some passages (see for example 166) he seems to suggest that the mechanical inexplicability of organisms lies in the fact that they are undetermined by the properties of their parts (as distinct from the fact that the properties of their parts depend on their presence in the whole). However, his introduction of the contrast between organic systems and machines as part of his explication of the notion of mechanism on 152–53 suggests that he does indeed take the non-machine-like character of organisms to be crucial to their mechanical inexplicability.

could not be contained . . . in any cause in merely mechanically operative nature," and would thus be entitled to view it as a purpose.

But, Kant goes on, we would not be entitled to regard it as a *natural* purpose: rather, "it could be seen [only] as a product of art" (ibid.). To "judge something which we recognize as a natural product at the same time also as a purpose, and hence as a *natural purpose* . . . more is required" (ibid.). This leads him to what he calls a provisional statement of what is required for something to qualify as a natural purpose: it must, he says be "cause and effect of itself" (ibid.). He illustrates this with an example, describing three important ways in which a tree is cause and effect of itself. First, a tree both can generate, and is generated by, another tree of the same species, so that the species maintains itself. Second, a tree produces itself through its own growth and development, processing and shaping the organic matter which is added to it in the course of its life. Third, the different parts of the tree depend on one another for their continued existence: the leaves cannot subsist without nourishment from the trunk, which in turn depends on the leaves for its growth (§64, 371–72).[8]

The concept of a natural purpose is further articulated in §65, where Kant again distinguishes what is required for something's being a purpose, from what is required, more specifically, for its being a *natural* purpose. The first and more general requirement is "that the parts . . . are possible only through their relation to the whole" (373). A thing which meets this condition "is a purpose, and consequently grasped under a concept or an idea, which must determine *a priori* everything which is supposed to be contained in it" (ibid.). But this first condition is not sufficient for being a natural purpose, for "in so far as a thing is thought as possible only in this way, it is merely an artifact, i.e. the product of a rational cause which is distinct from the thing's matter (its parts)" (ibid.). For a thing to be, more specifically, a natural purpose, a second condition is required, namely that "its parts connect themselves into the unity of a whole by being reciprocally cause and effect of their form" (ibid.). These two conditions are restated a few sentences later. In a natural purpose, each part exists "for the sake of the others and of the whole" (ibid.). But this condition is not sufficient, because it applies also to artifacts: for something to be a natural purpose, each part must be thought of as producing the other parts, so that each produces the others reciprocally.

It is at this point that Kant introduces the contrast between organisms and machines. In a watch, "one part is the instrument [*Werkzeug*] of the movement of the others, but one wheel is not the efficient cause of the other; one part is there for the sake of the other, but not there through the other" (374). So a watch meets the first condition of being a purpose, but not the second. In contrast to the case of an organism, its parts do not produce one another; nor does it produce other watches or repair itself when damaged. Thus, Kant goes on to say, "an organized being is not merely a machine, for that has solely *moving* force, whereas

[8] Kant also mentions in passing "nature's self-help," by which some parts of an organism are able to make good the accidental loss of others, or by which the organism is able to respond to damage in the course of its formation by developing in a new and anomalous way; and later, at §65, 374, he alludes to the organism's capacity to regenerate missing parts. In what follows, I will treat these capacities as on a par with the powers of growth, reproduction and self-maintenance.

an organized being possesses in itself *formative* force . . . a formative force which propagates itself, which cannot be explained through the capacity of movement (mechanism) alone" (ibid.).

Taken on its own, Kant's reference to mechanism in this last sentence might appear to provide a clue to what he means by mechanical explanation elsewhere, and in particular in the Antinomy. We might thus be tempted to follow McLaughlin in interpreting the mechanical inexplicability ascribed to organisms in the Antinomy as a function of the "formative force" which distinguishes them from machines. But that intepretation is ruled out by the broader context. For it is quite clear that the contrast between organisms and machines is introduced, not by way of showing that organisms must be regarded as purposes—that is, in teleological terms—but rather to emphasize that they are products of nature rather than artifacts. So it cannot be in virtue of their non-machine-like character that organisms are mechanically inexplicable in the sense invoked in the Antinomy. Our failure to explain organisms mechanically must instead be a function of whatever it is about them which requires us to regard them as purposes: something which an organism shares with a watch or with a hexagon in the sand.[9]

2.

What, then, does Kant mean when he claims in the Antinomy that organisms are mechanically inexplicable? We might try to begin with Kant's gloss in §64 on what is required for something to be or to be regarded as a purpose, namely that "its form not be possible according to mere laws of nature" (370) or that its form display "contingency . . . in accordance with all empirical natural laws" (ibid.). But this leaves a lot of interpretative leeway. In particular, it leaves open the interpretation to which McLaughlin's view was supposed to provide an alternative: that organic phenomena fall outside the empirical causal nexus, that is, are not causally determined. McLaughlin, as we saw, avoids that interpretation by characterizing mechanical causality as the causality by which the parts of a thing determine the whole without the whole determining the parts: a causality which we find in machines but not in organisms. I rejected that characterization, but this leaves us with the original problem he faced. If we are to retain the constitutive

[9] The main textual evidence McLaughlin cites for his interpretation is Kant's claim that we represent a whole as mechanically produced when we regard it as being "a product of its parts and of their powers and capacities for combining on their own" (§77, 408, cited by McLaughlin at 152); this passage is cited by Allison as well ("Kant's Antinomy of Teleological Judgment," 27). But there is a difficulty with their use of this passage, namely that the condition Kant cites here for our representing something as mechanically produced fails to apply to machines, yet does apply to organisms. For, as he makes clear at §65, the parts of a machine do not self-assemble to form a whole, but require an external agent to put them together; conversely, "the parts of an organism connect themselves into the unity of a whole" (373) and thus "produce a whole out of their own causality" (ibid.). So the passage cannot be used to support a view of mechanical explanation on which organisms are not mechanically explicable whereas machines are. It may of course seem puzzling that Kant, while asserting throughout the Antinomy that organisms are mechanically inexplicable, should nonetheless be implying here that we represent them as mechanically produced. But in fact he believes that we do regard organisms as mechanically produced, and that this is permissible as long as the mechanism is "subordinated to teleology" (an idea he invokes in §78, §80 and §81). I cite an example of mechanism subordinated to teleology in section 2, and discuss the notion briefly at the end of section 3.

status of the causal principle, then the principle of mechanism—which in the *Critique of Judgment* is merely regulative—cannot be identified with that of causality. So what sets mechanical explanation apart from explanation in accordance with causal laws?

Now McLaughlin assumes that this problem is that of finding the "specific difference" through which mechanism is distinguished as a particular species of the genus causality (152). Relatedly, he sees the *Critique of Judgment* as "sharpening" or "differentiating" the notion of causality put forward in the *Critique of Pure Reason* (154). In the *Critique of Pure Reason*, on McLaughlin's view, Kant assumed an exclusively reductionistic conception of causality, taking for granted that all causality involved the conditioning of the whole by its independently existing parts. Later, in the *Critique of Judgment*, he refines his notion of causality, so that this reductionistic conception of causality becomes merely a species of causality in general; it is this species which now comes to be called mechanism (154).

However, apart from whatever difficulties we might find with McLaughlin's particular characterization of mechanism, the general suggestion that we view it as a species of causality seems to me to be on the wrong track, at least if we understand "causality" as it appears in the first Critique. First, causality in the *Critique of Pure Reason* is a relation between events in time, where an event is construed as a change of state in a substance. But the candidates for mechanical explanation in the *Critique of Judgment* are, at least on the face of it, things rather than events: what requires explanation in the case of a bird or of a hexagon in the sand is not that such-and-such a change took place in such-and-such a substance at such-and-such a time, but the very existence of the bird or hexagon. And even though Kant does call mechanism a "kind of causality" (§70, 387; §71, 389), he does not seem to have in mind causality in the sense of the first Critique, but rather a kind of causality which relates things rather than events: for example he speaks of the (efficient) causality by which a house is the cause of rent, and of the (final) causality by which rent is the cause of a house (§65, 372). Second, contrary to McLaughlin's developmental hypothesis, the notion of mechanism does not make its first appearance for Kant in the *Critique of Judgment*. Rather, the idea of mechanical explanation, and more specifically that of the mechanical inexplicability of organisms, are invoked in some of his earliest writings, long before he arrived at the conception of causality which figures in the *Critique of Pure Reason*.

It is these early writings which, I believe, provide us with our best clue to what Kant means by mechanical explanation in the context of the Antinomy. For here we find Kant not only describing mechanical explanation in general terms, but also seeking to provide concrete mechanical explanations of particular phenomena: explanations which he takes to be lacking in the case of organisms. Thus the *Universal Natural History* of 1755 has as its primary aim to show the "mechanical origin of the entire world-edifice" (1:215), that is, to "derive through mechanical laws the formation of celestial bodies . . . and the origin of their motions" (1:221). This amounts, he says, to showing that the order in the celestial system derives from "the most universal and essential properties of matter" (1:223)—that is, the attractive and repulsive forces which are fundamental to matter. These forces by themselves are sufficient to account for the production of the "well-ordered whole"

which is the celestial system, even from matter in a state of initial chaos (1:225–26). And the production of this well-ordered whole does not, as in the view of Epicurus or Lucretius, rely on chance or accident, but solely on the necessary laws through which nature is bound. The "natural properties" matter possesses in virtue of these laws—its forces of attraction and repulsion—bring it about necessarily (1:227). Very roughly, as Kant goes on to claim, the attractive force causes clumps of matter to form, producing stars and planets; at the same time, the repulsive force generates lateral motions in the matter, which, combined with those motions generated by the attractive forces, cause these bodies to rotate around one another. In this way both the existence of the celestial bodies themselves, and their motions, can be accounted for in terms solely of the fundamental forces of matter, without need to suppose any special arrangement of matter, or to make any appeal to chance.

But organisms present an altogether different case. "We can say . . . without presumption '*Give me matter, I will build a world out of it!*' that is, give me matter, I will show you how a world must arise out of it . . . . But can we boast of such advantages concerning the least plant or insect? Are we in a position to say '*Give me matter, I will show you how a caterpillar can be produced?*" (1:230). Kant clearly thinks the answer is no. In a passage prefiguring his claim about the Newton of the grassblade, he goes on to say that "we will sooner understand the formation of all celestial bodies, the cause of their motions, in short, the origin of the entire present arrangement of the world-edifice, than we will come to know distinctly or completely the production of a single herb or of a caterpillar from mechanical grounds" (ibid.)

The account of the heavens offered in the *Universal Natural History* is recapitulated as part of the *Only Possible Proof* of 1763; here Kant describes it as "a hypothesis of mechanical explanation" of the origin of the celestial system (2:137). It is offered in partial support of a broader thesis, already hinted at in the *Universal Natural History*, that most of the apparent order and harmony of the universe requires no special appeal to Divine purpose, but can be accounted for in terms of the most fundamental and universal laws of nature. But again, organisms are explicitly excluded: "it would be absurd," Kant says, "to regard the first production of a plant or animal as a mechanical side-consequence [*mechanische Nebenfolge*] of universal laws of nature" (2:114). For, being composed of a multiplicity of different organs, plants and animals display a "contingent" rather than a "necessary" unity (2:106–7). Because of their composite character we have no choice but to suppose that a "wise creator . . . has brought the matter of which they are composed into such excellent order" (2:125).[10]

[10] For a more detailed discussion of these early writings, as well as a more systematic treatment of the question of what Kant means by mechanical explanation in the context of the Antinomy, see my "Kant on Understanding Organisms as Natural Purposes," in ed. Watkins, *Kant and the Sciences*. In that paper I suggest that an explanation on the basis of chemical laws (as for example an explanation of crystal formation) also qualifies as a mechanical explanation, and I address very briefly the question of how chemical laws and powers relate to the laws of motion and moving forces (note to end of section 3). In this paper, however, I try to disregard the complications associated with the status of chemistry in Kant's scientific scheme.

Now there are of course substantial differences between Kant's view at this very early stage of his career and his view in the *Critique of Judgment*. One difference is apparent from the last quotation. At this stage Kant thinks that we can assert that organisms—or at least the first organisms of each species—are produced in accordance with divine purpose, whereas in the *Critique of Judgment* he thinks that the assumption of divine purpose plays at most a heuristic role in guiding our investigation of organisms. Another, related, difference is that the impossibility of explaining organisms mechanically is not yet restricted to human beings. Whereas in the *Critique of Judgment* our failure to explain organisms mechanically is ascribed in part to the discursive character of the human intellect, so that another kind of intellect (an intuitive intellect) might not be subject to this limitation, the mechanical inexplicability of organisms at this early stage is independent of the limitations of the human intellect. Both of these differences stem from the critical turn in Kant's philosophy. However, there is nothing in this critical turn that would imply a radical change in his view of what mechanical explanation itself consists in, or at any rate the kind of mechanical explanation that is possible for a discursive intellect. And indeed, the few concrete clues that the *Critique of Judgment* offers as to the nature of mechanical explanation suggest that the view has remained the same. Thus at the end of the Dialectic of Teleological Judgment he gives as an example of an attempt at mechanical explanation the hypothesis that a maggot "is to be seen as a product of the mere mechanism of matter," and he glosses the "mere mechanism of matter" in turn as "the new process of formation which matter brings about on its own when its elements are set free by putrefaction" (§78, 411). This suggests that, as in the two early works cited, we explain something mechanically when we explain its production as a result of the unaided powers of matter as such.

Another passage that goes into detail about the attempted mechanical explanation of organisms is in a section of the *Critique of Judgment* where Kant is trying to show that the principle of mechanism, while it has a necessary place in the explanation of organisms, must nonetheless be "subordinated to a teleological principle" (§80, 417). Here Kant notes that the anatomical similarities among different animal species suggest that they are produced from a common archetype [*Urbild*], allowing us to hope that "here perhaps something might be achieved with the principle of the mechanism of nature" (418). For this "analogy of forms . . . strengthens the suspicion of an actual kinship [*Verwandtschaft*] in production from a common original mother through the stepwise approximation of one animal species to another, from . . . the human being to the polyp, and from this even to mosses and lichens and finally to the lowest step of nature discernible to us, [i.e.] to crude matter [*rohe Materie*]; from which and from the forces of which according to mechanical laws (like those according to which it operates in producing crystals) the whole technic of nature . . . appears to stem" (418–19). He goes on to endorse a hypothesis which at first seems to be a version of this account: the "archaeologist of nature" is free to allow that "the maternal womb of the earth . . . initially gave birth to creatures of a less purposive form, these in turn giving birth to others which were more suited to their place of origin and their relations to one another" (419).

But he adds a crucial qualification: if we adopt this hypothesis we must "in the end ascribe to the universal mother an organization which is purposively set up towards [*gestellt auf*] all these creatures" (ibid.). We can allow that "something organic [can be] produced from something else which is organic, even if it is specifically different from it" (419n.). However, we cannot allow "the production of an organized being through the mechanism of crude unorganized matter," for that hypothesis is "absurd" (*ungereimt*) (ibid.). This last point is emphasized again in the following section, in his approving description of the theory of epigenesis put forward by Blumenbach. "It is from organized matter that he begins all physical explanation of these formations. For that crude matter could have formed itself originally according to mechanical laws, that life could have sprung from the nature of the lifeless, and matter of itself could have arranged itself in the form of a self-maintaining purposiveness, he rightly declares to be contrary to reason" (§81, 424).[11]

These passages suggest that, just as in the early writings, Kant identifies the mechanical inexplicability of organisms with the impossibility of accounting for them in terms of the fundamental powers of matter as such. While matter organized in specific ways has the capacity to produce organisms (so that we can account for a particular bird in terms of the powers of the fertilized egg from which it came, or for the existence of complex plants in terms of the powers of primeval mosses and lichens), matter as such does not. Or at least, not as far as we can tell, given the abstract concept of matter to which we are restricted in virtue of our discursive intellects. While an intuitive intellect might be able to grasp the necessity of the existence of organisms from its representation of matter in all its concrete particularity, the content of our representation of matter is limited to our grasp of its fundamental moving forces. And while, as we saw in the *Universal Natural History*, these forces suffice to account for the existence of the celestial system, they are not sufficient to account for the existence of plants and animals.

But, it might now be objected, might Kant not hold that it is precisely the non-machine-like character of organisms that makes them mechanically inexplicable in this way? If this were so, then the notion of mechanical inexplicability as I have just described it would not stand in contrast to the notion of mechanical inexplicability proposed by McLaughlin. Rather, the latter would be a refinement of the former: it would be impossible to account for the existence of organisms on the basis of the powers of matter alone precisely because these powers are insufficient to account for the reciprocal causal relations by which the organism's parts create and maintain one another. By contrast, the powers of matter alone would be sufficient to account for the existence of the celestial system because that system, like a machine, is composed of antecedently existing parts and has its properties in virtue of the independent properties of those parts.

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[11] This characterization of Blumenbach's view may not be quite accurate: in his *Manual of the Elements of Natural History* Blumenbach describes the formative drive (*Bildungstrieb*) responsible for the production of organisms as belonging to "previously unorganized but organizable seminal matter" (§9 of the tenth edition, translated by R.T. Gore [London: W. Simpkin and R. Marshall, 1825], 10), rather than to matter that is already organized.

There is at least one piece of textual evidence for this suggestion, namely the last passage I quoted, where Kant describes it as contrary to reason that "matter of itself could have arranged itself in the form of a *self-maintaining* purposiveness" (§81, 424; my emphasis). But other passages tell against it. When Kant says in the *Only Possible Proof* that "it would be absurd to regard the first production of a plant or animal as a mechanical side-consequence of universal laws of nature" (2:114), he is quite explicit that this holds, not only on his preferred hypothesis that organisms have a natural capacity to produce their like (in his later terminology, the theory of epigenesis), but also on the hypothesis that each individual organism is produced immediately by God (as in what he later calls the theories of occasionalism and individual preformation).[12] Since on the latter view, the parts of the organism are not produced by one another but are, instead, completely formed in miniature at the time of the organism's creation, this seems to indicate that the mechanical inexplicability of organisms in the relevant sense does not depend on their non-machine-like character. Moreover, in explaining what differentiates organisms from those products of nature which are mechanically explicable, Kant does not cite their capacity to produce or maintain themselves, but rather—as we have already seen in passing—their composite character. Man, for example, has different organs for seeing, hearing, smelling and tasting (2:106); plants have vessels for drawing up sap, taking in air, processing sap (2:107); it is the contingent unity of these different parts which requires us to view the organism as a product of choice rather than of the necessary workings of matter.

Similarly, when Kant describes the mechanical inexplicability of an organism in the *Critique of Judgment*, he omits any mention of its non-machine-like character. Thus at §61, which introduces the argument of the Critique of Teleological Judgment, Kant says that when we consider "the construction of a bird, the hollowing in its bones, the position of its wings for movement and of the tail for steering, etc., we say that all this is in the highest degree contingent according to the mere *nexus effectivus* in nature, without appealing to a particular kind of causality, namely that of purposes [*nexus finalis*]; i.e. that nature, regarded as mere mechanism, could have formed itself in a thousand ways without hitting precisely on the unity according to such a principle" (360). It is plausible to take this as a description of the bird's mechanical inexplicability; but there is no mention of the feature by which the bird's parts produce or maintain one another. Instead, all the features Kant cites would hold equally well of a mechanical bird constructed for the purpose of flight.[13]

This still leaves open the question of why Kant takes it that the forces of matter alone are insufficient to account for the existence of an organism, or, for that matter, of a complex machine. Even though the *Only Possible Proof* alludes to the composite character of an organism, this may seem to be insufficient for distin-

[12] For this later terminology, see the *Critique of Judgment* §81, 422–23.

[13] See also "On the Use of Teleological Principles in Philosophy" (1788), where Kant suggests that the crucial feature in virtue of which an organized being defies mechanical explanation is that "it is possible only through the relation of everything in it to one another as end and means" (8:181). As we saw in section 1, this feature too belongs to artefacts as well as to organisms: while the parts of a watch are not responsible for one another's production, "one part of a watch is indeed there for the sake of the others" (§65, 374).

guishing a plant or animal from, say, a planetary system, which might also be regarded as composite. How can Kant be as confident as he is in the *Critique of Judgment* that we could never show the origin of a plant or animal from the forces of unorganized matter alone? To some extent he is simply adopting, without argument, a standard eighteenth-century view on which moving forces by themselves cannot give rise to the complex patterns of regularity characteristic even of very simple organisms. Maupertuis, for example, takes the forces of "impenetrability, mobility, inertia and even [gravitational] attraction"[14] to be insufficient to account for plant and animal formation: "a blind and uniform attraction, spread out in all the parts of matter," he says, "cannot serve to explain how these parts arrange themselves to form a body with even the most simple organization."[15]

Where Kant does see a need for argument, however, is in rebutting the view—also very common in the eighteenth century—that matter has a natural tendency to produce organisms in virtue of powers over and above moving forces. Thus Maupertuis ascribes to matter a "principle of intelligence . . . similar to what we call *desire*, *aversion*, *memory*,"[16] which he takes to belong, not just to collections of organized matter such as we find in animals, but to the "very smallest parts of matter,"[17] and indeed to every one of these parts.[18] And Buffon, while not ascribing mental principles to matter, nonetheless claims that "matter inclines to organization" in virtue of general principles analogous to—but going beyond—the principle of gravitational attraction.[19] In his 1788 essay, "On the Use of Teleological Principles in Philosophy," Kant explicitly challenges a version of this view put forward by Georg Forster, for whom matter possesses a fundamental power for organization that enables it to produce plants and animals. Kant accuses Forster of going beyond the boundaries of natural science by inventing a new fundamental force whose possibility cannot be proved by experience: something "for which reason has no entitlement, for then it would have no trouble explaining *whatever* it wants, *however* it wants" (8:182).[20]

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[14] *Système de la Nature* (Third edition, Paris, 1756; facsimile reprint, Paris: J. Vrin, 1984), §III, 140–41.

[15] *Système de la Nature*, §XIV, 146.

[16] *Système de la Nature*, §XIV, 147.

[17] *Système de la Nature*, §XVII, 149.

[18] *Système de la Nature*, §XXXI, 157. It is true that, according to Maupertuis, the formation of the first individual of each species of plant and animal was miraculous (§XXX, 157), and thus not a result of the powers inherent in matter; but Maupertuis makes clear that he holds this view for religious reasons (§XXVII, 154), and there seems to be no scientific or philosophical reason why matter's principle of intelligence could not have enabled it to produce the first organisms without the help of a miracle.

[19] Chapter Three of *The Generation of Animals*, in Volume Two of *Histoire Naturelle*, (1749), quoted from John Lyon and Phillip R. Sloan, eds., *From Natural History to the History of Nature* (Notre Dame and London: University of Notre Dame Press, 1981), 185. According to Buffon, these principles should qualify as mechanical, for it is reasonable to hold that "mechanical principles are nothing but general effects, which experience has pointed out to us in matter, and that every time a new general effect is discovered, either by reflection, comparison, measure, or experience, a new mechanical principle will be gained, which may be used with as much certainty and advantage as any we are now acquainted with" (185). I take Buffon to be proposing here just the kind of "invention of new fundamental forces" to which Kant objects in the views of Herder and Forster (see below).

[20] A less developed form of this criticism appears in Kant's 1785 review of Herder's *Ideas for a Philosophy of Human History*, 8:53–54. See also Kant's more specific criticisms of hylozoism (the view

Is Kant justified, then, in saying that organisms are mechanically inexplicable in the sense I have identified? And, more specifically, has he given us enough of an account of what it is about organisms which rules them out as candidates for this kind of explanation? I will not try to pursue these questions here. All I want to emphasize in this context is that the impossibility of deriving the existence of organisms from the forces originally inherent in matter does not depend on the self-causing nature of organisms. Kant would equally well reject the claim that matter could organize itself into the structures with the observable complexity of organisms, but (as on the theories of occasionalism and individual preformation) without the capacity for genuine growth, regeneration or production of offspring.[21]

3.

My aim in the previous section was to characterize mechanical inexplicability in the sense invoked by Kant in the context of his argument for a teleological understanding of organisms. Organisms are mechanically inexplicable, in this sense, if we cannot account for their existence in terms of the powers of matter as such. It follows from this characterization that the mechanical inexplicability of organisms, understood in this sense, cannot be identified with what I have been calling the non-machine-like character of organisms. To say that organisms are non-machine-like is to say that they are not assemblages of independent parts, but that they are instead composed of parts which depend for their existence on one another, so that the organism as a whole both produces and is produced by its own parts, and is thus in Kant's words "cause and effect of itself." But this character, which is unique to organisms, is obviously different from the kind of mechanical inexplicability described in the previous section, which applies not only to organisms, but also to machines and to most other artifacts.

It remains true, however, that the non-machine-like character of organisms corresponds to a kind of inexplicability which can be called "mechanical" and hence qualifies as "mechanical inexplicability" in a second sense. For the non-

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that matter is endowed with intentions) at §65, 374 and §73, 394–95, and in the *Metaphysical Foundations of Natural Science* at 4:544; for criticisms of Buffon and Maupertuis on a different although related point, see the *Only Possible Proof*, 2:114–115. Kant is probably alluding to a view like Herder's or Forster's in the *Critique of Judgment* at §78, 411, when he says that insistence on the pursuit of mere mechanism "must make reason fantasize and roam around in chimeras [*Hirngespinste*] of natural capacities which do not admit of being thought." The historical background of Kant's criticisms of Herder and Forster is discussed in Zammito, *The Genesis of Kant's Critique of Judgment*, 199–213.

[21] Here and earlier in this section I have assumed that the theories of occasionalism and individual preformation—in contrast to the theory of epigenesis—are contrary to Kant's view of the organism as "cause and effect of itself" and thus as non-machine-like. To this it might be objected that on the individual preformation theory, at least in its most familiar "encasement" variant, the organism meets at least some of the conditions for being cause and effect of itself, since it is capable of producing its like by virtue of the miniature organisms within it (and, on some versions, of regenerating missing parts by virtue of the miniature replacement parts it contains). However, Kant makes clear that the organism on this theory does not genuinely produce its like; what takes place, rather, is the unfolding of a miniature organism which has already been produced in all its complexity by God (§81, 423–24). Accordingly, the generation of organisms on the preformation view is on a par with the occasionalist view, on which each individual organism is created immediately by God on the occasion of each mating (§81, 422; a similar point was made earlier by Maupertuis, *Système de la Nature*, XI, 144–45).

machine-like character of organisms entails that we cannot explain the powers of an organism, or the regularities that it manifests, in terms of more fundamental powers belonging to more basic constituents of the organism. We cannot explain these powers or regularities, that is, as we explain those of a machine. This is not to say that the non-machine-like character of organisms rules out the possibility of *any* explanation of their powers in terms of the powers of their constituents. For example, we can explain an animal's capacity to take in and digest food by appeal to the powers of its mouth, stomach and intestines. But such an explanation is lacking in the sense that the parts or constituents to which we appeal in such an explanation are no more basic than the organism itself, so that the powers they possess are no more fundamental than the powers to be explained. This is because the parts of the organism are capable of existing with *their* powers only in virtue of their presence in the whole organism with *its* powers. Our explanation is non-reductive and, in the end, circular; what accounts for the powers of the organism is ultimately the organism itself (or another organism of the same species).

I want now to look more closely at this second kind of mechanical inexplicability, and at how it differs from mechanical inexplicability in the sense invoked in the antinomy of teleological judgment. As a first step, I want to raise a question about what Kant intends to rule out when he denies that an organism is "merely a machine." So far, I have described the non-machine-like character as deriving from the relationship in the organism of what might be called its "organic" parts, for example the leaves and roots of a tree, or the mouth and stomach of an animal. These are what we intuitively regard as the parts of an organism, and in denying that an organism is merely a machine, Kant means to rule out that they are equivalent to what we intuitively regard as the parts of a machine. An organism is not composed out of its organic parts in the way a watch is composed out of (say) wheels and springs, since these parts—unlike those of a watch—cannot exist independently of the whole to which they belong. But, it might be asked, could we not still regard an organism as assembled out of pre-existing parts of *inorganic* matter, that is, as a machine whose parts are not organs and tissues, but rather molecules or atoms? Admittedly, we would have to view the parts of the organism on this hypothesis as constantly changing, leaving the body and being replaced throughout the organism's life. We could still regard it, however, as a self-maintaining, self-repairing and self-reproducing automaton, whose behavior at any time could be accounted for by reference to the arrangement of matter in the organism at that time or at some earlier time. The apparent composition of the organism would be in effect illusory: while the organism would appear to be made up of organs, themselves composed of organic tissues, a proper understanding of the organism would require seeing it as a vastly complex arrangement of sub-microscopic particles of matter, of just the same kind as those making up the inorganic universe.[22]

[22] Note that this hypothesis does not require that we could define an organism of a given species as such-and-such an arrangement of matter, since (leaving aside the complications associated with the fact that even for a single organism the arrangement changes with the organism's growth and development) we could allow that no two organisms of a given species would have the same arrangement. On the hypothesis that I am considering, it is enough that a certain arrangement of matter at a given time be sufficient for the existence of an organism at that time.

The question of whether Kant means to rule out this last possibility has a bearing on how we understand the associated sense of mechanical inexplicability. If he does not mean to rule out the possibility that organisms are automata of the kind just described, then the associated sense of mechanical inexplicability is very limited. All that it implies is that we cannot achieve a satisfactory explanation of the workings of an organism in terms of the powers of its organic parts, given that the existence of those parts depends on those very workings. It does not imply that we could not arrive at a reductive explanation of an organism's workings in terms of the properties of its inorganic parts, that is of the material particles which enter into its composition. If, on the other hand, he does want to rule out the possibility that organisms are machines composed of material particles, then the relevant sense of mechanical inexplicability is much stronger. It excludes the possibility of any reductive explanation of an organism's powers or workings in terms of the powers of its parts, whether those parts be organic or inorganic.

Our present-day understanding of organisms would favor the weaker of these two alternatives. We think of the workings of organisms as ultimately explicable in terms of the functioning of cells and organelles, which are themselves explicable in terms of the properties of molecules and their constituent atoms. So an organism can in a sense be viewed as an enormously complicated arrangement of material particles which are capable of existing independently of the organism. But Kant himself seems to endorse the second, stronger alternative. For, as we have already seen, he says that an organism is not a machine "because a machine has solely moving force," whereas an organized being has a "formative force . . . which cannot be explained through the capacity of movement alone" (§65, 374). The capacity of organisms to reproduce themselves requires an "original organization" whose principle is "unfathomable" (§81, 424).[23] This suggests that an organism cannot be viewed as a system of material particles, since otherwise we could understand its behavior (including its growth and reproduction) in the same way that we understand the workings of a clockwork mechanism: there would be no reason for Kant to describe its organization as "unfathomable."[24] Not only, then, do the organic parts of the organism depend on the whole, but there is also no possibility of a deeper-level analysis of the organism's workings in terms of inorganic parts which do not depend on the whole.

This will be disappointing to those seeking a reading of Kant that is more congenial to modern science. But it should be noted that the view I have ascribed to him is just what we might expect given his views on chemistry, and particularly on the chemistry of organic compounds, which are also at odds with fundamental

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[23] See also the *Only Possible Proof*, where Kant describes the capacity of organisms to "produce [*erzeugen*] their like according to a regular [*ordentlich*] law of nature" as "not conceivable [*nicht begreiflich*] to us" (2:114), so that, for example, it is "in no way to be understood how. . . a tree is supposed through an inner mechanical constitution to be capable of so forming and modeling its sap that something originates . . . which contains a similar tree in miniature, or out of which such a tree could come to be" (2:114–15).

[24] It might be suggested that Kant's insistence on the unfathomability of organic processes shows, not that he does not regard organisms as machines, but that he follows Leibniz in regarding them as machines with infinite complexity. But his discussion of organized bodies in the Antinomy of the first Critique (A526/B554-A527/B555) indicates that he rejects Leibniz's view on this point; see the note after next.

assumptions of contemporary science. Here I have in mind his rejection of the "atomistic" or "corpuscular" philosophy, associated with the "mechanical" way of explaining the differences among different chemical species, in favor of a contrasting "dynamical" view of matter (see especially §4 of the General Observation on Dynamics, *Metaphysical Foundations of Natural Science*, 4:530–35). While the mechanical view accounts for chemical differences in terms of the different shapes of constituent atoms, the dynamical view explains such differences in terms of variation in the proportion of attractive to repulsive force (4:532, 4:533–34). Chemical solutions on the dynamical view do not consist in a mixture of atoms belonging to one ingredient (i.e. with one kind of shape) and atoms belonging to another ingredient (i.e. with another kind of shape). Rather, at least in the case of a perfect or complete solution, the solution is completely homogeneous in the sense that both ingredients fully penetrate each other and the space occupied by the solution (4:530–31). A complete chemical solution, then, cannot be viewed as consisting of a collection of particles belonging to the more basic chemical substances of which it is formed; every part of the solution contains an equal proportion of both substances.[25]

Now Kant allows that experience cannot determine whether any given solution is in fact complete, and that it may in fact be the case that all solutions contain undissolved particles of their ingredients. But he insists, against the atomistic view, that a perfect or complete solution is at least possible; and moreover he suggests that even if we ourselves are incapable of creating such solutions through artificial means, they might come about naturally in the formation and maintenance of living things: "even if art were not capable of any powers of solution of this kind, which could bring about a complete solution, nonetheless nature could still perhaps give proof of such powers in its vegetable and animal operations, and perhaps thereby produce matters which, even though they are mixed, cannot be separated again by any art" (4:531–32). Both Kant's insistence on the possibility of a perfect chemical solution, and his suggestion (albeit tentative) that it is realized in the case of organic compounds, show his distance not only from the atomistic views proposed by his contemporaries, but also from present-day views of the structure of matter. More specifically, Kant's view of organic compounds appears to rule out a view on which basic organic materials have their characteristic properties in virtue of a spatial arrangement of inorganic particles, in the way that, for example, we take blood to have the property of taking up oxygen in virtue of the structure of the hemoglobin molecule. And this in turn rules out a view of organisms as machines ultimately composed of discrete inorganic parts, although it might leave room for less intuitively obvious versions of the machine view.[26]

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[25] For a very useful discussion of Kant's views on chemical compounds, see Martin Carrier, "Kant's Theory of Matter and his Views on Chemistry," in ed., *Kant and the Sciences*.

[26] The interpretation I am defending might be challenged on the basis of the following remark from the Antinomy section of the first Critique: "only experience can determine [*ausmachen*] how far organization in an articulated [*gegliederte*] body may go, and even if it were certain not to arrive at any non-organic [*unorganischen*] part, nonetheless such parts must at least lie within possible experience" (A527/B555). The last clause in particular seems to contradict my understanding of the non-machine-like character of organisms by suggesting that we must allow the possibility that organisms are composed of inorganic material parts, even if experience never reveals these parts to us. However,

But if we understand the second kind of mechanical explicability in the stronger way that I am proposing, then we become liable to a certain kind of confusion between the two kinds of mechanical inexplicability, which I am trying to distinguish. This confusion can arise in so far as we are tempted to characterize the second kind of mechanical inexplicability in terms of the explanatory inadequacy of matter, or more specifically, the impossibility of accounting for the powers of organisms in terms of the motions of material particles. This can make it seem as though both kinds of mechanical explicability come down to the same thing, namely the impossibility of "reducing organisms to mere matter," that is, of explaining organic phenomena in terms of the powers of matter alone. In order to avoid the confusion, we need to be clear about how these two kinds of mechanical inexplicability differ in spite of the fact that they both imply the "irreducibility" of the powers of organisms to the powers of matter. Now one way in which we might try to distinguish the two kinds of mechanical inexplicability is in terms of what it is, in each case, which fails to be explained. The first kind of mechanical inexplicability, it might be suggested, consists in the insufficiency of the powers of matter to explain the origin of an organism; whereas the second kind involves their insufficiency to explain how an already constituted organism is capable of functioning. But this way of marking the difference is questionable. One reason is that the self-producing character which Kant ascribes to organisms makes it hard to draw a sharp distinction between the origin of an individual organism and its functioning. The functioning of an organism includes, not only the activities through which it maintains itself in maturity, but also its growth and development; and these processes are continuous with the process through which the organism comes to be in the first place.[27] Thus the origin of an individual oak cannot be treated

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the remark needs to be understood in context. It is part of a brief discussion of organized wholes in which Kant warns against moving from the view that body (a *quantum continuum*) is infinitely divisible, to the view that a particular organized body (a *quantum discretum*) can be articulated to infinity. "It is not thinkable," he says, "that in every articulated (organized) whole, each part is again articulated, and that in such a way, through dismantling [*Zerlegung*] of the parts to infinity, we always arrive at new artificial parts [*Kunstteile*], in a word, that the whole is articulated to infinity" (A526/B554); or, as he puts it a few sentences later, "we contradict ourselves" in thinking of "an organic body articulated to infinity" (A526-27/B554-55). Kant's point here seems to be directed against Leibniz's view of organisms as infinitely complex machines: "each organized body of a living thing is a kind of divine machine or natural automaton, which infinitely surpasses all artificial automata [in that it is] a machine in each of its parts. . . . natural machines, that is living bodies, are still machines in their least parts, to infinity" (*Monadology* §64, in Leibniz, *Philosophical Essays*, Roger Ariew and Daniel Garber eds. [Indianapolis: Hackett Publishing Company, 1989], 221; see also *A New System of Nature*, in ibid., 142). The problematic remark thus occurs as part of Kant's denial, against Leibniz, that an organism can be viewed as a machine whose parts are themselves machines, and so on to infinity. The point of Kant's claim that non-organic parts "must at least lie within possible experience" can, given this context, be understood as follows: if we regard an organism, like a highly complex machine, as analyzable into independent components which are themselves machines, we cannot regard the analysis as proceeding to infinity, but must at least allow the possibility that it terminates in components that cannot be further analyzed. Kant's point, then, is conditional: *if* we regard an organism as a machine, that is, as analyzable into parts that do not in turn depend on the whole, *then* we must regard it as a machine which is finitely rather than infinitely complex. Understood in this way, it does not contradict the view which I am attributing to Kant in the third Critique, namely that organisms cannot be viewed as machines at all.

[27] This is also very clear in Blumenbach, for whom "generation [*Zeugung*], nutrition [*Ernährung*] and reproduction [*Wiedererſetzung*] are simply at bottom mere modifications of one and the same force, which in the first case builds, in the second maintains, and in the third repairs," a point which

separately from the workings of the oak, since a full account of how an oak functions must include an account of how oaks produce acorns and how acorns develop into oaks.

A further, and deeper, reason has to do with what it means to claim that the powers of matter are insufficient to account for the production of organisms, or for that matter, of complex artifacts. This question arises when we consider that, in a certain sense, the powers of matter are insufficient to account for the production of *any* particular material object (at least as long as its identity conditions are specified in enough detail). In the case of any arrangement of matter, for example that of a randomly chosen clod of earth or heap of sand, we can ask how it is that the matter came to be arranged in that precise way. And appeal to the powers of matter in general will not provide an adequate answer. Such an appeal might explain why a quantity of sand under certain circumstances will come to be arranged in a roughly conical shape, but not why a grain of this particular shape has come to lie adjacent to a grain of that particular shape rather than of some other particular shape, or why the heap as a whole has precisely this contour rather than some other contour. To put the same point in another way, there is a sense in which the powers of matter might be regarded as no less capable of producing the kind of regular arrangement that is typical of organisms and artifacts, than of producing any precisely specifiable arrangement of matter. The impossibility of accounting for the existence of organisms in terms of the workings of matter as such is due to the extreme improbability that matter could spontaneously have arranged itself into structures with the requisite order and complexity. But from a purely statistical point of view, it might be regarded as no less improbable that our moon should have come to have precisely the arrangement of craters on its surface that it, in fact, has.

Now of course we do think that there is a difference between the arrangement of matter in an organism or artifact on the one hand, and the arrangement of matter in a heap of sand or at the surface of the moon on the other. Even though both arrangements are, to a high degree, undetermined by the powers of matter as such, we take the arrangement of matter in an organism to require explanation in a way that the arrangement of matter at the surface of the moon does not. So we think of the contingency of the arrangement of matter in the case of an organism or artifact as amounting to an explanatory failure which has to be made good by appealing to factors over and above the powers of matter, whereas, in the case of a heap of sand or the surface of the moon, we do not see a need to explain why

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he also puts by describing nutrition as a "universal but unnoticeably continued generation" and reproduction as a "repeated but only partial generation" (*Über den Bildungstrieb und das Zeugungsgeschäfte*, [Göttingen: Johann Christian Dieterich, 1781], §7, 19). (Note here that 'reproduction,' corresponding to the German 'Wiederersetzung' and the Latin 'reproduction,' means the regeneration of missing or damaged parts, not the production of offspring.) A similar view is expressed by Buffon, who, referring to the "active power" responsible for generation, describes it as "the power which animals and vegetables have to assimilate the matter that serves it for food," and goes on to ask rhetorically, "is this not the same, or at least has it not great connection with, that which is the cause of reproduction?" (Chapter Two of *The Generation of Animals* in Volume Two of *Histoire Naturelle* (1749), quoted from Lyon and Sloan, *Natural History*, 180). It is possible that the view derives from Aristotle's claim that nutrition and reproduction ('reproduction' here in the sense of producing offspring) correspond to one and the same potentiality of the soul; see *On the Soul*, II.4, especially 416a19.

the relevant matter ended up in precisely this, rather than some other, arrangement. What seems to make the difference is the orderliness and regularity displayed in the one kind of case but not in the other. The existence of organisms carries with it the existence of innumerable regularities: in the shape of organisms, in their behavior, and in their patterns of growth and reproduction. By contrast, most non-organic natural objects display little or no regularity; and to the extent that they do display regularity, as for example in the case of the regularity exhibited by the motions of the planets, that can be explained as deriving from the regularity inherent in matter by virtue of its conformity to fundamental laws of attraction and repulsion. It is thus the regularity exhibited by organisms, not just the mere fact that they correspond to a statistically improbable arrangement of matter, which calls for an explanation above and beyond appeal to the powers of matter as such.[28]

This suggests that we need to look more closely at the claim that the powers of matter are insufficient to account for the production of organisms. In particular, it suggests that what the powers of matter fail to account for is not a certain event or series of events, namely those involved in an organism's coming into being, but rather a certain kind of regularity, namely the regularity exhibited in an organism's structure and workings. To say that the existence or production of organisms cannot be accounted for by appeal to the powers of matter as such, is to say that the regularity exhibited by organisms cannot be accounted for solely by appeal to the regularity with which the parts of matter attract and repel one another. In contrast to the regularities manifested by the solar system, the regularities of organisms cannot be seen simply as an expression or manifestation of the regularities inherent in the workings of matter. They constitute instead a different order of regularity, over and above that exhibited in matter's conformity to fundamental laws of moving forces.

In the context of the present line of argument, what this means is that the kind of mechanical inexplicability we have just been discussing—what I have been calling the first of Kant's two kinds of mechanical inexplicability—cannot be seen as

[28] Richard Dawkins gives a different answer to the question of what distinguishes organisms from other, no less statistically improbable, arrangements of matter. Organisms display a quality he calls proficiency: "either proficiency in a particular ability such as flying . . . or proficiency in something more general, such as the ability to stave off death, or the ability to propagate genes in reproduction" (*The Blind Watchmaker* [New York: W.W. Norton and Co., 1987], 9). He describes organisms as possessing "adaptive complexity," a feature which he illustrates by pointing out that a living thing "work[s] . . . to keep itself in being, and to reproduce its kind," something which is not true of most of the other configurations in which the same matter could be arranged ("Universal Darwinism," first published in D.S. Bendall, ed., *Evolution from Molecules to Man* [Cambridge: Cambridge University Press, 1983], reprinted in David L. Hull and Michael Ruse, eds., *The Philosophy of Biology* Oxford: Oxford University Press, 1998], 17). This suggests, in contrast to the view proposed here, that it is on account of their apparently teleological character that organisms require explanation: they need explaining because they are good for, or adapted towards, the attainment of an end (in particular, the end of self-preservation). However, it seems to me that it is not a necessary condition of a natural phenomenon's requiring explanation that it appear to be goal-directed. Any kind of pattern or regularity calls for explanation, whether or not it appears to be teleological. Moreover, I am inclined to think that the feature of being goal-directed or adapted for a purpose is not a basic characteristic of organisms, but rather a feature which we ascribe to organisms in virtue of their displaying an order or regularity which cannot be explained in terms of more fundamental physical or chemical regularities. For more discussion of this last point, see "Kant on Understanding Organisms."

bearing solely on the origin of organisms in contrast to their functioning. The point that Kant is making when he describes matter, left to its own workings, as incapable of producing organisms, is not just about the causal preconditions required to bring organisms into existence, but also about the regularities manifested in the structure and workings of organisms once they have been produced.[29] This gives us a further reason, in addition to the consideration I mentioned earlier about the difficulty of distinguishing the workings of existing organisms from the processes through which organisms come into being, for rejecting the suggestion that Kant's two kinds of mechanical inexplicability are different in so far as they bear on distinct *explananda*. In both cases, what we are trying and failing to explain is the regularity manifested in organic processes, irrespective of whether those processes are involved in the production of a new organism, or in the self-maintenance of an organism that has already come into existence.

We see, then, that the risk of confusion mentioned earlier cannot be avoided by appealing to a distinction between the origin of organisms on the one hand, and their workings on the other. Both kinds of mechanical inexplicability can be characterized in terms of the inadequacy of matter to account for the same thing, namely biological regularities. We might thus easily be tempted to conflate the two kinds of mechanical inexplicability as corresponding to a single intuition about what we might call the limits of mechanism: the intuition that we need to appeal to something over and above matter and its motion in order to make sense of the natural powers and regularities associated with living things. But, as the distinction between the two kinds of mechanical inexplicability suggests, the idea of the limits of mechanism encompasses two quite different lines of thought. And the potential confusion between them can be avoided by recognizing that there is a difference between the kind of explanation that fails in each of the two cases. In the case of the first kind of mechanical inexplicability, that invoked in the Antinomy, we cannot explain how the sorts of regularities characteristic of organisms come to hold simply in virtue of the powers of matter *tout court*: the existence of matter alone, without any special arrangement, does not necessitate the existence of organisms with their complex patterns of behavior. However, this leaves open the possibility of accounting for organic phenomena, including the coming-to-be of individual organisms, in terms of the motions of matter in some particular configuration (for example it leaves open that we could account for the origin of a bird in terms of the particular arrangement of matter to be found in a fertilized egg). It thus leaves room for a second and weaker kind of explanation, one that accounts for organic phenomena by appeal not just to the powers of matter as such, but also—and perhaps more importantly—to the way in which the matter comprising the organism at any given time is arranged. It is this kind of explanation, corresponding to the second kind of mechanical inexplicability, which Kant takes to be ruled out by the non-machine-like character of organisms. For the latter entails that we cannot identify an organism with a certain arrangement of matter, and hence that organic change cannot be explained by showing how one material configuration follows from another according to the laws of motion.

[29] This point and its implications, are developed more fully in "Kant on Understanding Organisms."

Moreover, we can reinforce the distinction between these two kinds of mechanical inexplicability by noting that they play quite different roles in Kant's account of organisms. The first kind, as was made clear at the outset, constitutes part of Kant's argument for regarding objects in teleological terms. It is because of this kind of mechanical inexplicability that we have to regard them, like artifacts, as purposes.[30] But the second kind is of a piece with the other feature invoked in Kant's characterization of organisms, namely their status as natural. If we are to regard organisms as natural, we cannot regard them, like artifacts, as arrangements of material parts whose unity is externally imposed. Rather, we must view them as internally unified: the parts of which they are composed must "connect themselves into the unity of a whole" (§65, 373) and hence be reciprocally cause and effect of one another's existence. It is because of this requirement on viewing organisms as natural that we cannot account for their behavior in terms of the motion of independently existing material parts.

4.

Comparing Kant's view of organisms with that of Aristotle can illuminate the distinction I have been trying to draw. For, as I now want to argue, we can find a parallel distinction between two strands of thought in Aristotle's natural teleology.[31] The first strand of thought appears in *Physics* II. 8–9, where Aristotle is criticizing the view that natural things are produced and exist through material necessity alone. He describes this view in II.8 as the view that "since the hot and the cold and the like are of such and such a kind, therefore certain things *necessarily* are and come to be" (198b11–14).[32] If one holds this view, he says at II.9, it is

> just as if one were to suppose that the wall of a house necessarily comes to be because what is heavy is naturally carried downwards and what is light to the top, so that the stones and foundations take the lowest place, with earth above because it is lighter, and wood at the top of all these as being the lightest. (200a1–5)

But of course a wall does not come to be in this way: stones, earth and wood will not produce a wall through their own powers of motion, even though those powers make them suitable to serve as the material of a wall. Rather, "though the wall does not come to be *without* these, it is not *due* to these, except as its material cause; it comes to be for the sake of sheltering and guarding certain things" (200a5–7). The case is similar, Aristotle goes on to say, in all things which involve "that for the sake of which": "the product cannot come to be without things which have a necessary nature, but it is not due to these (except as its material); it comes to be for an end" (200a7–10).

The context makes clear that Aristotle primarily has in mind plants and animals, and their organic parts. Inorganic matter left to its own necessary workings will no more produce an animal than stones, earth and wood will produce a wall:

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[30] I offer an account of this argument in "Kant on Understanding Organisms."

[31] I am not claiming that Kant was directly influenced by Aristotle's writings on natural teleology. However, the broadly Aristotelian character of much eighteenth-century biology, as well as Aristotle's apparent influence on other aspects of Kant's thought, suggest that there may be an indirect historical connection responsible for the parallel I go on to elaborate.

[32] Translations of Aristotle are from *The Complete Works of Aristotle: The Revised Oxford Translation of Aristotle*, Jonathan Barnes, ed. (Princeton: Princeton University Press, 1984).

the powers of matter are insufficient on their own to account for the determinate structure characteristic of living things. He makes the point again in *Generation of Animals* II.1 with an explicit analogy between the organic parts of animals, and artifacts:

> Just as we should not say that an axe or other instrument or organ was made by the fire alone, so neither shall we say that foot or hand were made by heat alone. The same applies also to flesh, for this too has a function. While, then, we may allow that hardness and softness, stickiness and brittleness, and whatever other qualities are found in the parts that have life and soul, may be caused by mere heat and cold, yet, when we come to the principle in virtue of which flesh is flesh and bone is bone, that is no longer so; what makes them is the movement set up by the male parent, who is in actuality what that out of which the offspring is made is in potentiality. This is what we find in the products of art; heat and cold may make the iron soft and hard, but what makes a sword is the movement of the tools employed, this movement containing the principle of the art. (734b27-735a3)[33]

The powers of the elements, such as heat and cold, are sufficient to produce such qualities as hardness and stickiness, but not the determinate form in virtue of which an axe is an axe, or flesh, flesh. For this there is required in addition a specific movement, which is initiated either by the artisan, or by the male parent, but which in either case is for the sake of something.

According to this first strand of thought, then, the existence of an organism cannot be accounted for in terms of the powers of matter alone: and this is a point on which organisms are analogous to artifacts.[34] But at the same time—and this is

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[33] We find the same analogy in *Meteorology* IV.12, 390b3-14, with the difference that Aristotle there takes heat and cold to be sufficient to form the homoiomerous parts of animals (such as flesh, bone, hair, sinew): it is only the anhomoiomerous parts (such as head, hand or foot) which require a cause in addition to "cold and heat and their motion."

[34] This claim apparently conflicts with Aristotle's commitment to the view that some species of organism are spontaneously generated. Aristotle gives examples of organisms produced this way at *History of Animals*, V.1 (where he describes insects as generated out of putrefying earth), V.15 (shellfish out of mud and slime), and V.19 (insects out of dew, decaying mud, timber, excrement). The most detailed discussion of spontaneous generation is to be found at *Generation of Animals* III.11, where Aristotle describes the production of such organisms in terms of the action of *pneuma*, which contains vital heat, or more literally "soul-heat": organisms form quickly when the *pneuma*, with its soul-heat, gets enclosed, forming a "frothy bubble" (762a18–25). However, while Aristotle's commitment to spontaneous generation raises large problems which I am unable to address here, I want to note a few considerations which suggest that the conflict is not as serious as might appear. Most importantly, even though Aristotle does allow that matter of certain specific kinds is capable of generating organisms, he seems to hold that the powers of the matter in question go beyond the heat, cold, wet and dryness of the four terrestrial elements. The matter in question has to include *pneuma*, endowed with soul-heat; and while there is much disagreement about what Aristotle means by *pneuma* and "soul-heat" in the context of his theory of generation, he seems to think that the *pneuma* is not just hot air. For he distinguishes the heat of *pneuma* from the heat of fire: *pneuma*, he says, is "analogous to the element of the stars" (*Generation of Animals* II.3, 736b35-737a6). So if we qualify the claim (i.e. that matter on its own cannot produce organisms) as applying only to the four terrestrial elements, then the conflict is removed. Furthermore, in *Metaphysics* VII.9, Aristotle upholds the analogy with artifacts even for spontaneously generated organisms by saying that their production requires a movement like that of the workman's tools in the case of an artifact, or of a seed in the case of organisms that are generated in the usual way. The matter which produces spontaneously generated organisms is of a special kind which can "move itself in the particular way" required for the production of an organism (1034a14): "the natural things which . . . can be produced spontaneously are those whose matter can be moved even by itself in the way in which the seed usually moves it; but those things which have not such matter cannot be produced except by parents" (1034b4–6). Finally, it should be borne in mind that the case of spontaneous generation is exceptional: most species of plants and animals are generated by a parent, and their generation is for the sake of an end.

the second of the two strands of thought—Aristotle holds that an organism is unlike an artifact in having a nature, that is to say, a principle of change and of staying the same which belongs to it essentially. Aristotle's most explicit discussion of this point is at *Physics* II.1, where he says that plants and animals, as well as the simple bodies (earth, air, fire and water)

> differ from things which are *not* constituted by nature. For each of them has within itself a principle of motion [*kinēseōs*] and of stationariness [*staseōs*] (in respect of place, or of growth and decrease, or by way of alteration). (192b12–15)

He goes on immediately to contrast them with artifacts:

> On the other hand, a bed and a coat and anything else of that sort, *qua* receiving these designations—i.e. in so far as they are products of art—have no innate impulse to change. But in so far as they happen to be composed of stone or of earth or of a mixture of the two, they *do* have such an impulse, and just to that extent—which seems to indicate that nature is a principle or cause of being moved and of being at rest in that to which it belongs primarily, in virtue of itself and not accidentally. (192b15–23)

As this passage makes clear, artifacts differ from organisms (and other natural bodies) because, even though they do have a tendency to change and to resist change, that tendency belongs to them only accidentally, in virtue of the matter of which they are composed: for example, a bed has a tendency to fall, but only because of the heaviness of earth which enters into its composition, and not because of any property belonging to it *qua* bed.

Aristotle goes on to say more about what is involved in the idea of a thing's nature being a principle of change in the thing "in virtue of itself and not accidentally":

> I say 'not accidentally', because (for instance) a man who is a doctor might himself be a cause of health to himself. Nevertheless it is not in so far as he is a patient that he possesses the art of medicine: it merely has happened that the same man is doctor and patient—and that is why these attributes are not always found together. So it is with all other artificial products. None of them has in itself the principle of its own production [*poiēseōs*]. But while in some cases (for instance houses and the other products of manual labor) that principle is in something else external to the thing, in others—those which may cause a change in themselves accidentally—it lies in the things themselves (but not in virtue of what they are). (192b23–32)

Two points are important here. The first is that a thing's having a nature is a matter of its having a principle of change where the change is essentially and not accidentally in the thing *itself*. So a doctor's healing himself is not an example of the kind of change attributable to a nature, since it is only accidental that the doctor heals (and is healed by) himself, rather than healing (or being healed by) another person.[35] The second is that Aristotle implicitly identifies a thing's having a nature with its having in itself "the principle of its own *production*" (my emphasis). The principle of an artifact's production either lies outside the artifact (as in the case of a house), or is in the artifact only accidentally (as in the case of the healthy doctor). In contrast, at least by implication, natural things have in

[35] This point is elaborated in Sarah Waterlow [Broadie], *Nature, Change and Agency in Aristotle's Physics* (Oxford: Oxford University Press, 1982), 39–41.

themselves the principle of their own production, as well as of their own change of place, growth, and alteration.

The idea that animals produce themselves, and the corresponding contrast between animals and artifacts, is brought out explicitly in the section of *Generation of Animals* II.1 from which I quoted earlier in connection with the first strand of thought. Here, as we saw, Aristotle draws a parallel between the parts of animals, and artifacts. Hand, foot, flesh and bone are like an axe or a sword in that they do not come to be by fire or heat alone: to make them a specific movement is required, which in the case of artifacts is "the movement of the tools employed, this movement containing the principle of the art." But he also points out that the movement in the case of the parts of animals is not the movement of the artisan's tools, but rather "the movement set up by the male parent, who is in actuality that out of which the offspring is made is in potentiality." And, as the continuation of the passage makes clear, this is associated with a marked disanalogy between artifacts and organisms: the principle by which an artifact is produced lies outside the artifact, in its maker, whereas in the case of the organism it lies in the organism itself. Thus Aristotle concludes his discussion of the formation of animal parts by saying that, in the case of the sword, the art whose principle is contained in the movement of the instruments "exists in something else, whereas the movement of nature exists in the product itself, issuing from another nature which has the form in actuality" (735a3–5).[36]

At this point we should begin to see a parallel between Kant's view of organisms and that of Aristotle. For their views share a common logic that is reflected in the two strands of thought I have just identified. On the one hand, Kant and Aristotle both hold that the powers inhering in matter as such (whether it be Newtonian matter with its attractive and repulsive forces, or the Empedoclean elements with their characteristic sensible qualities and tendencies towards motion) are insufficient to account for the existence of organisms with the regularities they manifest: a point which can also be put by saying that matter in a state of chaos will not of itself give rise to organisms. For both of them, this is something that organisms and artifacts have in common; and both of them invoke it as part of their argument for understanding organisms in teleological terms. But on the other hand, they both emphasize a disanalogy between organisms and artifacts in so far as the principle of an organism's production, growth and maintenance lies within the organism itself (or in another organism which is identical with it in respect of species). And this idea of organisms as self-producing is not invoked by Aristotle, any more than it is by Kant, as part of an argument for teleology. Rather, for both philosophers it is of a piece with the idea that organisms are natural beings rather than products of art.

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[36] In so far as the "self-producing" character of an organism is bound up with the organism's being produced by a parent which is identical with it in respect of form, it does not seem to apply to spontaneously generated organisms. For, as Aristotle says explicitly in several passages (for example at *Metaphysics* VII.9, quoted in the note before last, and at *On the Soul* II.4), such organisms do not reproduce their like. This raises a problem about how to understand them as having natures, but I shall not try to address it here. Instead, I shall simply issue the qualification that what I go on to say about Aristotle's view of organisms applies only to those species of organisms that are not spontaneously generated.

The parallel is strengthened when we consider that for Aristotle, as well as for Kant, this second strand of thought carries with it a commitment to what I have been calling a "non-machine-like" view of organisms. In contrast to the case of an artifact, which is composed out of pre-existing parts or matter, the parts of an organism (including the matter of which it is composed, such as flesh or bone) do not exist independently of the organism but rather come into existence with it and perish with it. Thus, turning again to Aristotle's discussion of the formation of animal parts in *Generation of Animals* II.1, we read that

> the semen is of such a nature, and has in it such a principle of motion, that when the motion is ceasing each of the parts comes into being, and that as a part having life or soul. For there is no such thing as face or flesh without soul in it; it is only homonymously that they will be called face or flesh if the life has gone out of them, just as if they had been made of stone or wood. And the homogeneous parts and the organic come into being together. (734b22–28)

The living thing does not come to be as a machine does, by being assembled out of previously formed parts; rather the parts come to be as already "having life or soul," which implies that the living thing is already in a sense present when the first part comes to be. Similarly, the parts of an organism cannot survive its death, as the parts of a machine can survive its destruction: the face and flesh which may appear to remain are so called "only homonymously," and hence are not the same as existed in the living organism.[37] Nor are such parts as face, hand or foot formed

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[37] The aspect of Aristotle's view to which I am drawing attention in this paragraph has been remarked on by a number of commentators, including J.L. Ackrill, W. Charlton, Waterlow [Broadie], and Myles Burnyeat. See Ackrill, "Aristotle's Definitions of Psuchê," first published in 1972 and reprinted with original page numbering in Jonathan Barnes, Malcolm Schofield and Richard Sorabji, eds., *Articles on Aristotle, iv; Psychology and Aesthetics* (London: Duckworth, 1979), 125–26; Charlton, *Aristotle's Physics I and II* (Oxford: Oxford University Press, 1970), 76–77; Waterlow, *Nature, Change and Agency*, 72–73 and 88–89; and Myles Burnyeat, "Is an Aristotelian Philosophy of Mind Still Credible?" in Martha Nussbaum and Amelie Rorty, eds., *Essays on Aristotle's De Anima* (Oxford: Oxford University Press, 1992), 25–26. Burnyeat in particular has emphasized the "homonymy principle" (invoked in the passage I just cited from *Generation of Animals* II.1 and in many other passages from Aristotle) as a ground for ascribing this view of organisms to Aristotle. Against this, S. Marc Cohen has argued on the basis of *On the Soul* II.1, 412b14–15, and *Meteorology* IV.12, 370a7–19, that the principle applies also to artifacts ("Hylomorphism and Functionalism," in Nussbaum and Rorty, 70–71); to the extent that this is true, the homonymy principle would not appear to establish a principled difference between artifacts and organisms of the kind I am suggesting. However, as Michael Woods points out, Aristotle does not invoke the homonymy principle for *parts* of artifacts (e.g. bricks) as he does for parts of organisms (e.g. eyes), and I am inclined to agree with him that Aristotle would not have been tempted to deny that "a brick not integrated into a larger structure was only homonymously a brick" ("Human Being and Individual Soul," in T. Scaltsas, D. Charles and M.L. Gill, eds., *Unity, Identity and Explanation in Aristotle's Metaphysics* (Oxford: Oxford University Press, 1994), 284. A similar view is expressed by G.E.R. Lloyd, "Aristotle's Psychology and Zoology," in Nussbaum and Rorty, 164–65.

Complicating the picture, Jennifer Whiting and Mary Louise Gill have argued independently that there is a sense in which the homoiomerous parts such as flesh and bone survive the organism. For they claim that there are in fact two kinds of flesh: "functional" flesh, which exists only within the living organism, and "compositional" (Whiting) or "material" (Gill) flesh, which consists in a certain ratio of elements necessary (but not sufficient) for the existence of functional flesh. (See Whiting, "Living Bodies," in Nussbaum and Rorty, 77–85, and Gill, "Material Necessity and *Meteorology* IV.12," in Wolfgang Kullmann and Sabine Föllinger, eds., *Aristotelische Biologie* [Stuttgart: Franz Steiner Verlag, 1997], 156–57.) However, this does not in itself tell against the view that the organic or functional parts of an organism (both the anhomoiomerous parts, and functional flesh and bone) cannot exist without the organism: it is closer to the view, a version of which is discussed in the text below, that the organism is composed of elemental parts which can exist independently of it.

out of antecedently existing flesh and bone, the way that the parts of a machine or other artifact might be forged out of metal or sculpted out of wood, for "the homogenous and the organic parts come into being together."[38]

Now in section 3, in our discussion of the parallel commitment in Kant's view, we considered a question about how much Kant means to rule out when he denies that organisms are machines. Does he mean to deny, not only that an organism can be viewed as a machine composed of organic parts (e.g. leaves and roots), but also that it can be viewed as a machine assembled out of pre-existing parts of inorganic matter? I argued that Kant should be read as holding the stronger view. To say that organisms are non-machine-like is to rule out *any* sense in which an organism is composed of pre-existing parts, organic or inorganic. A parallel question can be raised for Aristotle. Does Aristotle mean to rule out the possibility that, even though an organism does not consist of independently existing *organic* parts, it can nonetheless be regarded as a certain arrangement of matter at a more fundamental level—that is, elemental matter? If he does not, then organisms might after all be viewed as machines capable of growth, reproduction and other biological functions simply in virtue of the interactions of the earth, air, fire and water, which are their ultimate constituents. As in the hypothesis we envisaged (and rejected) for Kant, these machines would be self-maintaining, self-repairing and self-reproducing, and their constituent matter would be constantly replaced. But we could still account for the behavior of any one of them at any time in terms of the arrangement of the matter comprising it at that, or some earlier, time.

While the question is a controversial one, there are reasons to think that Aristotle would not accept this view of organisms. J.L. Ackrill has argued that the elements are "too remote" to serve as the matter of a living organism: thus the only candidates for the matter are the organic parts, which, as we have already seen, lack independent existence.[39] And even if the elements, which apparently enter into the formation of organisms, do in some sense continue to exist within them, it does not appear that they do so in anything like the way that the parts of a machine exist within the machine. Thus Sarah Waterlow [Broadie] has argued that, even though a living organism is in a sense composed out of the elements, the elements are either not actually present in the organism, or, if they are actually present, are modified in such a way that there can be no question of explaining the organism's behavior in terms of the powers they possess independently of the organism.[40]

Moreover, this is just what we might expect in view of Aristotle's conception of organisms as endowed with natures. For, as Waterlow also argues, something counts as having a nature in Aristotle's sense only if it is a substance, that is to say, only if it has *per se* unity. Something whose unity is merely *per accidens* does not have a

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[38] I follow A. L. Peck (footnote to his Loeb Classical Library translation of *Generation of Animals* [Cambridge: Harvard University Press, 1953]) in taking "organic parts" here to refer to the anhomoiomerous (non-homogeneous) parts.

[39] "Aristotle's Definitions of Psychê," 130–31. However, Whiting argues that the textual support offered by Ackrill is inadequate ("Living Bodies," 81–82).

[40] *Nature, Change and Agency*, 81–86.

nature of its own to which its changes can be ascribed: rather, its changes must be ascribed to the natures of the substances that enter into its composition. But the unity of a machine, like that of any artifact, is *per accidens* rather than *per se*. A machine is a collection of more primitive constituents, and it moves and changes as it does in virtue of the motions and changes of those more primitive constituents, not in virtue of any principle belonging to the machine in its own right. Thus a view on which organisms consisted of arrangements of elemental matter would deprive them of their status as substances endowed with natures. Instead, the only true natural substances would be the elements themselves, and organisms would be like artifacts (which are not genuine substances and which do not have natures), consisting merely of these substances in various arrangements and dispositions.[41]

I have been arguing in this section that Kant's two kinds of mechanical inexplicability are parallel to two strands of thought in Aristotle: the first supporting a teleological conception of organisms, and emphasizing the analogy between organisms and artifacts; the second supporting a conception of organisms as natural, and emphasizing the way in which organisms differ from artifacts. But there are important differences between Kant's and Aristotle's conceptions of natural teleology which might appear to undermine any such parallel. One difference bears on their respective conceptions of the role of teleology in understanding organisms. For Kant, teleology has a merely regulative role: it is a condition of our investigating living things that we regard them in terms of purposes, but it does not follow that living things really are produced and maintained by goal-directed powers (whether inside or outside nature). Whereas for Aristotle, organisms really are for the sake of something: teleology is required not merely for our understanding of organisms, but is integral to the processes by which organisms are produced and maintained in existence.

This difference, however, is not as important as might appear. For on Kant's view, regarding organisms as purposes is not just a temporary expedient we must adopt pending a more complete understanding of mechanical nature, but something which is in principle indispensable given the discursive nature of our human intellects. While Kant leaves open that an intuitive intellect such as God's might be able to understand the possibility of organisms from the nature of matter alone, and hence without need to invoke the concept of purpose, this is impossible for human beings given that, like all our empirical concepts, our concept of matter is derived from sensory experience rather than being given to us by intellectual intuition. Matter as it must be conceived by human beings—that is, matter as understood in terms of moving forces—is thus no more capable on its own of producing and maintaining living things than the Empedoclean elements are for Aristotle. And as long as we restrict ourselves to the human point of view (a point of view which Aristotle does not question) the possibility of living things requires teleology no less for Kant than for Aristotle.[42]

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[41] *Nature, Change and Agency*, 48–52.

[42] Compare W. Wieland, "The Problem of Teleology" (originally published 1970 as chapter 16 of *Die Aristotelische Physik* [Göttingen: Vandenhoeck und Ruprecht, 1962]; reprinted in translation with original page numbering in Jonathan Barnes, Malcolm Schofield and Richard Sorabji, eds., *Articles in*

A second important difference bears on Aristotle's and Kant's respective conceptions of what is involved in a living thing's counting as natural. We have seen that Aristotle associates the naturalness of a living thing with its possessing a nature: an "inner principle of change and staying the same" in terms of which we can account for its behavior. But like other philosophers influenced by the "new science" of the seventeenth century and its development by Newton in the eighteenth century, Kant rejects the Aristotelian ontology of a multiplicity of individual substances endowed with specific natures. Saying that plants and animals are natural products does not commit him to saying that they have Aristotelian inner principles of change; instead, it appears to imply only that they are not brought into existence by the will of an intelligent agent.

However, Kant's view of organisms as products of nature does nonetheless commit him to a position that, to some extent, parallels Aristotle's: that the characteristic regularities exhibited by organism are part of the natural order. Such biological laws as the law by which oaks produce acorns and acorns in turn produce oaks are genuine laws of nature, and grasping them is part of what is required if we are to achieve a full understanding of nature's workings.[43] We can see the point here by contrasting the regularities exhibited by organisms with the regularities that would be exhibited by a man-made automaton capable of maintaining itself and producing replicas of itself. It is true that once the automaton is in existence, its subsequent behavior, including the behavior leading to the production of further automata, will be natural in the sense that it will follow in accordance with natural laws from the arrangement of its parts and from the arrangement of the material in its environment. And this will be true also of the behavior of the subsequent automata and the way in which they produce replicas of themselves in turn. However, the regularities through which the automata maintain themselves and produce one another will not themselves be natural regularities, for they will reflect an organization imposed on the natural workings of matter by the maker of the original automaton. It will not be a law of nature that one automaton produces another, in the way that Kant believes it to be a law of nature that natural things produce their like; and while we may be interested in looking into how one automaton is capable of producing another, such an enquiry will be part of engineering rather than the investigation of nature.

Aristotle i: Science [London: Duckworth, 1975]). Wieland claims that "teleology has no greater. . . importance in [Aristotle's]. . . work than it has in Kant's philosophy" (276), not because Kant is more of an Aristotelian than usually thought, but rather because Aristotle is more of a Kantian. All that Aristotle's analysis of natural teleology provides, he says, is "the proof that we are *allowed* to use, for natural processes, the conceptual apparatus of goal and purpose which we use already in common modes of speech" (271). But if this were so, then Aristotle's natural teleology would be even weaker than Kant's, since Kant holds that we are *required* to use this conceptual apparatus if we are to have any understanding of—or even to describe—the workings of organic nature.

[43] For example, Kant describes it as a "known law of nature" that one tree generates another (§64, 371), and he refers to the laws by which organisms are produced as "known laws of experience [*Erfahrungsgesetze*], according to which natural science must judge its objects" (§68, 382); see also his mention of a "natural law" of the causality of purposive forms in nature (§66, 377). In the *Only Possible Proof* he describes the theory of epigenesis as ascribing to individuals "the capacity of generating their like according to a regular law of nature [*gemäss einem ordentlichen Naturgesetze*]" (2:114); even though this terminology is not used in the parallel discussion of epigenesis and its rival theories in the *Critique of Judgment* (§81, 422–24), it is clear that Kant's view on this point remains the same.

Thus even though Kant does not officially endorse the Aristotelian idea of living things as individual substances endowed with specific natures, he nonetheless agrees with Aristotle in taking the changes undergone by living things, *qua* members of the species to which they belong, as due to irreducible principles of nature. For both philosophers, the study of nature requires the investigation, not only of the regularities governing inorganic matter, but also of the regularities characteristic of each species of living thing.[44] In contrast to the case of automata, whose characteristic behavior is determined only in part by natural principles, and much more saliently by the particular way in which natural principles are exploited by the inventor or engineer, the characteristic behavior of organisms is entirely due to natural principles. What is natural is not just the way in which the behavior follows from the initial form or structure of the organism, but the form or structure itself: the form or internal constitution whereby an acorn is capable of growing into an oak is no less natural than the processes through which, given the constitution of the acorn, the oak comes to be.

5.

In conclusion, I want to say something briefly about how the recognition of this distinction can help us to evaluate Kant's and Aristotle's views about organisms in the light of recent science. In spite of the huge scientific differences—especially in physics and cosmology—which separate Kant's time from Aristotle's, the chemistry and biology to which Kant was committed remain deeply Aristotelian. Kant's views about organisms, no less than Aristotle's, may thus appear to have been completely invalidated by the subsequent, revolutionary, developments in these fields. In a shift marked in its early stages by Friedrich Wöhler's synthesis of urea in 1828, and leading to the spectacular discoveries in molecular biology in the latter half of the 20th century, the need to invoke an irreducible "formative force" specific to organisms has been shown to be illusory. Organisms are composed, not of a special kind of organic matter, but of elements common to the non-living world also: what differentiates plants and animals from non-living things is simply a matter of how the atoms of these elements are arranged.

But if we recognize the distinction I have been arguing for in this paper, we can see that the triumph of molecular biology invalidates only one of the two strands of thought I have identified. In allowing us to construe organisms on the model of machines, it presents a prima facie threat to that aspect of Kant's and Aristotle's view which most of us would be inclined to favor: namely that organ-

[44] This is something of an over-simplification given that Kant, unlike Aristotle, is prepared to envisage the hypothesis that the various species are descendants of a more fundamental species or plurality of species (§80, 418–19; see section 2 above). To the extent that Kant allows that hypothesis, he will allow that an understanding of the workings of nature need not include an understanding of each species individually, but can be confined to the more fundamental principles which govern the behavior of the ur-species and which ultimately account for the production and behavior of the derivative species. (Aristotle also allows that the understanding of living things need not involve an understanding of each species individually, but can include a grasp of principles common to groups of species; see *Parts of Animals* I.1, 639a15-639b7 and I.4, 644a25-644b8. But since he does not endorse an evolutionary hypothesis, he has less justification for that position.)

isms are to be regarded as products of nature rather than divine artifacts.[45] But it does not present a challenge to the more controversial aspect of their view, namely their commitment to teleology. For that commitment—at least in so far as it is based on scientific considerations—depends on the claim that we cannot account for the regularities of organisms in terms of the regularities of inorganic matter as such, regardless of its specific arrangement. And that claim can be maintained even if we allow that organisms are not essentially self-causing in the way Kant and Aristotle believed, but instead maintain and replicate themselves only in virtue of the special arrangement of the atoms of which they are composed.

What might instead appear to challenge the argument for teleology is another great contribution to our present-day understanding of organisms: namely the theory of evolution by natural selection. For although this theory, at least as developed so far, offers an account only of how more complex organisms developed from less complex ones, it offers a promising approach for understanding the origin of life itself from inanimate matter. All we need to suppose is that at some point in the history of our earth certain fairly simple molecules arose which were capable of replicating their own structure with occasional variations. We can then see how the kinds of molecules characteristic of living things might have come about simply through the natural selection of those variants which replicated more frequently, and how the "selection pressures" on these might in turn have given rise to the complexity characteristic of actual organisms.[46]

But here again it is helpful to keep apart the two strands of thought I have distinguished. For, rather than seeing the theory of natural selection as a challenge to the argument for a teleological understanding of organisms, we can more plausibly see it as a defense of the view that organisms are natural. The argument for teleology, as we have seen, can be put by saying that matter has no natural tendency to organize itself into the kind of regular forms characteristic of organisms: while the nature of matter is such as to necessitate certain outcomes (such as, in Kant's *Universal Natural History*, the existence of the celestial system), the presence of plants and animals is not among these. But this argument is not undermined by the theory of natural selection. For natural selection ascribes a crucial role to chance or contingency. Rather than showing how matter *had* to become organized into plants and animals, in virtue of the laws of its own nature, it shows how matter *could* have become so organized: not in virtue of the laws of its

[45] Thus Michael Behe, in *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: The Free Press, 1996), has tried to argue for creationism precisely on the basis of the complex machine-like structures revealed by biochemistry. Ludwig von Bertalanffy also invokes the argument that, if organisms are machines, then they require an engineer (*Modern Theories of Development,* J.H. Woodger, trans. [first published 1933, reprint New York: Harper, 1962], 36–40). But he uses it to opposite effect, namely as a *reductio* of the identification of organisms with machines.

[46] See, for example, the non-technical accounts given by A.G. Cairns-Smith, *Seven Clues to the Origin of Life* (Cambridge: Cambridge University Press, 1985) and by John Maynard Smith and Eörs Szathmáry, *The Origins of Life: From the Birth of Life to the Origin of Language* (Oxford: Oxford University Press, 1999).

own nature, but in virtue of a series of contingent (although not necessarily improbable) events.[47]

What natural selection does undermine, by contrast, is the argument that the presence of plants and animals requires a divine artificer. For it allows us to see how organisms could arise through natural processes, and hence qualify—in spite of their teleological character—as products of nature. That aspect of Kant's and Aristotle's view was challenged, I just suggested, by the achievements of molecular biology, which encourage us to regard organisms on the model of highly complex artifacts. But the theory that life originated through natural selection offers a response to that challenge by showing how these artifact-like structures could have arisen without the intervention of a conscious agent.[48] Admittedly the conception of "natural" here is very different from the conception which Aristotle and Kant would have accepted. For, as I pointed out a moment ago, the kind of natural production hypothesized by the theory of natural selection allows a central role to chance: and chance is excluded from both Aristotle's and Kant's conception of nature. But despite that caveat, we can still see the selectionist account as playing something of the same kind of role for us that the non-machine-like character of organisms plays for Aristotle and Kant. Like the non-machine-like character of organisms, it enables us to avoid a Platonic conception of organic form as supernaturally imposed on independently existing matter. Yet it does not enable us, any more than the non-machine-like view of organisms, to dispense with teleology.

The suggestions presented in this last section—in particular, that recent developments in biology do not undermine the need for teleology in accounting for organisms—are controversial and require more defense than I can give here. My point in this section, however, has been, not so much to defend Kant's and

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[47] Stuart Kauffman challenges what he takes to be the standard view among biologists that natural selection is the primary or sole source of biological order, arguing instead that, given sufficient chemical complexity, molecules self-organize into living systems. As he puts it in his non-technical account, *At Home in the Universe* (Oxford: Oxford University Press, 1995), "whenever a collection of chemicals contains enough different kinds of molecules, a metabolism will crystallize from the broth," resulting in what he calls "order for free" (45). On this view, in contrast to the selectionist view, matter in chaos (assuming sufficient complexity) not only *can* but *must* become organized into living things. To the extent that this theory is taken as the sole explanation for biological regularities, then it represents the kind of view Kant dismisses as "contrary to reason"—namely one on which "crude matter could have formed itself [into organisms] according to mechanical laws" and that "matter of itself could have arranged itself in the form of a self-maintaining purposiveness" (§81, 424). Such a theory would undermine Kant's argument for teleology as I have interpreted here, since it would show that organisms are, in the relevant sense, mechanically explicable. However, it is hard to believe that the kind of self-organization Kauffman describes is sufficient to account for all or even most of the regularity exhibited by living things, and Kauffman himself concedes that it is just one part of an account that will include chance and natural selection (*At Home in the Universe*, 185–86).

[48] This response is rejected as inadequate by Behe, who claims that the incremental changes that make possible natural selection could not account for what he calls the "irreducible complexity" of living systems—the fact that they consist of a multiplicity of well-matched parts all of which are required for the functioning of the system. (Bertalanffy, citing earlier discussions by Sapper and Jordan, also argues that natural selection is insufficient to account for the origin of organisms as construed on the "machine theory," although, as noted earlier, his point is not to defend creationism but rather to attack the identification of organisms with machines [*Modern Theories of Development*, 38–40].) A convincing case against Behe's view is made by Niall Shanks and Karl H. Joplin in "Redundant Complexity: A Critical Analysis of Intelligent Design in Biochemistry," *Philosophy of Science*, 66 (June 1999).

Aristotle's appeal to teleology, as to illustrate some of the possible implications of the distinction I have been trying to draw. These implications can be rejected without affecting the more general conclusion of this paper. This is that we cannot do justice to Kant's or Aristotle's accounts of organisms without recognizing their distinct commitments, on the one hand to the teleological character of organisms, and on the other to the status of organisms as natural; and that this requires distinguishing between the two kinds of mechanical inexplicability which they ascribe to organisms.[49]

[49] Versions of this article were presented at a Pacific Division APA session in April 2000 and at McGill University and the Université de Montréal in November 2000. I am grateful to audiences on those occasions for their comments. I am also grateful for comments from Randall Amano, Sarah Broadie, Tom Ryckman, Daniel Warren and two anonymous referees.