

Chapter 14

Difficulties for Natural Law Based on Modern Conceptions of Nature

Richard F. Hassing

The expansion of human power to change the forms of things, both natural forms and social, political and cultural forms, is a hallmark of modernity. This power brings benefits to humanity that no one should minimize. But there is a problem. As Leon Kass puts it, '[e]verything is in principle open to intervention; because all is alterable, nothing is deemed either respectably natural or unwelcomely unnatural.'¹

I focus here on the role of natural philosophy and modern natural science in the expansion of human power over nature. Accordingly, in reading Kass's statement, we must be sensitive to the question, does the problem he describes arise because of the way nature really is? Or does it arise because of our own misperception and misjudgement of the way nature is? Both are partly true: nature is less Aristotelian and more malleable than Aristotle and Aquinas thought; but there is also misperception resulting from an immoderate disposition towards science, nature and human nature. Therefore, we have a twofold philosophical mission: first, deciding what natural science truly says about nature; second, correcting exaggerated and false interpretations of natural science. In the following remarks, I attempt to do both.

Early Modern Philosophy: Francis Bacon and Laws of Nature

Francis Bacon is a famous and seminal thinker for the modern project of mastery of nature. His *New Organon* of 1620 contains a remarkably prescient account of laws of nature. The idea of laws of nature in early modern philosophy is aimed at removing from science Aristotelian natural forms and ends:

When man contemplates nature working freely, he meets with different species of things, of animals, of plants, of minerals; whence he readily passes into the opinion that there are in nature certain primary forms [Aristotle's formal causes] which nature endeavors to educe [Aristotle indeed says: form . . . is the end of generation; *Metaph* 1015 a 12].²

[But] in nature nothing really exists besides individual bodies [true particles, II 8; thus no forms], performing pure individual acts [thus no potentiality] according to law [for example Newton's law of gravitational force, Lorentz's law of electromagnetic force].³

¹ Leon Kass, *Toward a More Natural Science* (New York, 1985), p. 11.

² *New Organon*, I. 66

³ *New Organon*, II. 2

And so] forms are figments of the human mind, unless you call those laws of action forms⁴

[T]he philosophy which is now in vogue [Scholastic philosophy] embraces and cherishes certain tenets . . . as with respect to the doctrine that the heat of the sun and of fire differ in kind [because celestial bodies and terrestrial bodies are essentially distinct; *Phys* 198 a 30–32]. Which things, if they be noted accurately, tend wholly to the unfair circumscription of human power . . . Whereas it is most unskillful to investigate the nature of anything in the thing itself, seeing that the same nature which appears in some things to be latent and hidden is in others manifest and palpable.⁵

What is Bacon trying to say? He is trying to say that if we study, for example, gravitation, only in the bodies that are obviously heavy, like a stone, we will never discover, as Newton did, that gravitation applies to both heavy bodies down on earth and celestial bodies up in the heavens. In fact gravitational attraction applies to all bodies of any species or kind: celestial, terrestrial, living, non-living, natural, artificial. This radical universality of gravitational attraction expresses a new type of relation between sensible effects and their intelligible causes.

The relation between the sensible and the intelligible is a standard topic in philosophy. What sort of intelligible causes best explain the sensible effects, the phenomena, that we see with our eyes and point at with our fingers, like a stone falling, a squirrel running, men arguing about politics, the sun shining and supporting all life on earth? In the history of philosophy and natural science, we find different answers to this question. For example, in Plato, the intelligible Forms or Ideas are notoriously separate from sensible particulars, such that there is no Platonic science of nature (*epistēmē physikē*), thus no Platonic biology, in sharp contrast to Aristotle. In Aristotle, the intelligible forms – formal causes – are not separate from matter, but rather are in natural substances in a special, intimate way.⁶ In fact, Aristotelian forms can exist and be at work only in their correlative matter. In the following, I focus on the Aristotelian and Thomistic account in comparison to early modern philosophy and natural science, where we find yet a third, and new type of relation between the sensible and the intelligible. Following Richard Kennington, I call this new type of relation neutral in relation to species, or species-neutral.⁷ (I apologize for this clumsy terminology but it fits.) It is typified by Newton's universal law of gravitation. The Darwinian principles of random variation and natural selection are also species-neutral.

In general, different accounts of the relation between sensible and intelligible convey different implications concerning what is within our power. Our beliefs about what is within our power in turn affect our choices, and the pattern of our choices shapes our ethical disposition, and thus our perception of the world.⁸ Therefore, it is

⁴ *New Organon*, I 51

⁵ *New Organon*, I 88

⁶ Plato, *Republic*, 509d–511c, *Timaeus* 49e. Compare Aristotle, *Phys* 2 1, 192b21–3, 193b5

⁷ Richard Kennington, *On Modern Origins: Essays in Early Modern Philosophy*, ed Pamela Kraus and Frank Hunt (Lanham, Md., 2004), pp 24–5

⁸ Aristotle, *NE* 1113a20–b2, 1114b23–5, 1115b21, 1144a33–6, 1176b27

very important to assess correctly what science really says about nature and human nature, and to correct exaggerated and unwarranted claims about nature and human nature based on incorrect interpretations of natural science. Failure to do this leads to an incoherence in our own self-understanding: we end up believing that we are no different from other animals, that we are just monkeys, and at the very same time that we are masters of the universe! How can monkeys be masters of the universe? Well, I return to my main story.

In the natural science of Aristotle and Aquinas, the relation between sensible and intelligible is, as we shall see, specified to the species, or species-specific. This means that what differentiates one species or natural kind from another is more important than what the two different species or natural kinds have in common. In the sciences of Bacon, Descartes, Newton, classical physics and Darwinian biology, the relation between sensible and intelligible is species-neutral. This means that what different species have in common is more important than what specifically distinguishes them. Modern scientific examples of what different species have in common are mass, which is common to all bodies, random variation and natural selection, and the universal genetic code, which are common to all living bodies. Aristotle and Aquinas did not know about species-neutral causes of motion in nature.⁹ Species-neutrality – even more than materialist reductionism – is the characteristic of those modern conceptions of nature that pose problems for Thomistic natural law.

Let us continue with Bacon and complete the essential idea: the species-neutral universality of laws of nature, for example, Newton's law of gravitation, brings with it new possibilities for prediction and control of natural processes, and for the alteration or transformation of one kind of body into another kind. Scientific laws of nature provide us with surprising new powers. For example, we exploit the law of gravitation in humanly controlled space flight; we transform, as it were, a terrestrial body into a celestial body. Terrestrial bodies and celestial bodies, despite their strikingly different visible patterns of motion, are not made of different materials, corruptible and incorruptible, as Aristotle and Aquinas mistakenly thought. Thus, Bacon says,

If a man be acquainted with the cause of any nature . . . in certain subjects only, his knowledge is imperfect . . . But whosoever is acquainted with [laws of nature] embraces the unity of nature in materials the most unlike [for example, a magnet and living flesh],

⁹ This is overstated in order to make a point. More precisely: Aristotle and Aquinas did not know about (1) species-neutral *active* causes of motion in nature that (2) are not given in ordinary, prescientific experience. The obvious distinction between male and female is common to all animals and many plants, and is thus species-neutral. The famous Aristotelian principle, 'all that is moved is moved by something [that is distinct from the moved]' (*hapan to kinoumenon hypo tinos anagkê kineisthai*, *Phys.* 7 1, 241b34; *omne quod movetur necesse est ab aliquo moveri*), is true of every kind of body, and is thus species-neutral. But it is a statement about what can *not* be a cause of self-motion in any mobile, namely the common *ratio* of body, that is divisibility and per se mobility; see Aquinas, *In phys.*, n. 889, and Richard F. Hassing, 'Thomas Aquinas on *Phys.* VII 1 and the Aristotelian Science of the Physical Continuum', in Daniel O. Dahlstrom (ed.), *Nature and Scientific Method* (Washington DC, 1991), pp. 109–56, also available in pdf on my website, <http://philosophy.cua.edu/faculty/rfh>.

and is able therefore to detect and bring to light things never yet done [for example, nuclear magnetic resonance imaging in medical diagnostics].¹⁰

We are told . . . that there are three kinds of heat: the heat of heavenly bodies, the heat of animals, and the heat of fire; and that these heats . . . are in their very essence and species – that is to say, in their specific nature – distinct and heterogeneous. . . . [But] the [Baconian] understanding [rejects] the notion of essential heterogeneity.¹¹

Bacon rejects the heterogeneity of Aristotelian natural forms in favour of the homogeneity of laws of nature. The heterogeneity of natural kinds – cats and dogs and people – is strikingly apparent to sense perception and ordinary experience. The homogeneity of laws of nature becomes intelligible not through ordinary sense perception but only through Method, a major theme of early modern philosophy (Bacon, Hobbes, Descartes, Spinoza). Finally, then, says Bacon,

On a given body to generate and superinduce a new nature or new natures is the work and aim of human power.¹²

I note that, in Bacon, the term ‘nature’ means quality. Bacon audaciously teaches that an Aristotelian ‘nature’ or species is really just an accidental, not essential, effect of Baconian laws and particles.

A contemporary example of generating and superinducing a new Baconian nature is the production of tobacco plants and pigs that glow in the dark (their snouts glow in the dark). Genetic scientists have superinduced bioluminescence (of fireflies and jellyfish) into plants (tobacco) and animals (pigs) that were never bioluminescent before. This is possible because there is one genetic code for all species;¹³ it is not the case that there is one genetic code for pigs, and another for jellyfish, another for fireflies, another for tobacco. The genetic code is species-neutral, not species-specific. This means that the Aristotelian doctrine of the special dependence of natural form on its own correlative matter is partly wrong, because in some way the form of a firefly – the principle of its characteristic activities – does not depend exclusively on firefly-matter. On grounds of Aristotelian species-specific principles, pigs and tobacco that glow in the dark should not be possible. Of course the prospect of applying such bizarre methods of genetic modification to human beings – specifically to human embryos – lies far in the future. But it has already been described and favourably considered by the well-known molecular biologist Lee Silver. According to Silver,

One way to identify types of human enhancements that lie in the realm of possibility – no matter how outlandish they may seem today – is through their existence in other living creatures. . . . Relatively simple animal attributes that fall into this category include the

¹⁰ *New Organon*, II 3

¹¹ *New Organon*, II 35.

¹² *New Organon*, II. 1

¹³ I am told, by Richard Sternberg (private communication), that, in fact, there are exceptions to this.

ability to see into the ultraviolet ... or the infrared range – which would greatly enhance a person's night vision ¹⁴

With this abiding Baconian intention or disposition, and its partial truths about nature in the background, let us look further at modern doctrines and discoveries about nature that pose difficulties for natural law. These arise especially in physics and biology. For convenience, let us stay with the three familiar examples that I have already introduced.

Newton, Darwin, DNA

In physics, Newton's *Principia* culminates the seventeenth-century development of mechanism and inspires the mechanical conception of the world in terms of particles and forces. In biology, Darwin's *Origin of Species* of 1859 initiates a revolution in our understanding of living nature. After Darwin, living nature consists of temporal flux, not fixed forms or species. A century later, in 1953, Watson and Crick discover DNA, the molecular basis of heredity, mutation and selection. Listen to some emblematic statements by these founders

Newton:

I deduce [by gravitational forces] the motions of the planets, the comets, the moon, and the sea. I wish we could derive the rest of the phenomena of Nature by the same kind of reasoning from mechanical principles, for I am induced by many reasons to suspect that they may all [!] depend upon certain forces by which the particles of bodies [attract and repel each other] . . . These forces being unknown, philosophers have hitherto attempted the search of Nature in vain ¹⁵

Again, Newton:

Every body can be transformed into another, of whatever kind. ¹⁶

That sounds utterly fantastic, and it is, but it follows very logically from Newton's model of the universe in terms of particles and forces. This universal model or world conception is a vast but logically simple generalization of Newton's successful gravitational theory of the solar system. The Newtonian forces-and-particles model defines the first reductionist programme in natural science: future research will be conducted on the fundamental assumption that all complex wholes are merely sums of tiny, simple parts or particles. Aristotelian forms or souls are thereby assumed either not to exist, or not to be important for our science of nature. And so a cat or a dog is assumed, for purposes of future research, to be merely a cloud of particles. This first modern doctrine of universal reductionism is based on an unwarranted generalization of Newton's warranted physics (his gravitational physics). But it captured the imagination of scientists for nearly two centuries, being finally refuted by quantum

¹⁴ Lee M. Silver, *Remaking Eden* (New York, 1997), p. 237

¹⁵ *Principia*, 1686. Preface

¹⁶ *Principia*, 1686 (Latin), Hypothesis III.

physics I would argue (and have argued¹⁷) that in fact there has never been, even in the time of Newton and regardless of quantum physics, a sound science-based argument for universal reductionism. Yet, to this day, natural science, specifically biology, remains closed to the idea of soul as a principle of organic beings. Question: Can natural law do without a notion of form or soul as a biological principle, a source of appetite, apprehension and activity in organic beings? Even a single-cell organism has preferences regarding the nutriment it metabolizes.¹⁸ Perhaps natural law can do without a concept of soul as a general biological principle. But, I wonder, is it not the case that many of our judgements about what is 'respectably natural or unwelcomely unnatural' begin with the phenomena of health and well-working in living things? This is my comment on the historical significance of Newtonian physics and its unwarranted generalization for the disappearance of formal cause or soul from the modern science of nature. Roughly speaking, after Newton, nature loses humanly meaningful content. This prepares the transition to Kant and German Idealism.

Next, Darwin:

We shall have to treat species [as] merely artificial combinations made for convenience [of language]. This may not be a cheering prospect; but we shall at least be free from the vain search for the undiscovered and undiscoverable essence of the term species.¹⁹

Note that for both Newton and Darwin, the idea of species, or formal causes in nature, for example, cat-form, dog-form, is 'vain'.

Finally, Francis Crick on the DNA sequence hypothesis or central dogma of molecular biology:

[I]he specificity of a piece of nucleic acid is expressed solely by the sequence of its bases, and that this sequence is a (simple) code for the amino acid sequence of a particular protein.²⁰

As colloquially paraphrased, 'DNA makes RNA, RNA makes proteins, and proteins make us.'²¹ Crick's statement obviously foreshadows genetic engineering.

What do these statements by Newton, Darwin and Crick convey? Clearly, not the whole or comprehensive truth about nature (they are not even mutually consistent); they convey partial truths about nature, truths about restricted or particular classes of phenomena and kinds of being (gravitational systems, organisms and molecules). Quantum physics and recent developments in the molecular biology of gene expression,²² show that these statements cannot be the whole truth about nature. But the parts or aspects of nature that are correctly described were indeed not known to

¹⁷ Hassing, 'Wholes, Parts, and Laws of Motion', *Nature and System*, 6 (1984): 195–215, and 'Animals versus the Laws of Inertia', *Review of Metaphysics*, 46 (1992): 29–61. Both are available in pdf on my website, <http://philosophy.cua.edu/faculty/rfh>.

¹⁸ See, for example, Kass, *The Hungry Soul: Eating and the Perfecting of Our Nature* (Chicago, 1999), Chapter 1.

¹⁹ *The Origin of Species*, p. 447.

²⁰ Francis Crick, 'On protein synthesis', *Symp. Soc. Exp. Biol.*, 12 (1957): 138–63, at p. 2.

²¹ Evelyn Fox Keller, *The Century of the Gene* (Cambridge, Mass., 2000), p. 54.

²² See, for example, Keller, *The Century of the Gene*, pp. 54–5, 66–7, 70–71, 99–101, 136, 141–3.

Aristotle, and not known to Aquinas, the main source of natural law. Therefore, nature is more Aristotelian than modern science thinks, but, as noted, nature is also less Aristotelian than Aristotle and Aquinas thought. And this is a source of difficulty for Thomistic natural law. When our powers were fewer, our purposes were clearer.²³

I now have two tasks: first, I must try to explain more clearly the new aspect of nature discovered by modern natural science, namely species-neutrality. Second, I (and we all) must ask, what does the term 'natural' in Thomistic natural law mean? There are several senses of 'nature' as used by Aquinas in his account of natural law. They are generic (we are all animals), specific (we are social-political and rational animals), paradigmatic (we admire excellent or virtuous human performance).²⁴ With which of these Thomistic meanings of nature do the modern scientific problems lie and what could be done to defend what is best in natural law today? Let me be practical, and jump ahead to my conclusion, and answer this two-part question right now.

Conclusion in Advance

The modern scientific problems concern mainly²⁵ the generic and the specific meanings of nature; that is the problems concern our natural inclinations towards self-preservation, health, freedom from pain, and our natural inclinations towards mating, and having and raising children.²⁶ These inclinations are biologically rooted but specifically human, specifically human in many ways but especially because of all that is involved in the development and education of human children; much more than in the offspring of any other species of animal.

Further examples of what Aquinas did not know about are the genetic science of ageing, which aims to extend healthy human life many decades, and psychopharmacology, which aims at freeing us from emotional pain, like painful memories. Many types of reproductive technology contribute to the artificial separation of sex, reproduction and parenting. These are three things that Aquinas surely assumed were by nature connected. Obviously, the project for the transformation of natural forms merges with the project for the transformation of social and cultural forms, especially marriage and the family. In general, the modern doctrines of nature as malleable go hand in hand with the radicalization of human freedom. Thus, it is widely taught today that human beings have no ends prior to choice; rather all 'ends' are created by autonomous choice.

What can be done? I think of two things: empirical social science, and, as I have already noted, philosophical interpretation of natural science. Many researchers have studied the empirical social-science data on the conditions in which children develop and function well in human society, and the conditions in which they do not. I cite my colleague in economics at Catholic University, Sophia Aguirre.²⁷ In

²³ See Kass, *Toward a More Natural Science*, p. 158

²⁴ See *ST I-II*, q. 94, a. 2 c., a. 3 c.

²⁵ Performance-enhancing drugs impact the paradigmatic level of human nature. This problem lies outside the range of my brief presentation.

²⁶ See *ST I-II*, q. 94, a. 2 c.

²⁷ See <http://faculty.cua.edu/aguirre>

addition to social-science research, philosophical interpretation of science, nature and human nature are needed. Leon Kass has already done much in this area. I would also highly recommend the work of my teachers and colleagues in philosophy at Catholic University, the phenomenologist Robert Sokolowski, and the historian and philosopher of science William A. Wallace. Needless to say, Robert Spaemann is justly regarded as among the very best contemporary moral and political thinkers.

I wonder, however, whether the fruits of ageing science – the extension by decades of healthy human life – and also of psychopharmacology, will not be very tempting and create serious problems for human life. You recall that the third level of the natural law according to Aquinas, after self-preservation and species-preservation, concerned our lives together in society, beginning with the requirement that we avoid giving offence to those among whom we live. Would living to 150 years be offensive to other, younger people? I think it would be very offensive, because it blocks renewal and regeneration. And so this would be a challenge to contemporary natural law: how to say ‘no’ voluntarily to new powers of life-extension. In general, how should we think about the problems of ageless bodies and artificially happy minds? I return now to my remaining technical task: explaining the species neutrality of modern scientific accounts of nature.

Species-neutrality, Continued

This topic is complex and requires more discussion than is possible in a short presentation.²⁸ The following remarks are unavoidably fragmentary, and may generate more darkness than light, for which I apologize. I begin with the Aristotelian, species-specific account of form and matter. This is the necessary background against which to examine modern, species-neutral doctrines and discoveries.

Aristotle:

Nature is a principle and cause of being moved or of rest in the thing to which it belongs primarily and essentially, and not accidentally.²⁹

The form is nature to a higher degree than the matter.³⁰

[A] different form requires different matter.³¹

[A]ll things that change have matter, but there is distinct matter in distinct things.³²

²⁸ See Richard F. Hassing, ‘Introduction’ and ‘Modern Natural Science and the Intelligibility of Human Experience’, in Hassing (ed.), *Final Causality in Nature and Human Affairs* (Washington DC, 1997), pp. 1–51 and 211–56. Also my exchange with Larry Arnhart, ‘Darwinian Natural Right?’, *Interpretation*, 27, 2 (1999–2000): 129–60; ‘Defending Darwinian Natural Right’, *Interpretation*, 27, 3 (2000): 263–77; ‘Reply to Arnhart’, *Interpretation* 28, 1 (2000): 35–43. The exchange with Arnhart is available in pdf at <http://philosophy.cua.edu/faculty/rfh>.

²⁹ *Phys.* 192b21–3.

³⁰ *Phys.* 193b7.

³¹ *Phys.* 194b9.

³² *Metaph.* 1069b25.

For each motion it is the subject capable of that motion which has that motion.³³

Aquinas summarizes succinctly:

[T]he soul and other natural forms are not per se subject to motion ... they are, moreover, the perfections of mutable things³⁴

I interpret these statements in the following way: form is the principle and cause of the pattern of change and stability characteristic of a natural kind as given in ordinary sense perception, for example an eagle, a dog. Different visible patterns of behavior (flying, running) require correspondingly different forms and matters, because things that move in very different ways should have correspondingly different causes of motion. This is just common sense. Dog-matter cannot receive eagle-form; dogs cannot fly, because they do not have wings. Form can be at work only in its correlative matter. Form is a holistic principle: it is in the informed natural substance as a whole, not in virtue of the material parts; this is the meaning of the term 'primarily' (*prôtôs, primo*) in Aristotle's definition of nature.³⁵ If the dog or the eagle is separated into parts, dismembered, the animal is killed, the form is destroyed.

In the tradition of Aristotelian natural science, there is an essential, not accidental connection between the way a thing moves, its material structure and the active causes of its motion. As Maimonides says, '[if] the form of the motion of the [celestial] spheres would not be indicative of their matter [incorruptible], this would be the ruin of all principles.'³⁶ Thus, things that move in essentially different ways as manifested to our senses possess essentially different kinds of matter and sources of motion. They have different natures.

Therefore, celestial bodies are essentially different from terrestrial bodies (this is the great error of medieval physics), and among terrestrial bodies, living things are essentially different from non-living things. And among animals, the kind that thinks, speaks and acts in order to be what it is – the human animal – is essentially different from any other kind. There are natural kinds of things, and they are essentially, not accidentally, heterogeneous. The stable differences in the way things appear to ordinary sense perception are effects that proceed per se, not *per accidens*, from intelligible causes and principles. This means that what the different natural kinds have in common, for example corporeality (they are all bodies), is not as fundamental as what differentiates and specifies them. How could it be otherwise? If what the different natural kinds have in common is more important than what distinguishes them, then what we human beings have in common with the other animals is more important than what distinguishes us, and so the human should be understood in terms of the non-human – understood in terms, say, of random variation and natural selection. But how could the human ever be adequately understood in terms of the non-human? The human cannot be understood in terms of the non-human. This truth is the most fundamental reason why Aristotle's science of nature is species-specific.

³³ *Phys.* 251a14

³⁴ *In Trin.* q. 5, a. 2, ad 6.

³⁵ *In Phys.* n. 145.

³⁶ Maimonides, *Guide of the Perplexed*, trans. S. Pines (Chicago, 1963), II 22, 49b, p. 319.

Against this Aristotelian (and Socratic, Platonic, Thomistic) background, the species-neutral theories and discoveries of modern natural science stand out in sharp relief. I have said enough about genetic engineering and the Baconian feats made possible by the universal genetic code. What about Darwin? The Darwinian principles of random variation and natural selection are currently understood to apply univocally to all living species. As Stephen Jay Gould said, '[t]he only thing that's happening in nature is that individual organisms are striving for personal reproductive success.'³⁷ This means that the natural living kinds or species are only accidentally, not essentially, heterogeneous. The apparently stable differences in the way things (merely) appear to ordinary sense perception are effects that proceed *per accidens*, not *per se*, from their intelligible causes, namely from variation and selection. And among animals, the human kind – despite all appearances to the contrary – is not essentially different from any other kind. We animals, we the living species, have evolved specifically different means to one and the same species-neutral end: reproductive fitness. Therefore, in this current interpretation of the results of Darwinian science, the human powers of thought and action are just survival tools. I would argue (and have argued³⁸) that this is an unwarranted and exaggerated interpretation, like the universal reductionism mistakenly based on Newtonian physics. But just as Newton was right, and Aristotle and Aquinas wrong on the question of terrestrial and celestial matter, so Darwin was right about the mutability of living species, and Aristotle and Aquinas wrong in their belief that 'the soul and other natural forms are not *per se* subject to motion'³⁹ How to give each side, Darwinian and Aristotelian, its due? I think it can be argued that, even though living species came into being from common ancestors over a long period of time, they presently possess natures that are normative and worthy of respect. In other words the term 'survival' should be taken in its species-specific and not its species-neutral sense. But this is a topic for a longer discussion.

Lastly, I discuss briefly how Newton's law of gravitation is a paradigm for species-neutral principles of motion in nature. The law says that any two bodies attract each other with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them. Think of mass: it is common to all bodies and parts of bodies, from electrons to galaxies. As such it cannot distinguish one species of body from another.⁴⁰ Therefore, the gravitational force of attraction does not depend on the kind, size, shape, internal structure or function of the two bodies in question. For this reason, in celestial mechanics, wherein the

³⁷ Stephen Jay Gould, *Darwin's Revolution in Thought* (Northampton, Mass., 1995).

³⁸ See my exchange with Larry Arnhart, cited in note 28 above.

³⁹ William A. Wallace, 'Is Finality Included in Aristotle's Definition of Nature?', in Hassing (ed.), *Final Causality in Nature and Human Affairs*, pp. 52–70; see p. 70 on formal causality and evolution.

⁴⁰ Spinoza, *Ethics* II 37 and 38, provides a perfectly succinct formulation of the meaning of species-neutrality in early modern philosophy and science: 'That which is common to all [bodies] . . . and which is equally in a part and in the whole [for example, Cartesian extension, Newtonian mass], does not constitute the essence [the Aristotelian species; *Metaph* 1030a12] of any particular thing. Those things which are common to all . . . cannot be conceived except adequately.'

bodies under study do not bump into each other, extended, divisible bodies can be taken as unextended, indivisible points, mass-points! We are now used to this way of thinking about nature, but Newton's law of gravitation is really very paradoxical and surprising. Ordinarily, the way two bodies interact is strongly dependent on what kind they are. Just think of a mouse and a cat: the mouse is repelled, the cat attracted. Think of a cat and a dog: the dog is attracted up to a critical distance at which the cat scratches its nose, and then the dog is repelled. It's a complicated and very species-specific interaction. Thus Newton's development of the idea of central forces as principles of motion in nature that are indifferent to the visible species of bodies was remarkable. The notion that such principles could give rise (via subsensible particles) to the visible species of bodies was the source of Newton's astonishing claim that, '[e]very body can be transformed into another, of whatever kind.'

In sum: universal claims like this are exaggerated and unwarranted by the particular scientific results on which they are based. Thus, extreme claims for the power of genetic engineering are not warranted by the particular results of genetic science on which they are based. And Stephen Jay Gould's claim that universal reproductive fitness is the only natural end of any living species is not warranted by the particular results of neo-Darwinian biology. Nevertheless, in each case, partial truth about nature underlies the immoderate claims. This requires some new thinking, philosophical and social-scientific, about the meaning of nature and human being.

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