Introduction

The world of Descartes' physics is austere enough to gladden the heart of the most fervent reductionist. Cartesian matter is space itself, and all that pertains to matter is no more than an elaboration of figure, size, and motion. From that bare inventory is produced everything that nature presents to our senses: the stars and planets; the rivers, seas, and mountains of our planet; its metals, stones, and oils, its plants, its animals, the human body. All forms, all powers, all qualities other than the modes of matter are evicted from the world of Descartes. Its plants and animals have no souls: nothing sets them apart from the inanimate world around them. Only in humans is there a distinct principle, a substance whose modes are not found among, or derived from, the modes of matter.

The elimination of the souls of animals and plants is of a piece with the elimination of forms and qualities generally from nature. Since living things, with their great variety of visible forms and actions, and their numerous similarities to us, offer the greatest resistance to the Cartesian program, physiology,[1] as much as physics, had to go under the knife if the program was to succeed. In certain respects this was the more radical operation. Those who, like Descartes' Aristotelian predecessors, defended forms and qualities

might well concede that in physics they were superfluous. But that living things should lack souls—that they should be nothing other than machines—was, for many of Descartes' contemporaries, an insuperable obstacle to the acceptance of his natural philosophy.

Some aspects of Descartes' work on living things have been studied: the theory of the senses and the passions, the strategy of simulation proposed in *L'Homme*, the criteria by which to distinguish bodies with souls from mere automata.[2] Descartes' physiology, by contrast, has often been given only cursory treatment or dismissed.[3] Yet he devoted about one-fourth of *L'Homme* to circulation, locomotion, respiration, and digestion;[4] a significant portion of the fifth part of the *Discours* reports on the work in *L'Homme*; the *Description du corps humain* is entirely devoted to physiology and embryology; and various notes and portions of his letters take up particular questions, notably the role of the heart in circulation. He invested perhaps even more time trying to unravel the mysteries of genera-

1. 'Physiology' (physiologia) was originally used to denote all of natural philosophy, and is so used in its infrequent occurrences in Aristotelian textbooks. In the sixteenth century it began to be used to denote the "natural part" of medicine—the study of the nature, powers, and functions of human beings. In this sense physiology included anatomy. 'Physiology' is used in the modern sense in the middle of the eighteenth century, although the older use as a synonym of 'natural philosophy' continued in Germany to the end of that century. See Rothschuh 1968:13–14, Duchesneau 1982:xiii-xiv. The Aristotelian science of the soul included both physiology and psychology in the modern sense; though it is slightly anachronistic, I will sometimes use 'physiology' to denote the part of that science that studied the operations of the vegetative soul, and also the corresponding part of Descartes' work.

2. Among recent works, see Perler 1996 on sensory representation, Kambouchner 1995 on the passions, and Giglioni 1995 on automata.

3. Recent exceptions to the rule include Bitbol-Hespériès 1990 and Grene 1993; Pichot 1993 is a guide to the texts with an insightful commentary; the new edition of Le Monde and L'Homme edited by Bitbol-Hespériès and Verder is indispensable.

tion than in explaining the behavior of light, and (if one judges by his advice to Queen Elisabeth) much more than in metaphysics. Add to this a concern, amounting to obsession according to some contemporaries, with health and the prolongation of life, and it is clear that the relative neglect of Descartes' physiology does not accord well with the portion of his working life that was given over to it. It reflects, rather, philosophers' current interests in the cognitive faculties and in questions of method.

The revolution, moreover, that in *L'Homme* was proposed in the science of life was if anything more radical than the revolution in physics proposed in *Le Monde*. Descartes proposes to eliminate the living as a natural kind. The science of life is henceforward to be, not the science of a special part of nature consisting in those things that live, and that therefore have souls, but rather an extension of physics.[5] Descartes' *Principia*, had they been completed according to plan, would have moved without a break from explaining the behavior of magnets to explaining the behavior of plants. Aristotelian natural philosophy interpolated a series of forms, of increasing perfection, between prime matter and the immortal soul. Descartes' natural philosophy has only two levels of perfection: extended substances, which are all on a par, and the soul. He does take over the characterization of animals as self-movers or *automata.* But like other verbal coincidences, this

4. In the table of contents supplied by Clerselier for his edition of L'Homme (1664), two of the five parts and 26 of 106 articles are devoted to physiology. The Description, written in 1648, was published by Clerselier with L'Homme. The Primæ cogitationes de generatione animalium, which are a series of fragments from various periods of Descartes' career, were published only in 1701, and the Anatomica, which are excerpts by Leibniz from Descaretes' manuscripts, in 1859–1860. It should be noted that despite the posthumous publication of all but the Discours, Descartes' views were circulating already in the 1640s by way of Regius and others.

5. "No epistemological frontier separated the part of physics that occupied itself with inorganic realities from that which occupied itself with organic realities" (Duchesneau 1982:xiv). The overlap in the two uses of 'physiology' mentioned in n. 1 is indicative of the lack of distinction.

one hides a shift of concept. The principle of life is no longer a form peculiar to living things: it is the heat of the heart, the same heat which is found in fire or rotting hay, and which consists in the violent motion of small particles. Though we are inclined to believe that animals, because they resemble us in so many ways, must have souls like ours, in fact there is nothing in them that resembles the soul—no sensations, no passions, no judgments or volitions. Conversely, the human soul has nothing to do with the vital operations that in Aristotelian physiology are referred to the vegetative part of the soul. These belong instead to the body-machine. In Aristotelianism the domain of the living stretches from the lowly plant to the perfect being; in Cartesianism there are two separate domains, joined only by way of the union of the human soul and its body. In neither do you find living things in the Aristotelian sense. The body-machine does not live, since it has no powers, but only passive qualities derived from the modes of extension; nor does the soul, since it has no part in nutrition, growth, or generation.

Descartes' program, then, is to explain all those functions of the body that occur in us without thought. Those functions include the functions of the vegetative part of the soul as well as those of the sensitive soul: nutrition, growth, and generation, on the one hand; sensation, passion, imagination, memory, and locomotion on the other. Of the vegetative functions, nutrition and growth were easily disposed of by adapting the accounts of his predecessors. But generation proved to be an obstacle Descartes never quite managed to overcome. In the absence of any organizing power, such as others thought to be present in the seed, the formation of the fetus must result from the operation of efficient causes acting independently of each other and of the final form. Thus is the vegetative part of the soul suppressed, together with those functions of the sensitive soul—what we would now call "reflex actions", for example—that do not require thought. The living world, humans aside, has no property, and includes no entity, that would distinguish it from the nonliving.

Part I of *Spirits and Clocks* treats first the question of the principle of life, and then the animal-machine as self-mover. Explaining the cyclical operations of the body evoked from Descartes a variety of new or adapted concepts—the system by which the pulse is produced, the fluidity of the body, the Ur-animal or basic body plan which is supposed to result from the first circular flow of the blood. Though there is only a hint at an explanation of the transmission of characters, Descartes does attempt to explain individual differences. In particular he offers, in Latin notes not published in his lifetime, two accounts of sexual difference. I conclude the first part with a discussion of two questions facing Cartesian physiology: the basis upon which parts or organs in the body are to be designated, and the role of normality or health in his project.

The "statues" of *L'Homme* are said to be machines, constructed by God so as to imitate human bodies as closely as possible. But it is clear that those machines are not just *like* human bodies: they, *are* human bodies. That notorious claim raises a number of questions, which occupy Part II of this work. What was the import in Descartes' time of calling something a machine? "Machinism" was a tool by which to bring living things within the scope of a mechanistic physics. It enabled the application to them of the analysis of capacities which the engineers of the period were beginning to codify in their descriptions of machines—the fountains and pipe organs that Descartes asks his reader to consider in *L'Homme*, for example. In principle, the analysis of capacities would break down the organism into simple mechanisms whose operations could be explained by the laws of nature. Ideally, it provides a bridge between the behavior of complex machines and the realm of the demonstrable in physics; in practice, it was a device for persuading readers that a bridge existed—if only in the mind of God.

The machine is, stereotypically, an artifact, something made. Christian philosophy had long regarded God as the *artifex maximus* and his creations as analogous to human art. There was, in that respect, nothing new in Descartes' comparison of animals and

machines. But Aristotelian philosophers instituted a difference in productive power between divine creation and human industry. God alone, or his spiritual intermediaries, can create the souls of the more perfect things in nature, especially animals. The formation of the body and its organs belongs to the seed and the womb; but the soul, which is the form of the body, must be introduced by a higher agent. Descartes, on the other hand, would have it that animals differ only in degree of complexity from the clocks and pumps we make. Their parts are finer, more intricate, but not in any sense more perfect. Unless, as Leibniz would later argue, God's artifacts are endowed with an *infinite* complexity, there is no essential distinction between his power to make animals and ours to make machines. One marker on the boundary between nature and art is thereby erased.

Descartes' earlier works—from the notes written in 1619–1620 to *L'Homme*—dwell on the possibility of *simulation*. Machines can produce illusions; they can also dispel them. In combatting our inveterate opinion that animals are not machines, Descartes urges that we imagine machines capable of simulating all the operations we see in animals, which presupposes the existence of the things simulated. On the other hand, he invites us to consider a world in which there are no animals, but only machines that more or less closely resemble the animals of the actual world. The machine-simulation would deceive us were we to encounter it, *except* that (paradoxically enough) since the animals of the actual world *are* machines, we would not, as it turned out, be deceived at all. The argument here turns on two sorts of resemblance: the *good* resemblance between various familiar mechanisms and the organs of animals, and the *bad* resemblance between the organs and operations of animals and our own. The good resemblance leads to truth, the bad to falsehood. I will consider, in Chapter 5, how Descartes manages to distinguish good resemblance from bad, and the role of simulation in the project of his physiology.

If one takes Descartes at his word, the only material individuals in nature are either regions in space or else collections of such regions moving together in one direction. Call

this "physical" unity. The body-machine evidently lacks physical unity. Yet Descartes, like everyone else, speaks of the body as if it were one thing. Even the machines of *L'Homme* are so treated, despite the absence of souls in them. What then is the principle of unity of the body? In Chapter 6 I consider the various kinds of unity a Cartesian machine, animal or human, might be said to have. In addition to physical unity, a machine has that unity which consists in the joint operation of its parts to produce, under certain conditions, a single effect or range of effects—this I call "dispositional" unity. Commonsensically, its organs also have functional unity—the eye is one thing by virtue of its power to see. Though Descartes uses 'function', 'office', and other allied terms, it is not clear that he has a basis for doing so other than our ingrown tendency to project purposes onto the objects of nature. Useful though that tendency might be in everyday life, Descartes excludes it from natural philosophy. For other philosophers of his time divine intentions provided a basis for ascriptions of functions: the functional unity of an organ rests on the intentional unity it has by virtue of having a purpose assigned to it by God. But consideration of divine intentions is, in all but the human case, again excluded by Descartes from natural philosophy.

One last sort of unity is substantial unity. In Aristotelian physiology the body of an animal can be regarded as one thing by virtue of its union with a substantial form—the soul. Descartes occasionally asserts that for him too, in the human case, the soul is the substantial form of the body. In that case, then, but in that case alone, the body has substantial unity. But Cartesian soul has nothing in it that would imply that it should be joined with a *human* body, rather than the body of a rat, or for that matter a piece of bread. What remains puzzling is that we should have the bodies we have, that so complicated a machine should be joined with a soul.

A few words, finally, about the ambitions of this work. I have not undertaken here a comprehensive study of the literature on Cartesian machines, and still less on machines

generally in early modern philosophy. My intention has been to study what are, after all, familiar texts from a slightly different point of view, emphasizing the noncognitive functions of living things, those which are shared by all. The human case retains its centrality, if only because Descartes wrote very little on animals and almost nothing on plants. But I think it fruitful to move away from an exclusive focus on cognitive powers and on the mind-body problem, and to situate Descartes' work in the history of physiology rather than in the history of psychology alone. It was, after all, his relegation of the vital powers of the soul to the body alone that helped bring about the separation of those two disciplines.