Jean De Groot. *Aristotle's Empiricism: Experience and Mechanics in the Fourth Century BC*. Las Vegas, NV: Parmenides, 2014. Pp. xxv+442. $127.00 (paper).

This is quite a fascinating book. The work is an extended argument, thoughtfully organized with careful attention to detail and sourcing. I cannot speak to whether the argument will be convincing to all. But I cannot envision the argument being presented any better.

The author's overriding thesis is that mechanics played a much more substantial role in the development of Aristotle's natural philosophy than has previously been appreciated and that appreciating the role mechanics played leads to a more subtle and nuanced understanding of key aspects of Aristotle's natural philosophy. Somewhat more specifically, I see three intertwined theses as central to the author's overall argument:

i) the (relatively uncontroversial) view that even before Aristotle's time, basic mechanics, especially those involving the lever and related devices, were well understood, including a solid understanding of the quantitative principles underlying the workings of such devices;
ii) that this understanding of mechanics played a key role in the development of Aristotle's philosophy of nature (including but not limited to

cosmology, astronomy, animal movement, the soul, and embryology); and

iii) that an understanding of the role mechanics played in the development of Aristotle's thought leads to a richer, more nuanced understanding of key Aristotelian concepts (including but not limited to potency, form, universals, phenomena, and causes).

Regarding basic mechanics: levers, pulleys, and other related devices for conveying mechanical advantage and transferring mechanical force are everywhere in our lives. The gears that form the heart of our cars' transmissions, the valve mechanisms, the serpentine belt assembly driving our cars' peripherals, the door handle mechanism, and more are basically interconnected levers and pulleys. Likewise, our doorknobs, handles with which we flush toilets and control water faucets, our light and other switches, tapered rolling pins, zippers, and countless other everyday objects similarly are at bottom levers and pulleys. In a typical day, in our waking hours we likely do not go more than a few minutes without employing some form of a lever or pulley.

Likewise in ancient Greece. As the author notes, balance scales, axes, hammers, potters' wheels and millers' stones, wagon wheels and axles, tapered rollers for crushing stone, mechanisms underlying automata commonly used in the theater, oars, rudders, sailing equipment in general, and much more were likewise commonplace. All of these are, or work on the same principles as, levers and pulleys.

The author documents well that the key quantitative principles underlying the ways in which levers and pulleys convey mechanical advantage and transfer mechanical power were well understood in ancient Greece. The author likewise documents that scholars, most notably Aristotle and those in Aristotle's school, knew and appreciated these principles. Central among these principles—really a way of understanding the basic principles in a unified way—is what the author terms the "moving radius principle" (hereafter MRP). The MRP plays a central role throughout the book and is most easily understood by way of example.

Consider a basic lever, for example, a playground seesaw. Suppose that the fulcrum is located at the midpoint of the plank and that we have put chalk marks at various intervals along the edge of the plank. As the plank moves, we know there is a precise relationship between the distances moved by any two of the chalk marks, and there is a similarly well-understood characterization of the mechanical advantage we can gain using this as a lever. Now suppose we move the fulcrum of this seesaw higher off the ground, so that the fulcrum

acts as an axis allowing the plank to swing freely in a complete circle. The chalk marks now delineate radii of different lengths. But the same quantitative principles govern the distances moved and the mechanical advantages involved.

Levers, then, can be understood in terms of moving radii. A system of pulleys attached by a rope—say as found in a block and tackle—can likewise be viewed as interconnected series of moving radii. So too for gears—gears are levers (the teeth) attached to moving radii. In short, a wide range of mechanical devices can be viewed as moving radii, and the principles governing distances covered and mechanical advantages conveyed can be summarized by what the author terms the MRP.

The author documents that the MRP was well understood in ancient Greece and then moves on to analyze a range of Aristotelian texts. The goal is to show that the MRP was central in Aristotle's approach and that viewing these texts through the lens of the MRP gives us a richer and more nuanced understanding of key Aristotelian concepts.

In some areas of Aristotle's work, we can see that his understanding of mechanics, and especially the MRP, applies fairly directly. For example, in *Movement of Animals*, Aristotle analyzes motion involving a joint directly in terms of principles involving levers. And while the application of the MRP in *On the Heavens* and related sections of the *Physics* is more nuanced, the author convincingly argues that the MRP is an important and fundamental tool in Aristotle's analysis of the movement of the heavenly bodies.

In addition to these relatively direct applications of the MRP, the author argues that the principle influences and guides Aristotle's thinking in a broader way. The MRP is used as a sort of template, a sort of habit of thought, in Aristotle's analysis of a wide range of topics that on the face of it do not look like mechanical problems. Consider, for example, Aristotle's discussions of how small changes around the heart, resulting from, say, a slight feeling of cold or overhearing an insult, can lead to large bodily changes such as shivering or redness and anger. We certainly cannot directly apply a quantitative analysis based on the MRP to Aristotle's account of these sorts of changes. But the MRP does provide a way to understand how small changes can be magnified into large changes. And, the author argues, this pattern of thinking—of using the MRP as a sort of habit of thought—is common in Aristotle's approach to a wide range of problems.

Throughout these discussions, the author intertwines analysis of a range of key Aristotelian concepts, arguing that levers and related devices suggest a richer and more nuanced way of understanding such concepts. Consider just one example. The author argues at length and using a variety of Aristotelian texts that viewing Aristotle's use of potency (*dunamis*) through the lens of the MRP suggests a different way of understanding this key concept. There has been a good

deal written in recent years, with a good deal of disagreement, about how potency ought to be understood. Generally, though, potency tends to be viewed not as an active principle, but rather as a sort of passive receptivity. And potency is often taken as a near tautology, a nearly vacuous concept, along the lines of Moliere's dormitive virtue in which the explanatory principle contains what it is that needs to be explained.

Approaching potency by thinking in terms of mechanical devices such as the lever—and the author argues that this is very much how Aristotle approached the subject—suggests an alternative view of potency. In this view, potency plays both a passive and an active role. For example, a lever does indeed have a passive receptivity, one that derives primarily from the material it is composed of and the arrangement of that material. But when a lever is put to use, the receptivity of the lever does not simply passively receive some form; rather, an outside form provides an initiating action, a sort of initiating push, which then triggers power latent within the lever and immediately results in a particular and distinctive kind of action. So thinking of potency with the lever as a model suggests Aristotle saw potency as existing in both a passive and active sense and that potency is far from a trivial concept but is instead rich in explanatory power.

I need to stress, strongly stress, that what I am saying here does not come close to doing justice to the author's arguments and analyses concerning potency. And I have not even touched on the wide range of other Aristotelian concepts the author addresses, including the general nature of Aristotle's empiricism, Aristotle's concept of *phainomena*, the workings of the soul, and more. I have read a lot of and about Aristotle, but I have never looked at Aristotle the way this author invites us to. Even if a reader is not convinced of the author's key conclusions, I think most readers will find it interesting to look at these texts, and at Aristotle's natural philosophy in general, through the lens of mechanics. As to the author's overall thesis, that mechanics played a substantial role in the development of Aristotle's natural philosophy and that recognizing this can lead to a more nuanced understanding of his views—I came away from the book thinking this rings true.

Richard DeWitt, *Fairfield University*