tation cannot be judged ignorant, even now that we have a century's advantage of him. He polished with a lapidary's care and can hardly have let this and other similar passages stand through six editions from simple oversight. As for being a villain, he is the very archhero of antiteleology. Can it be that Bernatowicz has overlooked one of "the usual excuses," or that he has in certain instances mistaken something else for teleology?

Among the things most characteristic of organisms—most distinctive of living as opposed to inorganic systems—is a sort of *directedness*. Their structures and activities have an *adaptedness*, an evident and vital *usefulness* to the organism. With sterile rigor one may say that "the hand of man grasps," that "sap rises in trees," or that "sea turtles go ashore and lay their eggs." How coincidental it is that such activities just happen to serve the necessities of the organism and of its species! How downright providential! How, in short, inescapably teleological! The "rigorous" statement lands us again squarely in the pre-Darwinian dilemma.

Darwin's answer and ours is to accept the common-sense view that "the hand of man [is] formed for grasping" (*1*), that "there has to be some sort of mechanism for raising sap" (*2*), and that "turtles go ashore to lay their eggs" (*2*) to the end (*teleos*) that the individual and the species may survive. But this end is (usually) unconscious and impersonal. Naive teleology is controverted not by ignoring the obvious existence of such ends but by providing a naturalistic, materialistic explanation of the adaptive characteristics serving them. Surely that is clear enough in the large, omitted context (for example, in *2*) of some of Bernatowicz' brief excerpts. It has recently been quite fully and, I think, lucidly discussed by one of the authors condemned by Bernatowicz (*3*). Because *teleology* has indeed become a dirty word, Pittendrigh has suggested that this undeniable end-directedness of evolution and of organisms be called "teleonomy."

With Bernatowicz, "we stand against the evil" of man- or god-oriented teleology, of animistic personification, and of illegitimate anthropomorphism. We stand equally against the "evil" of vitalism. (By the way, is such emotional language "rigorous"?) But when teleonomy, *sensu* Pittendrigh, is mistaken for teleology, "rigor" becomes evasion. It is stark reductionism that denies to life its most essential characteristics. It is a blind alley leading only to a biology without *bios*.

GEORGE GAYLORD SIMPSON
American Museum of Natural History
and *Columbia University,*
New York

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1. C. Darwin, *On the Origin of Species* (Murray, London, 1859).
2. G. G. Simpson, C. S. Pittendrigh, L. H. Tiffany, *Life: An Introduction to Biology* (Harcourt, Brace, New York, 1957).
3. C. S. Pittendrigh, in A. Roe and G. G. Simpson, Eds., *Behavior and Evolution* (Yale Univ. Press, New Haven, Conn., 1958), chap. 18.

From a microcosmic listening post the following ditty was picked up and recorded. There is uncertainty as to the author.

The Man and the Electron

Said A. J. B. to the electron,
"It's getting damned hot under here!"
"Jump my boy," said the electron,
"Your pants are beginning to sear."

Said A. J. B. to the electron,
"I didn't mean to run into the man!"
"Take a hint from me," said the electron,
"Keep out of crowds whenever you can."

Said A. J. B. to the electron,
"Oh boy, look at the fem over there!"
"The attraction is mutual," said the electron,
"Run meet her, then please disappear!"

PERRY R. STOUT
Kearney Foundation of Soil Science, University of California, Berkeley

E. G. Boring asks whether I want the teacher of science *never* to depart from the language of science. Now, *never* is an absolute, and it is difficult indeed to subscribe to an absolute. I would prefer to say that, so long as he purports to communicate the scientists' way of looking at the universe, the teacher of science would do well to avoid expressions inconsonant with that aim. Personally, I find it difficult to change as I move from classroom to luncheon table, and it seems dangerous to assume that the reverse change, between lunch and class, would be easier. It does not follow that avoiding teleology betrays a belief "that the scientific view of the world is the true view" (whatever "true view" may mean). Teachers of other disciplines present *their* views of the world and the "truth"; each contributes to a liberal education, and I would not dilute the contribution of the science teacher by conceding that his approach need not be thoroughly disciplined. This does not imply the superiority of one intellectual discipline over another.

We are agreed that language should be used with wisdom, good judgment, delicacy, and urbanity, but I do not see that precision and rigor are incompatible with these requirements. Unlike Boring, I am not confident that "scientific context" will develop proper attitudes irrespective of the choice of words. The modes of thought instilled in the student are, I maintain, due to the words. Schrödinger [*What Is Life? and Other Scientific Essays* (Doubleday, Garden City, N.Y.,

1956), p. 146] puts its very well: "In the inseparable union of speech and thought the primacy, rather paradoxically, rests with speech. When we hear the same words again and again pronounced with authority, we are apt to forget that they were originally meant as an abbreviation; we are induced to believe that they describe a reality."

Between Powers and myself there seems to be no disagreement—we will not teach teleological thinking in those areas where we insist that teleology is to be avoided. If teleological thinking becomes fruitful in certain areas, we hope that teaching in those areas will become appropriately oriented. I suspect, however, that such teleology as he describes will need to be presented at a considerably more sophisticated level than the examples I cited.

As for natural laws and the presupposition of a lawgiver, I can do no more than expose my thinking. Briefly, and therefore with oversimplification, I consider a natural law as a generalization of our observations. As such, each presupposes a "law-stater," hence Hooke's law, Boyle's law, and so on. The idea of a lawgiver has always seemed to me to derive from a mistaken analogy with juridical law. If, *from the viewpoint of science,* it is meaningful to presuppose a lawgiver of natural laws, I shall be grateful to hear the argument.

There seems to be no essential disagreement between my article and Simpson's letter. Simpson feels that "teleonomy" is a valid orientation to biology and would defend such expressions; I offered no argument against any philosophy, be it teleology or teleonomy, that one may *deliberately* include in his teaching. But even if one's convictions in favor of teleonomy lead to language such as I quoted, which way will the student bend—toward vitalism, naive teleology, and animism or toward teleonomy? Simpson thinks that the context from which some of my excerpts came would serve to controvert naive teleology and to inculcate teleonomy. Perhaps, but the naive, even primitive, attitudes I discover in students do not leave me optimistic.

Said Stout to the interphase nucleus,
"I'm tired, I've been going all day."
And the nucleus wearily answered,
"Me too; I'm for hitting the hay!"

Perry Stout's discovery of poetry (?) showing anthropomorphic wording at its ludicrous extreme is a device not unlike the idea I received from Julius Roth of the University of Chicago. Roth suggests cartoons, with quotations from texts as the captions. The possibilities are endless—at least until they reach an editor!

ALBERT J. BERNATOWICZ
Department of Botany,
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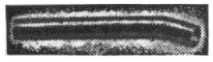

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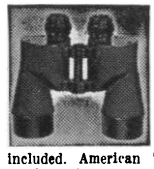

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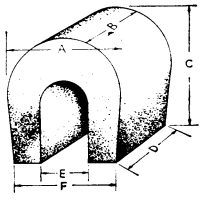

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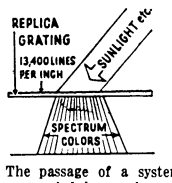

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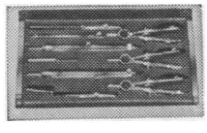

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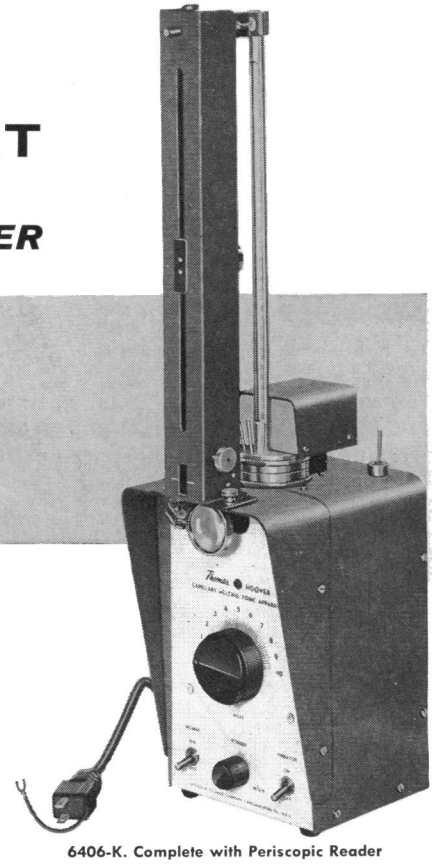

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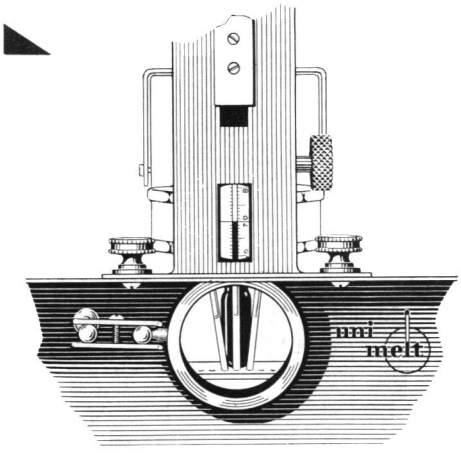

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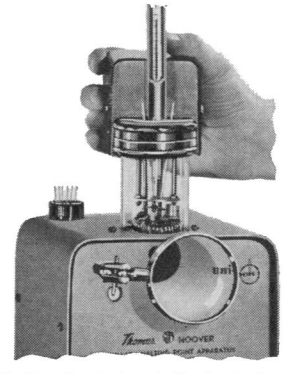

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