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## Discussion

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My comments are limited to the section on adaptation and paradaptation. I find the discussion of adaptation to be confusing because of imprecise use of words and apparent circular reasoning. For example, Bock states that all features existing for long periods of time, or used in the classification of animals, are adaptive. He follows this premise with the statement that in a survey he could find no characters used in avian classification that were not clearly adaptive. If the same definition of adaptation applies to the two sentences, the second is tautological; yet it is presented as support for the premise. Throughout the discussion, one is unable to determine what definition is adopted at a given moment. Bock strongly implies that he views adaptation as state of being, a viewpoint that I vigorously reject, but he may be attempting to make a point essential to the development of his argument. Certainly if every feature that exists is adaptive, nothing else can be used in

classification, and discussion of the usefulness of adaptive characters in classification is reduced to the level of absurdity, as Bock correctly states. To me, however, the absurdity occurs at the point at which adaptation is essentially equated with state of being. In my view, features that increase the reproductive potential of organisms are adaptive; if they do not do so, they simply exist. Certainly, we have sufficient information from such fields as developmental biology and genetics to indicate that nonadaptive (using my definition) features are maintained in populations by such phenomena as canalization, and it appears that Bock has attempted to avoid biological facts by directing attention to the semantic arguments.

I am equally unhappy with the discussion of paradaptation, which appears to me to be an attempt to add yet another name to what has long been recognized as the opportunistic nature of evolutionary processes. Bock groups various factors, such as mutation and recombination, features of the ancestral group, and timing, as "chance-based" evolutionary mechanisms and phenomena, and he states that these give rise to paradaptations. These factors are important in determining what change will or can occur, but they are hardly evolutionary mechanisms. Placing emphasis on such factors, rather than on the results of selective processes, seems strikingly close to mutationism. To me, mutation and recombination are sources of raw material on which evolutionary mechanisms act, and to place emphasis on opportunism of occurrence rather than selection seems a step backwards. However, the main point is that while Bock suggests that the paradaptive properties of characters determine the taxonomic usefulness of the various characters, he presents neither a rigorous nor even an operational definition of paradaptation. If paradaptations cannot be consistently and objectively identified, they cannot be used. When Bock uses the word "paradaptation," one could as well substitute "character" or even "thing." As it stands, the concept of paradaptation is highly subjective and cannot be used in building classifications or in other systematic work.

Features are said to be paradaptive and, at the same time, adaptive or nonadaptive, relative to different selection forces. This would seem to place too much emphasis on isolated parts of the organism and not enough on the whole organism, including its

full ontogeny and its populational and environmental relationships. However, I think that Bock's object in this paper is to make a plea for more careful character analysis with close attention paid to the origin and meaning of various morphological features. I certainly support him in this.

In my view, one ought to be very broadly comparative within groups—to study all members of the group being analyzed and all aspects of their morphology, as well as utilizing ontogenetic and developmental information—rather than emphasizing single functional units. My work on lower vertebrates indicates to me that comparative morphologists must develop an awareness of the developmental state of species at maturity. This is particularly crucial in lower vertebrates where paedomorphic and gerontomorphic modes of evolution are so prevalent.

Finally, I suggest that classifications be built on the basis of total available information, as we have heard again and again at this conference. Thus, when considering morphology, we should consider all parts and all stages of development. We must, as morphologists, remember that it is populations, not parts, of organisms that evolve. The parts are important, of course, and I consider careful and objective character analysis to be an important task of the comparative morphologist, and logical use of the derived information the most important task of the taxonomist. I prefer to build classifications on the basis of high correlation of specialized or derived (and adaptive, in my sense of the term) character states, which carry information concerning change and community of descent. By adopting rigorous methodological approaches and applying consistency tests to the results of the analysis of large bodies of data from different systems, problems resulting from convergence can now be readily surmounted. The most important role of comparative morphology to the taxonomist of the future will be in the area of character analysis, an activity that lies at the base of all taxonomic work and that has been approached too often in only a superficial manner in the past. It is at this point that the morphologist, with his functional, ontogenetic, and comparative approaches, can make his most meaningful contribution to taxonomy.