LETTERS

Nomina Generica

In a report by S. Remillard *et al.* (19 Sept., p. 1002), we read that a potent tumor inhibitor, maytansine, inhibits mitosis. From where does this remarkable substance come? We learn only that it was isolated from "various *Maytenus* species." Is it a mold, beast, or tree? I finally learned (*1*) that the substance can be extracted from the fruit, stem, and wood of *Maytenus*. Aha! Evidently it must be a plant. Aware of my botanical ignorance, I inquired of four botanists the nature of *Maytenus*; none could tell me anything. I eventually learned that it is a member of a group of flowering shrubs or shrub-trees.

No doubt it is essential to have a specific Latin name for each organism, but since more than 1.5×10^6 species of organisms have been identified, a generic designation is often not sufficient, particularly when these names have frequently undergone substantial change. The importance of retaining common names was made clear by George Wald (*2*) when he commented on a table of data on the precipitin test prepared by Nuttall in 1904, which showed that rabbit antiserum against human serum, when mixed with nonhuman serums, caused less and less precipitate the more distantly related was the species of animal providing the serum. Wald wrote:

> In the original version of this table, Nuttall mentions *Cynocephalus mormon* and *sphinx*, omitting their common names. I have learned since that one is the mandrill, the other the guinea baboon. Since Nuttall wrote in 1904, these names have undergone the following vagaries. *Cynocephalus mormon* became *Papio mormon*, otherwise *Papio maimon*, which turned to *Papio sphinx*. This might well have been confused with *Cynocephalus*, now become *Papio, sphinx*, had not the latter meanwhile been turned into *Papio papio*. This danger averted, *Papio sphinx* now became *Mandrillus sphinx*, while *Papio papio* became *Papio comatus*. All I can say to this is, thank heavens one is called the mandrill, the other the guinea baboon.

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2. G. Wald, in *Modern Trends in Physiology and Biochemistry*, E. S. G. Barron, Ed. (Academic Press, New York, 1952), p. 339.

We have been informed by R. E. Perdue, Jr., the botanist primarily responsible for the *Maytenus* collections in Africa, that the only common name he has found used for any species of *Maytenus* is "ack-ack," reflecting the sound made when the plant is burned as firewood. We appreciate Riggs calling our attention to a typographical error in the citation of a most important article.

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A New Characteristic of Life?

One of the major problems with the insight that Darwin and Wallace brought to our knowledge of the origin and diversity of life is its simplicity (*1*). The essence of natural selection lies in the notion that adaptiveness is a result of the differential reproduction of individuals of different genotypes. However, many people find the concept of natural selection too straightforward to explain the past and present array of living forms and their manifold means of adaptation. The article by J. M. Burgers (18 July, p. 194) is an example. He, with others, feels that the principle of causal relationship which forms the basis of scientific inquiry is not enough to account for the living world. Or, more simply put, surely life cannot be reduced to a set of interactions among atoms and molecules. It is indeed a distasteful realization, but likely true. Burgers argues that the human "notion of being alive" cannot as yet be explained by modern physical principles. From this he jumps to the statement that "we must give attention to the idea of freedom, as being an essential aspect of life. . . ." Life he defines as a game in which the players maneuver to maintain the ability to choose, to retain "some measure of freedom." Surely we are dealing here with as yet poorly understood psychological aspects of the human mind. Burgers is correct—neither physics nor biology can explain the "notion of being alive," but just because it happens to be a part of human psychic makeup does not render it a basic aspect of all life. There is always the hope that science will eventually lead us to an understanding of even such sacred complexities as our own minds.

In an attempt to bolster his argument for a new conceptual approach to the living world, Burgers appears to have reached some misunderstandings. He feels that, while molecular biology has revealed the structures and operation of living systems, it has added nothing to our understanding of the origin and evolution of these structures. Nothing could be further from reality. Much of what we know of the evolutionary history of many groups of organisms has been gained from a comparative analysis of structures across systematic boundaries. The results of molecular biology research have allowed similar comparisons at a finer resolution. Consider, for

example, the origin and evolution of cytoplasmic organelles in plants and animals. The current theories (*2*) are based largely on the findings of molecular biology and biochemistry. What about the analyses of the evolution of enzymes and other proteins? A newly emerging field of molecular evolution is based almost entirely on the techniques and data of molecular biology.

Burgers also seems to misunderstand the concept of natural selection. While he is correct in stating that reproduction generates more possibilities for life through the process of genetic recombination and selection, it cannot be considered "a secondary feature in the evolution of life." As I have noted above, differential reproduction is the essence of natural selection and it need not, as Burgers envisions, involve death. Moreover, contrary to Burgers' assertion, the idea of natural selection can be invoked to explain some molecular reactions, such as those involved in the replication of nucleic acids (*3*).

Burgers is insistent that life must possess something more fundamental than the ability to reproduce. He sees a "purposiveness" to the adaptations of organisms that suggests to him that the "evolution of forms of life is dependent on an interplay of traditions and initiatives as is the evolution of human societies." This belief is a more radical statement of the notion of orthogenesis first postulated by Eimer in 1897. Orthogenesis stipulates the gradual unfolding of preformed or rudimentary structures through evolutionary time.

Burgers' basic dislike of the notion of reproduction as an essential characteristic of life is seen in his concluding paragraph. He finds it impossible to imagine that what we call mentality could ever arise from a "chemical structure." The beauty of the process of natural selection is that it is creative; it proceeds in much the same way a work of art is generated—by trial and error and constant remolding. The marvels of the living world are indeed a compelling fascination, and man's infatuation with his own mind has become almost hypnotic. Yet natural selection as a process can still account for all these wonders if we will just give it the opportunity.

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2. R. A. Raff and H. R. Mahler, *Science* **177**, 575 (19 → L. Bogorad, *ibid.* **188**, 891 (1975).
3. S. Spiegelman, N. R. Pace, D. R. Mills, R. Levisohn, T. S. Eikhom, M. M. Taylor, R. L. Peterson, D. H. L. Bishop, *Proc. Int. Congr. Genet. 12th* 3, 127 (1969).

It appears that Richmond and I interpret the concept of natural selection differently. Like others, Richmond seems to attach to it an exaggerated reverence, as if it were a hallowed creed. In the last paragraph of his letter he writes: "The beauty of the process of natural selection is that it is creative; it proceeds in much the same way a work of art is generated—by trial and error and constant remolding." In my opinion the words "it is creative" are misplaced here, and the comparison is inappropriate. The trial and remolding which characterize the work of an artist are instances of what I call conceptual activity: the artist tests and remolds his creation so that it is adequate to express a concept formed in his mind. Natural selection, on the other hand, is an effect of the differential permissivity of the environment; no new forms are created, but some are eliminated, in passive secondary reactions to mutations. The creative effect is in the generation of the mutations. Much controversy can be resolved if the term "differential permissivity of the natural environment" is substituted for "natural selection"; this takes away the impression that natural selection can be regarded as an active creative factor.

Natural selection does not in itself produce new chemical compounds; it can only admit them or lead to their rejection. It can do this because of differences in the viability of the living organisms carrying them. I believe that natural selection can operate only in chemical systems where living beings already exist.

In my article I attempted to sort out processes in which conceptual activity and creativity are involved from those depending on causal relations (among which we may reckon death from predators). Perhaps Richmond and I are using different languages. I hope that my remarks may bring some clarification. I add that I do not dislike the notion of reproduction; I only suggest that it has evolved at a later stage in the history of life.

Albert Claude says in his Nobel lecture "The coming of age of the cell" published in *Science* (8 Aug., p. 433): "Life, this anti-entropy, ceaselessly reloaded with energy, is a climbing force, toward order amidst chaos, toward light among the darkness of the indefinite, toward the mystic dream of love, between the fire which devours itself and the silence of the cold." In a poetical form, this expresses some of the ideas that I tried to discuss in my article.

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