Adequate Protection

The recent letters of Goodman (Letters, 21 July, p. 210) and Grigas (Letters, 1 Sept., p. 746) describing the disability and real tragedy that can occur when a research worker becomes allergic to rodents prompts me to write this letter. Although I can be thrown into a state of respiratory collapse within minutes after exposure to rodents, I have found a regimen that allows me to work with impunity around the little beasts.

I protect myself first by wearing an industrial dust mask (be sure to get one certified by the Bureau of Mines "for protection against inhalation of dust not significantly more toxic than lead"). I have found that the Glenaire respirator made by the Glendale Optical Company, Woodbury, Long Island, New York, to be the most comfortable, and the price is only about $5. I also wear the industrial goggles made by the same company for protection against the terrible eye burning and tearing that the allergens produce. I have found these two items very helpful but insufficient. Apparently allergens also cling to my hair and clothes, and when I take off the mask, trouble begins. So I also wear a closely knit surgical gown (ordinary laboratory gowns are a poor second best) with tightly fitting knit cuffs. Finally I wear a surgeon's cap and disposable gloves. The gloves should be put on surgeon fashion, over the knit sleeves of the gown.

With this costume I am able to work freely with rodents for an entire day. It is essential to be absolutely rigid in adherence to all aspects of the costume and to check very carefully that everything fits snugly. The only real annoyance is that you will look a little weird, and you will constantly be asked questions. On the other hand, it is gratifying to note how many of your questioners are pretty girls.

MELVIN GOLDBERG
Department of Pathology, University of California, San Francisco 94122

Modern Taxonomy

In their article "The origins of taxonomy" (17 Dec. 1971, p. 1210) Peter H. Raven, Brent Berlin, and Dennis E. Breedlove paint a dismal picture of modern taxonomy. They argue that the present hierarchical system of classification, based upon the binomial species, is hopelessly inadequate to deal with the millions of kinds of living organisms. They suggest that only radically new systems dependent on the rapid retrieval of information from computer banks can solve the problem. However, they do not specify what these systems might be or how we could hope to make reductions in the highly skilled labor required to obtain and record them.

The problem is not in existing classification codes, which are at least adequate, but in the amount of effort devoted to taxonomy. Real taxonomists—the experts who record information about diversity on a continental or global scale—are in very short supply. Consider the ants, for example. Although these insects are dominant in most terrestrial ecosystems and comprise more than 7600 known living species—evidently only a fraction of those that exist—I know of only five entomologists in the entire world who work on their classification full time, and a scattering of others who contribute occasionally. If there were 50 such specialists instead (still a minuscule subpopulation of the entire international scientific community), one could expect to see the greater part of the world ant fauna elucidated, through conventional means, by no later than the end of this century. The ants are typical in this respect among the insects, which are the most species-rich of all organisms, and they are probably typical of most other groups of organisms as well.

Let us grant that 10 million kinds of organisms might be alive today, the extreme (and disputable) figure suggested by Raven *et al.* The inventory of even so great an assemblage is not beyond the reach of existing taxonomic methods, contrary to what the authors suggest. Most "alpha" taxonomists, that is, biologists who are concerned full time with the initial process of discovery and recording, master as many as 1000 species in their lifetime. (The upper limit is undoubtedly represented by one dedicated dipterist who has personally described over 10,000 new species of flies.) The entire task of alpha taxonomy, then, could conceivably occupy approximately 10,000 specialists for their lifetimes. It might be virtually finished—should it be undertaken—in 50 years. If the results were recorded by conventional means in books and journals some 10,000 volumes, filling 1 mile of shelves, would be required. The cost would be approximately $10 billion spread over two generations. This is not to deny that computer technology will greatly reduce the time and cost of analysis and recording, and render the mile of shelves unnecessary; in fact, the development of such methodology is already well advanced. Nor am I seriously suggesting a Linnaean NASA for the purpose of finishing alpha taxonomy by conventional means. My purpose is to dispute the fundamental contention of Raven *et al.* that it is "clearly out of the question" to complete a survey of many groups of organisms and that "our present taxonomic system is, in the face of the job for which it has responsibility, inadequate." This is defeatism, unrelieved either by necessity or by formulation of any concrete alternative.

Even more defeatist is the authors' belief that completing a world biotic survey has no merit in itself. They seem awed that only 15 percent of the kinds of organisms have been described. Surely the exploration of the remainder of life on Earth is not only justified but one of the most exciting and potentially fruitful tasks lying ahead.

E. O. WILSON
Biological Laboratories, Harvard University, Cambridge, Massachusetts 02138

Raven, Berlin, and Breedlove remark that "the taxonomic system we use appears to communicate a great deal about the organism being discussed, whereas in fact it communicates only a little." Does it? If I state that a certain organism is a fly, I immediately say a good deal about its structure, life history, and ancestry. If I place it in the family Drosophilidae, I specify the structure of adult and larva in considerable detail, and if I place it in the genus *Drosophila*, even more information is immediately implied. To state the species group to which an organism belongs is to describe the major features of its mating behavior, cytology, and so forth. If there is a better system of information retrieval, it is not to be found in the broad generalities these authors provide.

Having labeled the "biological species concept" as "spurious," without documentation, the authors proceed to make a series of statements that can be questioned: "We implicitly assume [from the classificatory process] that we know as much about a mite from the

Amazon Basin as we do about the mallard duck." "We" doubtless includes Raven, Berlin, and Breedlove, but does it include anyone else?

They continue, "It is often argued that, if we know about the systematics of a particular group of organisms in detail, we will be better able to utilize them in biological control programs. . . . What we have achieved in biological control . . . has been almost entirely the result of ad hoc studies of the problems when they become of interest. . . ." In fact, the vast majority of biological control programs have ended in partial or complete failure. A striking example of the importance of taxonomic discrimination in biological control is presented by DeBach (*1*).

Finally, Raven *et al.* conclude that "Taxonomic work has helped us only to a limited extent in understanding the functioning of ecosystems. . . ." Thinking that I may have been living in some sort of dream world, I reexamined the major works of such ecologists as Elton (*2*) and Odum (*3*), who confirm my own impression that determining the composition of the community in terms of organisms and their life histories and dispersal powers, and so forth, is a basic initial step in any analysis of ecosystems.

When new taxonomic methodologies are developed, as they surely will be, they will be more constructively realistic than those proposed by Raven *et al.*

HOWARD E. EVANS
Museum of Comparative Zoology,
Harvard University,
Cambridge, Massachusetts 02138

References

1. P. DeBach, *Ann. Entomol. Soc. Amer.* **53**, 701 (1960).
2. C. Elton, *The Pattern of Animal Communities* (Wiley, New York, 1966).
3. E. P. Odum, *Amer. Zool.* **8**, 11 (1968).

Raven *et al.* describe the development of pre-Linnaean and Linnaean methods of naming organisms. But they have not written one word about modern taxonomy, or is it modern taxonomy stripped of all its essential character which they discuss under "Problems for modern taxonomy"? We hesitate to accept this. Modern taxonomy is no longer the science of "giving names and nomenclature"; the final result of taxonomy will not be a list of all organisms, with their names, pictures, and full description. The final result has to be the understanding of the species concept, the genus concept, the family concept, and so forth, and the understanding of the relation and interaction between species or between genera. The origin of the species and not the origin of species, the development of the taxon and not of taxa are the special interests of modern taxonomists. They do not study the difference between species, but the difference between the species concept in different groups of animals.

It is impossible to describe all the species existing today. However, it is possible to describe certain taxa and to come to the understanding of these taxa, which in the future will help us understand the concept and meaning of the taxon.

Modern electronic equipment can indeed assist the registration and distribution of data concerning the taxa, but taxonomy can do nothing without the help of other disciplines, such as ecology, physiology, genetics, and anatomy.

Raven *et al.* deal with plant taxonomy; there are differences between plant taxonomy and animal taxonomy, but both branches of modern taxonomy are part of biological science, while the old taxonomy was probably more closely related to philately. Biology, the life science, the understanding of the development, adaptation, variability, and diversity of the most natural and original of all matter, is not dependent on, but culminates in, the science of taxonomy. As our environment must be protected against man by Man, it seems essential that we understand development (and disappearance), adaptation, variation, and diversity.

S. VAN DER SPOEL
A. C. PIERROT-BULTS
R. W. M. VAN SOEST
Department of Marine Evertebrates,
Institute of Taxonomic Zoology,
Plantage Middenlaan 53,
Amsterdam, Netherlands

The diverse points of view presented by the critics of our article bring into sharp focus the fundamental disagreements among taxonomists about classifying organisms, and even about what "taxonomy" comprises. Perhaps there are fewer than 10 million kinds of organisms in the world, but the order of magnitude is correct. Many of these organisms will become extinct, especially in the tropics, within the next 25 years, as the destruction of the tropical lowland forest becomes an event of global proportion. Some of these extinct organisms will have been named, others will not.

Only we, and not our successors, have the choice of what kinds of information to gather about a number of kinds of organisms, and the relations between them. The analysis of many tropical ecosystems will continue to be possible for only a few more decades, and the kind of monographic studies that might provide valuable comparative material for such analyses will not be completed for most groups of organisms in time.

There seems to us to be no a priori reason to assume that the taxonomic system we have inherited is the best or only one for dealing with this problem. It is a truism to say the world is changing rapidly, and the facts on which we should be basing our decisions are very different today from what they were a century, a decade, or even a year ago. Most of our decisions are based upon the implicit assumption that we live in a stable world, but we certainly do not.

Many modern tools are available for dealing with information, and we believe that systematists should, by virtue of the almost incalculable number of facts with which they are concerned, be among the first and not the last to adopt them. If, in the light of a careful consideration of the condition of the world as it is today, the magnitude of the task of the systematist, and the availability of many new tools for dealing with the diversity of nature, an individual taxonomist wants to keep on doing essentially what he and his predecessors have been doing for thousands of years, that is his decision; we, however, hope that at least some taxonomists will continue to seek more creative solutions to these problems. Special consideration should be given to gathering "unusual" kinds of data about particular aggregations of tropical organisms, rather than plodding ahead with the standard monographic approach for all groups regardless of size, importance in the ecosystem, or present knowledge of the group.

Perhaps sarcasm in the defense of the status quo is no vice, but if we want to consider the world as it is and make conscious, reasoned decisions about what kinds of information we shall gather and thus be able to transmit to our successors, it is not enough.

PETER H. RAVEN*
Missouri Botanical Garden,
St. Louis 63110

* Both of my coauthors are currently in the tropics engaged in field work and could not therefore join me in commenting upon the responses to our article.