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Micropaleontology—Mostly a Little about Much Concerning Many of the Little

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Micropaleontology—Mostly a Little about Much Concerning Many of the Little

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INTRODUCTION

We can readily define micropaleontology. With some discussion we can outline its purpose. After minor compromises we may even reach general agreement on its scope. But teaching it is far more difficult and formidable (Fig. 1). When all is said and done, no hard and fast method is likely to result. For micropaleontology itself is to a degree organic, growing and evolving.

DEFINITION

The simplest definition of micropaleontology is "the study of microfossils" (Fig. 2). Even though it has brevity in its favor, such a definition is not very revealing. We should watch out for cryptic expressions; they tend to delude us with their simplicity. In this case, we must decide *how* to study and *what* microfossils.

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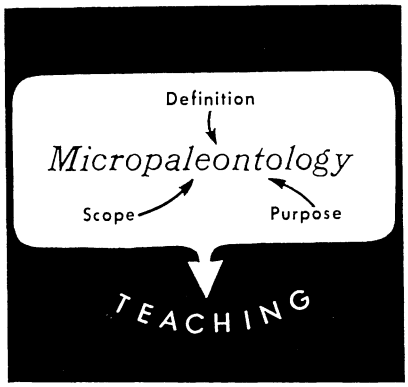

FIG. 1. Definition, scope, and purpose are parts of micropaleontology and teaching must involve them all.

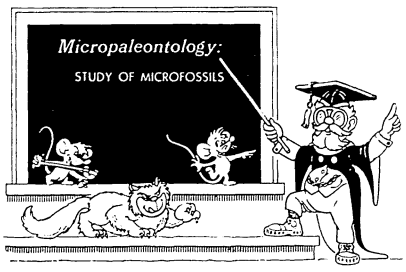

FIG. 2. The simple definition of micropaleontology is too simple, with more of trickery than of revelation.

At the start we should admit, however embarrassing, that micropaleontology came into being by default (Fig. 3). When paleobotanists and paleozoologists had sifted through the samples with hand lenses, whatever was too small for their proper scrutiny was given over to specialists with microscopes. Practically within our lifetime, these unwanted waifs of the fossil realm have been molded into a subject of university curricula and, some would like to think, the basis for a branch of science.

PURPOSE

The purpose of micropaleontology is to understand micro-organisms that lived in the past (Fig. 4). Not only are we concerned with identifying the fossils, but with learning how they once carried out vital functions and why they are found in certain associations. I find no objection to paleoecology as a specialized subject, as long as it is not forbidden in the investigation of microfossils. Whatever the organization and content of the course, the microfossil must be regarded as a once living animal, a member of a population, a creature that filled a place in a community at a particular time.

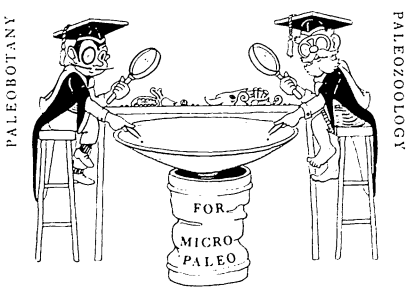

FIG. 3. Micropaleontology is born from tiny discards.

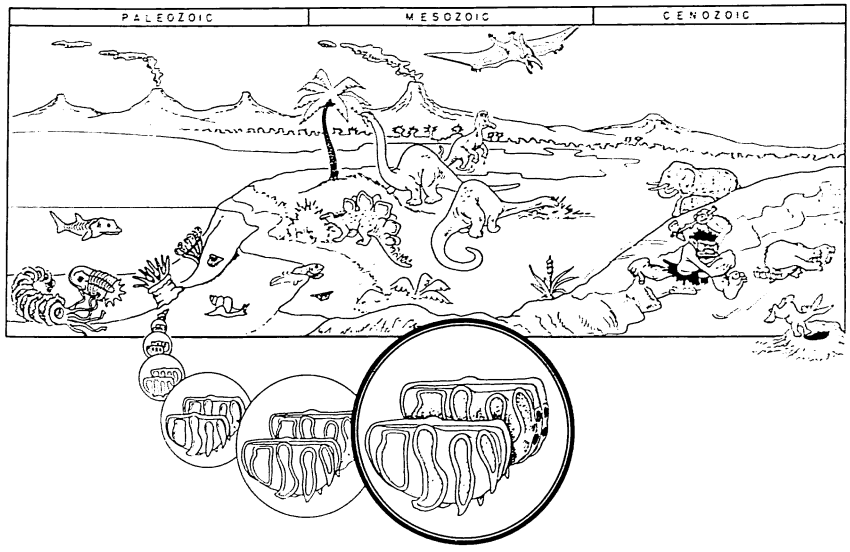

FIG. 4. Every microfossil was once a living animal, which filled a place in a community at a particular time.

SCOPE

The scope of the subject is techniques, terminology, taxonomy and interpretation as applied to fossil foraminifers, ostracods, conodonts, and scolecodonts (Fig. 5). To these could be added chitinozoans, tintinnids, radiolarians, thecamobids, hystrichospheres, coccoliths, bryozoa, and nannofossils. Even otoliths and skeletal elements of sponges, octocorals, and echinoderms have been included in the realm of micropaleontology.

TECHNIQUES

Whatever your viewpoint on micropaleontology, you must start the course *somewhere*. You may begin with reading or with looking, with the written words or with microfossils (Fig. 6). I prefer the latter because I believe

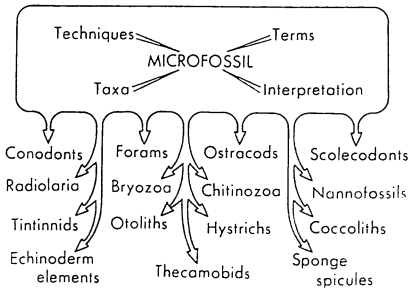

FIG. 5. Techniques, terminology, classification, and interpretation apply to every kind of microfossil.

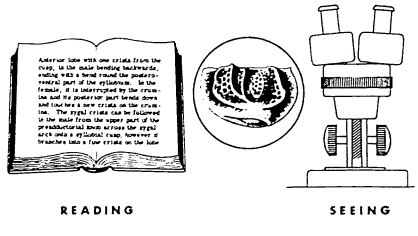

FIG. 6. There are two approaches to micropaleontology.

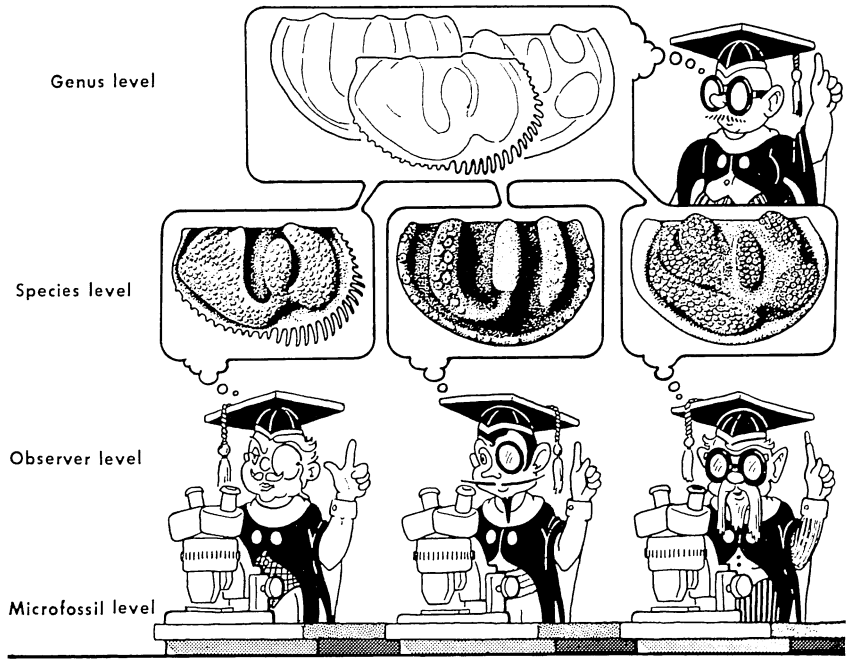

FIG. 7. To get from the reality at the specimen level to the concept at the species level, one must pass through the observer level, which is non-standard and unpredictable; the genus level is one more flight up from reality.

that in all the field of micropaleontology, only the specimen is real. I call it a deep conviction; my colleagues may call it stubborn tenacity. Nevertheless, the totally objective and complete description of a species has yet to be written. We jest about the brevity and inadequacy of micropaleontological work done a century ago; how think you that our writings will fare in 2070? Our science is growing in many dimensions, and I have faith that whatever we see, whatever we say, and whatever we do with microfossils will someday be much improved. Such improvement will come not from the library but from the laboratory, by new techniques for restudy and re-interpretation of specimens. The "species" as we know it in literature is only a concept, the family is only an idea based on several concepts, and the higher the taxonomic unit the farther from the reality, which is the microfossil (Fig. 7). To get from the microfossil to the "species" as we encounter it in literature, to get from the tangible to the concept, one must penetrate the observer level. Logically, therefore, we should start a study of micropaleontology with observing the specimen, rather than what someone once said he observed. The observation is the lasting foundation on which all else will be built. However, observing microfossils is not the same as observing macrofossils.

Techniques are essential. If no special procedures were involved, there

would be no micropaleontology. The proper use of the microscope is not enough. The student should be convinced very quickly that microfossils do not arrive on 1″ × 3″ labeled slides (Fig. 8). He is entitled to the ex-

FIG. 8. Some people still believe microfossils come on labeled slides; this must be attributed to poor teaching.

perience of washing his own sample, picking out his own specimens, and mounting them for study. If possible, he should try his hand at photography and camera lucida sketches. Some fascinating work can also be initiated with vibrotool, airdent, serial surfaces, thin sections, ultrasonic vibrator, and acid etching.

In the near future, leading departments will probably add electron-

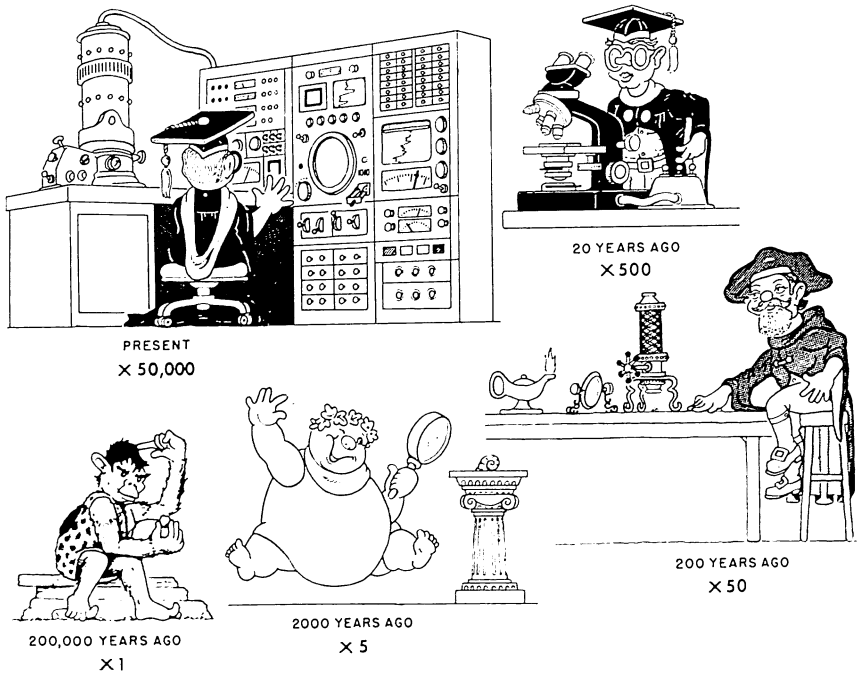

FIG. 9. Technological advances may be measured by magnification.

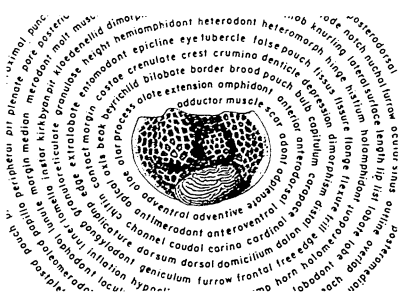

FIG. 10. Every little microfossil has a language all its own.

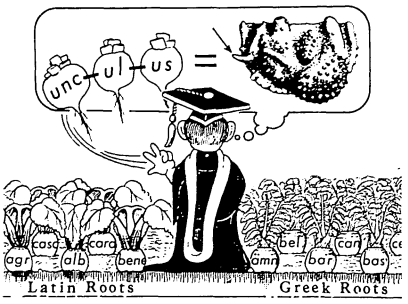

FIG. 11. A pleasant hour in the Garden of Terms—digging the bountiful Latin and Greek roots.

scanning to the available techniques. Computers are in operation at many places to handle masses of data. Electron microscopes are yielding magnifications we never dreamed were possible, and showing marvelous ultrastructures in the preserved remains of the little creatures (Fig. 9).

A generation ago, back before the turn of the half-century, magnifications of 25 or 30 times were considered adequate for nearly all micropaleontological work. The author who could produce a photograph reasonably in focus at such magnifications had honor, respect, and a very promising future. At that time, illustrations submitted for publication at 100 times were likely to be returned as ostentatious, unnecessarily wasteful of plate space, and liable to set a pernicious precedent in the *Journal of Paleontology*. Technology has rapidly moved the decimal point over one, two, and now even three places. Since we can see more, it logically follows that we can learn more. Ours is an age of promising exploration, and our students should be introduced to the basic tools and their operation at the outset.

TERMINOLOGY

Terminology is basic for understanding what has been written on any group. Every kind of microfossil has a language all its own (Fig. 10), the natural result of its being separated from other microfossils because of its peculiarities of morphology.

One of the significant characteristics of mankind is his capacity to learn something, to reflect upon it, to write down his interpretations and implications, and hand it down to generations he will never live to see. In this way, the human being starts on a foundation of experience that other living creatures do not have. Insofar as micropaleontology is concerned, most workers set down as accurately as possible what they see and think about micro-organisms and their fossil remains. To communicate new ideas, special words are coined as the occasion demands (Fig. 11). From the thicknesses of Greek and Latin dictionaries, one can predict a long and bountiful future

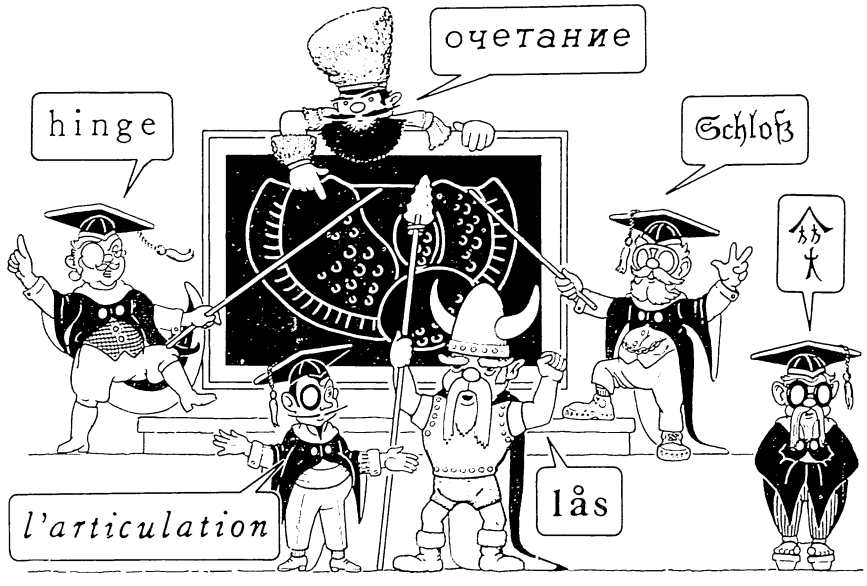

FIG. 12. Micropaleontologists speak many languages.

for term-makers. But even if writing and thinking proceeded at the same speed (which is gravely doubtful), problems would arise.

Micropaleontologists are no longer a small nor a close-knit group. They speak many languages, and many people work on the same microfossils (Fig. 12). Therefore, a multiplicity of terms continues to be spawned from the printing presses. Terminology becomes a subject in itself. The terms of one language must be correlated with those of other languages. Carried to extremes, a patois surrounds a particular genus. Like the robbers' loot in

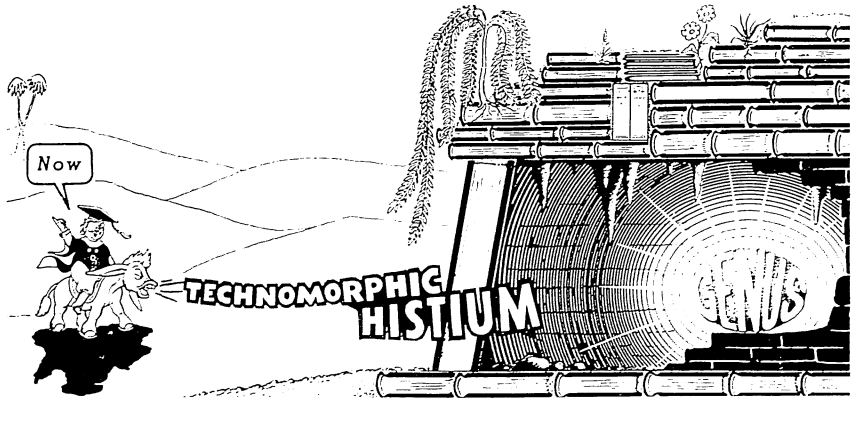

FIG. 13. Only knowledge of the special terminology opens the Cavern of Literature to reveal the hidden genus.

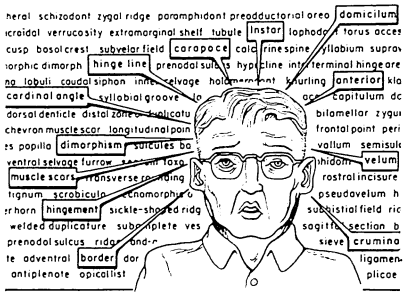

FIG. 14. The students can learn only some of the terms.

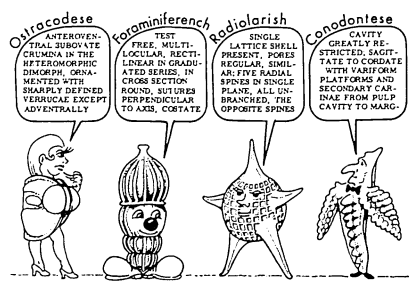

FIG. 15. Students must converse in the languages of several kinds of microfossils.

the *Arabian Nights*, the genus lies hidden in the cavern of literature, available only to those who know the special terminology (Fig. 13).

That is why such works as the *Treatise on Invertebrate Paleontology* are greatly appreciated. They create a time of compending, an assessment, a temporary deterrent to the international pastime of siring new terms.

The student can only learn some of the terms (Fig. 14). No handy reference is available for distinguishing the basic from the exotic. For most kinds of fossils, only the grosser elements need be named. Yet we would hardly be playing a fair game to lead the student to a smug satisfaction that he knows all about a microfossil because he can name fifteen parts. We must make clear that we are only introducing him to the specimen.

It can be argued, and with good cause, that an inordinate percentage of class time can be tied up in terminology, teaching the students to read and speak Foraminiferench, Conodontese, Radiolarish, Ostracodese, and so on (Fig. 15). Like techniques, terminology should be the Alpha rather than the Omega of the course. Nevertheless, the student has to have some fluency in order to understand any group.

This brings us to the real reason for terminology. A term has value only as it rightly conveys an idea about the structure which is present in the fossil (Fig. 16). As other specimens are compared, let the student evaluate for himself how well the term serves its function. Ideally, terminology and

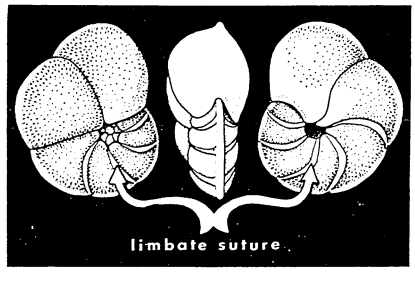

FIG. 16. Terms should have meaning, definite and unequivocal.

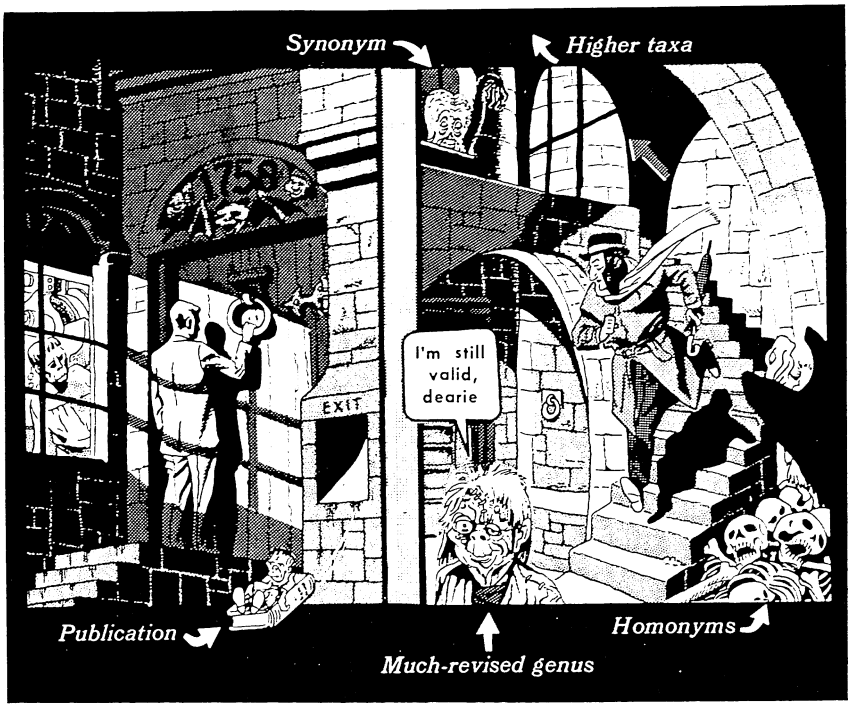

FIG. 17. The Sinister House of Nomenclature. (Adapted with permission from Mad, copyright 1958 by E. C. Publications.)

functional morphology can be combined so that each technical term assumes deeper meaning. Here time can be profitably spent at the expense of greater taxonomic coverage.

TAXONOMY

At some time in his education, the student in paleontology should be exposed to the International Commission on Zoological Nomenclature regulations and recommendations. He should know how to create new taxa as well as why to create them. In the foreseeable future he will have to wade through more than one quagmire of taxonomic tangles, constructing logic where little existed before. Perhaps these phases of our science can be handled in other courses; I would like it that way.

Even if we are not burdened with the *why* and *how* of taxonomy, we are very much involved with the *what*. Do we expound on all the families of forams; are we obligated to go through the superstructure of ostracod classification; should we explore alternative systems? What do we want from the course?

Unless computers take over micropaleontology, in which case we are unemployed antiques, the next generation will still be concerned with the foreboding House of Nomenclature (Fig. 17). This ICZN labyrinth, of sinister

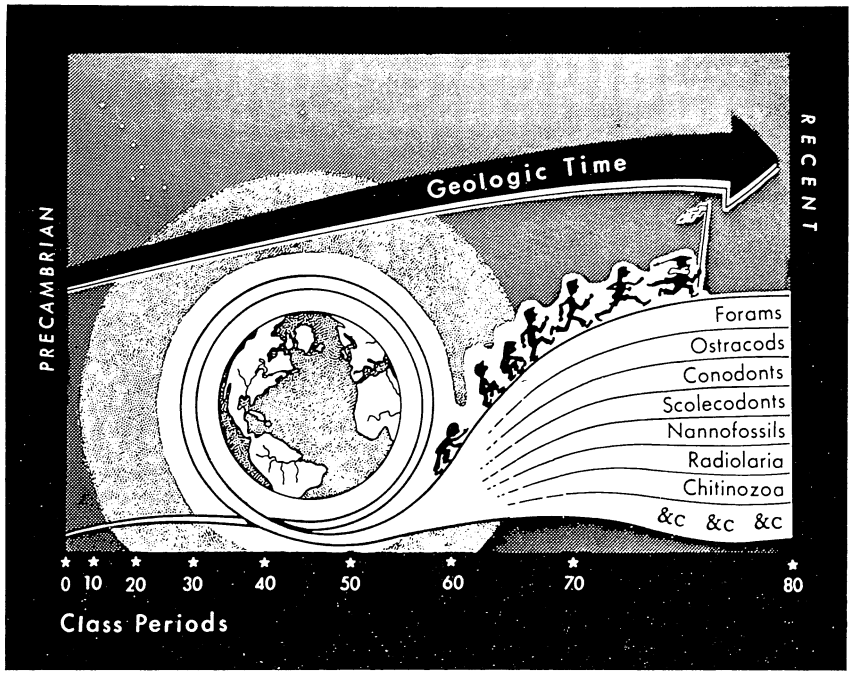

FIG. 18. Around the world in 80 classroom hours, through all of geologic time, with a dozen taxa.

antiquity, has passageways leading to all publications of systematics. In the course we cannot explore all the cubbyholes or plot all the cobwebs; we can provide a general floor plan so the student does not get lost immediately. Whether he likes it or not, the new micropaleontologist must start his contribution in the framework started in 1758 and extended and remodeled each subsequent year. Each taxon—species, genus, family, or higher—has its history and its revisions, pleasant or unpleasant. Synonyms are restless bones. Publications on nomenclature are many, with the author riding the subject for all it is worth. For the course, acquaintance with nomenclatural procedures is required, at least enough for orientation.

After many years I conclude that it is more important to know how to find the description of a taxon than it is to memorize the information. I speak of students, although the same might apply also to those of us who sometimes forget. In addition, it is more important to understand the content of a family than it is to be able to locate the description. With these suggested guidelines, you may decide for yourself what to make an integral part of your course. Actually, the pity is that microfossils used up so much of their evolution *before* our classifications were published; they deprived themselves of the opportunity to conform to taxonomic criteria and to group themselves discretely.

TIME LIMITATIONS

The college course has definite limitations in time. Drastic selectivity is necessary. For the student to learn all genera of microfossils in one year is impossible. To investigate even representative genera of all families and subfamilies is impracticable. To look at only a few genera is improvident. Is it better to glance at all the kinds of microfossils or to become acquainted with a few? We find ourselves somewhere between the charcoal and the rotisserie. Around the world in 80 contact hours covering a dozen taxonomic groups, through all geologic time? It can't be done (Fig. 18).

My own compromise is to restrict taxonomic coverage to those which are most actively being studied at the present time: foraminifers, ostracods, and conodonts. If your particular taste runs to other kinds of microfossils, well and good. After all, the same lessons can be learned from whatever materials you have at hand and know something about.

THE MAIN COURSE

After familiarity with techniques, terms, and elementary classification of selected groups, what do we do with it? Certainly more than we can explain in one course. But biometrics, growth, relationships of hard parts to soft organs, population structure, functional morphology, correlation of strata, ultrastructure, computer taxonomy, and phylogeny stand out as possible areas of emphasis (Fig. 19). We must observe, but we must also know what to

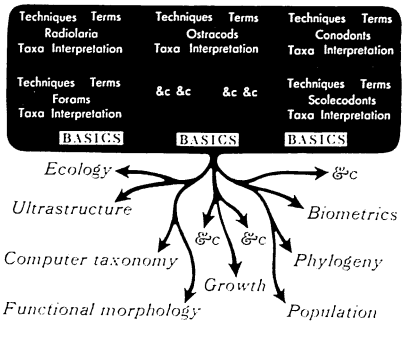

FIG. 19. What to do with the basic information—once you have it.

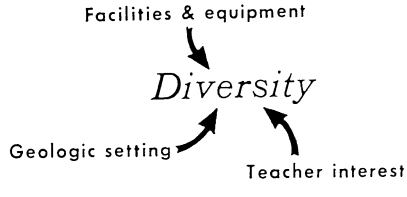

FIG. 20. Various factors influence the content and construction of the micropaleontology course, at each institution, and by each teacher.

do with our observations. In a ten-year course, nearly all uses of micropaleontologic data could be studied. Time being as it is, in our little field, we have to make the most out of few lectures, discussions, and labs.

In the hurly-burly, let us not forget that micropaleontology is the combination of micropaleozoology and micropaleobotany. For at least one kind of micro-organism, let the students see it alive, watch the progress of the aquarium population, and dissect a few specimens. From the study of living

animals, we can demonstrate the nature of the fossilized remains. For the price of a plastic bucket and one-hour traveling time, any teacher can start a culture of freshwater ostracods. If you are fortunate enough to be on the coast, make the most of your location; those in land-bound places have to try harder, but the closed-system marine aquaria now available are attractive and intriguing.

As many of my former students will recall, I frequently use the short scientific article as a direct application of what has been learned. It is the happy spur to student participation. The project must be selected with care. It cannot be so difficult that insufficient progress will be made during the available time, but on the other hand it should not be a simple sitting duck. Feedback from past courses indicates that this is one of the successful tools for teaching micropaleontology. If circumstances are favorable, the occurrence of the fossils can be studied in the field, tying in paleoecology with faunal analysis. Once research is organized and under way, students on their own will log an amazing amount of microscope and camera time.

DIVERSITY

There are many exciting aspects of the subject. Exact choices of course content will be influenced by the particular interests of the teacher, by the geological setting of the university, and by the special facilities and equipment available (Fig. 20). My own education in micropaleontology continues after 20 years. I never expect to finish it. Each course is a little different than any given previously; so it probably is with others. We try to provide our student with fundamental concepts so that he *can* proceed on his own and with incentive so that he *will* proceed. At the same time we provide an occasional vivid glimpse of micropaleontology in action.

SUMMARY

The little.—Because microfossils are so tiny, students must learn special techniques for disinterring them from matrix, for observing their configuration, and for examining their structure. Techniques remain the introductory part of the course.

Many of the little.—Of microfossils there are many kinds, and of each kind there are many families and genera. So numerous have taxa become that no one masters them all. Furthermore, every kind of micro-organism has its own terminology. Selectivity is necessary for the micropaleontology course, with scarely more than a glance at certain groups.

Much concerning many of the little.—Micro-organisms can be studied from many angles: systematics, functional morphology, population dynamics, ultrastructure, evolution, biometrics, and stratigraphy, to mention some. Not all aspects can be investigated in depth, even though they are significant and important.

A little about much. . . .—It is, of course, pleasant to know that the course

demands concentration on selected aspects of the subject rather than stretching of insufficient information to fill up the year. Yet we much choose where to focus in the panorama. A few points can be treated in depth, to acquaint the student with how micropaleontology works.

Mostly a little about much. . . .—With careful planning, time can be reserved for a special project. Fundamentals are necessary, certain basic concepts must be implanted, and techniques and terminology need to be taught. Afterward, however, the student deserves the exciting adventure of original investigation—the opportunity to try out what he has learned.

How well you succeed will depend on your ingenuity. After more than half an academic lifetime, I cannot lay out for each of you what will be best at your institution, in your class, with your facilities. In an age of new instruments, new approaches, and new knowledge, we must retain flexibility if micropaleontology is to have a future. "Play it loose," as the students say. From yesterday's experience we build today what we trust will be the foundation for better micropaleontology tomorrow.