SOME EXPANDED PALAEONTOLOGICAL HORIZONS

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ABSTRACT.—In order to get the greatest possible amount of information from fossils, they and their enclosing rock should be carefully studied in the field before they are removed for additional and more detailed study in the laboratory. A few of the many questions that might well be kept in mind during these studies are the following: (1) how were the organic remains buried and preserved? (2) what is the burial position of the actual fossil? (3) what kinds of tracks, trails and other miscellaneous marking are preserved? (4) what kinds of microscopic fossils other than usual ones sought, are in the rock? (5) what role has silica played in silicified fossils? (6) has there been selective concentration of elements by organisms? (7) how important have the organisms been as makers of simple crystals and symmetrical structures? (8) what kinds of evidence can be found bearing on the paucity and incompleteness of the fossil record? (9) what are the oldest fossils yet found and can we expect to find still older ones?

INTRODUCTION

THE fossil record is generally incomplete and not always representative of the life of the time, and fossils are too commonly sparse and poorly preserved. Therefore, we must learn to get the greatest possible amount of information from the fossils we find, and to be certain that our observations and collecting techniques are reliable so that we can trust our interpretations and conclusions.

If we accept a rather broad and all-inclusive definition of fossils, then there are many organically produced objects and features in sedimentary rocks that can possibly provide valuable and significant information of use to palaeontologists and stratigraphers. The following remarks, which are primarily for geology students and beginning palaeontologists, are directed towards some of these objects and features and certain problems in which they are involved.

BURIAL AND PRESERVATION OF ORGANIC REMAINS

Considering the many ways in which organic remains can come to rest on a depositional interface should allow one to predict some of the different kinds of burials to be expected in certain types of sedimentary deposits and sedimentary rocks. A heavy ash fall should strain the organic matter out of the air and incorporate it in the basal portion. Ancient ash deposits, therefore, should be carefully examined for fossils wherever possible.

Wind-carried items such as pollen, spores, cuticular fragments, diatom frustules and similar light particles may fall into highly saline water such as that in playas, into fresh-water ponds and lakes, or into oceanic waters. If these organically produced materials reach the subaqueous interface and are buried, they can record part of the life of the time in some unusual sedimentary rocks. Dust storms are known to have carried plant remains hundreds to thousands of miles from the place where they were drawn up in strongly rising air and to have deposited the materials in environments where they could not have been formed.

It follows, therefore, that salt deposits and ancient aeolinites and loesses of the geologic column should not be ignored as possible receptacles of certain kinds of organic remains.

Recent soils are full of organic remains of many kinds, both plant and animal, and some of these organic materials stand a good chance of being preserved if the soil itself is preserved. Should we not, therefore, examine ancient laterites and other residual soils along unconformities in the geologic column to determine if there are any fossils present?

Coal-balls, peat-balls, algal masses, shell accumulations worm-tube fascicles, and similar aggregations of organic fragments commonly contain the remains of organisms not directly concerned in building or constituting the gross deposit. In many cases, such aggregations give an unexpectedly rich harvest of fossils and throw valuable light on the ecological groups of the time.

Mud, sand and gravel lenses in recent and ancient floodplain deposits are promising places for accumulations of organic debris caught in side eddies, backwash areas, and still waters.

Nodules of all kinds should always excite the interest and curiosity of the palaeontologist because so commonly they are connected in origin with contained organic material. Splitting them will generally settle the question of whether they contain fossils.

These few random examples should suffice to show that if one observes conditions and processes around him, he should be stimulated to imagine how existing life might leave a record of its existence, and then to go on from this to suggesting the kinds of sedimentary features and rocks that deserve attention by the palaeontologist.

BURIAL POSITION OF FOSSILS

It has always seemed to me that some of the fascinating record of fossils is irretrievably lost when they are picked up at the base of a cliff or talus slope, in a stream bed, or along a seashore. This is because one does not see the fossil in its burial position, hence he misses the opportunity of studying the fossil *in situ* and consequently loses that evidence which he would have gained had he been able to view the fossil in the rock. Whenever and wherever possible, therefore, beginning palaeontologists should be encouraged to discover fossils in the enclosing rocks, and to note every detail of their burial position and relations before removing them from the rock.

TRACKS, TRAILS, AND MISCELLANEOUS MARKINGS

Many bedding surfaces have markings, either in relief or as depressions, and continuous or discontinuous, which excite the palaeontologist's curiosity and interest and challenge his imagination and ingenuity for an explanation. Many of these are rather clearly of animal or plant origin, and in some cases provide valuable and significant information regarding palaeoecology and palaeoenvironmental conditions. Others of doubtful origin but of equal interest also challenge one's imagination and create a keen desire to identify and explain them.

The young palaeontologist or stratigrapher should always be encouraged to describe and study these fascinating fossils, and to wonder about how they were formed and what they can tell him about ancient life. If he can feel that these unexplained fossils represent a special little problem all his own, they may well become the motivating force that will increase his interest in fossils in general.

MICROSCOPIC FOSSILS

The rapid growth of the science of micropalaeontology, and the increasing importance of many kinds of microscopic fossils, points to the future need for palaeontologists with good eyes, infinite patience, and a deep devotion to microscopic study. The rewards for this kind of palaeontologist can be great in money as well as in intellectual satisfaction, and he can make exceedingly valuable contributions to both palaeontology and stratigraphy by discovering new species and identifying forms previously described.

Opportunities for ambitious and eager younger palaeontologists seem almost without number.

SILICA AND SILICIFIED FOSSILS

Silica is one of the more mobile and ubiquitous substances on and near the surface, and silicified fossils are found in many rocks and over large areas. We need to know much more about the behavior of silica at normal temperatures and pressures, and how this substance behaves during diagenesis. For these reasons alone, as well as for others, silicified fossils in the field should be studied carefully *in situ* so that every possible detail of their relations can be observed and recorded.

SELECTIVE CONCENTRATION OF ELEMENTS BY ORGANISMS

Certain living plants and animals fix in their tissues or hard parts inordinately high concentrations of specific metals and other *ions*. With this in mind, it might prove rewarding to determine the composition of fossil shells that retain their original composition and of the sediments in which the shells are buried. Might not some of these yield unexpectedly high amounts of certain elements—a circumstance that could have useful chemical significance. For example, could the time of unroofing of an ore body possibly be determined by finding specific metals in unusual amounts in associated sedimentary rocks.

THE MAKERS OF SIMPLE CRYSTALS AND SYMMETRICAL STRUCTURES

Certain invertebrates make individual single crystals in their tissues and hard parts —a feat which man has not yet been able to duplicate at the pressure-temperature-solubility conditions of the water in which the particular animal lives. Study of this interesting situation is much needed and could well yield some surprising and highly useful results.

Many of the echinoderms make their complete exoskeleton or skeleton in the form of a single crystal of calcite. Articulate brachiopods produce in the tissue of their mantle, lophophore and body wall, tiny platelike spicules that are single crystals of clear calcite generally flattened parallel to the basal plane (III). Sponges and radiolaria use silica from the surrounding sea water to make beautifully symmetrical structures, some of which have symmetries similar to those of crystals

What biochemical and physiochemical factors are involved in these processes by which organisms precipitate *ions* from solutions and arrange these into such intricate and perfect configurations? There are problems without number in this fascinating and challenging no-man's-land where biochemistry, biophysics and biology meet, and palaeontologists should be interested in this area because here are the conditions under which organisms have been making their hard parts since life began on the planet.

PAUCITY OF THE FOSSIL RECORD

We should never lose sight of the fact that the evidence on which much of plaeontology is based is woefully small, commonly unrepresentative, and almost invariably incomplete. We never deal with complete populations, even in small groups; redeposited and abnormal forms may be mixed with normal forms; only parts of facies populations may be represented; only a part of the sedimentary record generally remains. In short, we must reconstruct the fullest possible picture from a paucity of fossil evidence, and this dramatically points out the necessity of seeking every shred of significant detail in fossiliferous rocks.

THE OLDEST FOSSILS

Palaeontologists are always interested in hearing about the latest discoveries of very old fossils like the algae and fungi recently reported from Pre-Cambrian silica nodules of Minnesota. These ancient plant remains, which may be as old as two billion years, indicate that fragile organic structures can be preserved in very old rocks, and should stimulate palaeontologists in every land to continue the search for fossils in the oldest rocks everywhere. Fine-grained clastic rocks—shales, argillites, phyllites and slates—and primary chertnodules and layers should always be carefully examined for fossil remains. Likewise, ancient volcanic ash beds should never be passed by as they might contain microscopic spores and plant fragments.

SUMMARY COMMENTS

It seems to me that the horizons of opportunity for beginning palaeontologists have greatly expanded in the past two decades for a number of reasons. Many excellent manuals, textbooks and comprehensive reference works have brought together widely scattered knowledge and organized it for ready use. Chemical and physical techniques of many kinds are available to the laboratory palaeontologist. Photographic developments and new methods of duplication and reproduction have greatly lessened the hours of tedious work once required of artist and lithographer in illustrating fossils. Means of travel to remote places have greatly inproved, and global palaeontology by individuals is now possible. There is, therefore, an encouraging future for our science, with promise of even greater discoveries to come, if we encourage study of every aspect of fossils and help interested persons to understand the great intellectual satisfaction that can come from such study.