Paleantology Essay, Research Paper

One of the principal objectives of geologists studying sedimentary rocks is the reconstruction of the environment in which the rocks were deposited. Correct reconstruction may result in the discovery of oilfields, deposits of salts, or base metals, and provide insight to our earth’s past. As evidence to ancient environments the geologist has the structures, textures, and composition of the grains that make up the sediments, and the fossils preserved in them. Organisms are far more sensitive to, and therefore diagnostic of, the environment in whixh they live than are the grains of sediment to the environment in which they were deposited. A study of the way of life and environmental requirements of organisms that become fossils therefore yields the most accurate information about the environment in which sediments were formed.

Ecology is the study of the relations between modern organisms and the environments in which they live; paleoecology is the study of these relations between species represented in the fossil record and the environments they inhabited. Unlike ecologists, the paleoecolgist has to work with organisms that are no longer alive and are very often misrepresented in the fossil record. Despite the limitations of dead and imperfectly preserved organisms, and the lack of direct information on the characteristics of the ancient environments, paleoecolgists can reconstruct ancient communities in considerable detail.

One of the greatest aids to paleoecological reconstruction is what is known as paleoecological inference. The paleoecologist infers that similar relationships existed in the past between organisms and their environments than those of modern organisms. During this process it undeniable that groups in the reconstructed ecosystem will be poorly represented or missing entirely. For example the primary producers of marine ecosystems are microscopic planktonic plants that are rarely preserved, but are presumed to have existed since the Archean because they are essential to life in the marine environment. In such a way paleoecologists can compare the forms of modern animals of known trophic roles with those of fossils to infer their positions in ancient ecosystems. This uniformitarian approach does not imply that conditions in the past were exactly the same as those of today – in fact, it is known that they were not. It does imply, however, that general laws governing the functioning of organisms have not changed in time, though environments may have.

Other tools at the paleoecologist’s disposal are independent of comparisons with modern communities. This is mainly constituted of evidence preserved in various fossils. Sometimes it concerns the actions or positions of the preserved organisms or their interaction with other organisms. Other times the chemical analysis of the fossil will reveal important paleoecological evidence. In order to reconstruct the pastenvironment succesfully the pakleoecologist must combine comaparisons with modern communities with direct evidence available within the fossil deposit itself.

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Direct paleoecological evidence is more reliable and accurate than the conclusions supported by paleoecological enference, but is rather limited since. According to Donald Prothero in Bringing Fossils to Life (1998) the strongest evidence comes from extraordinary fossilization that actually preserves behaviour. In this book he mentions Boucot’s (1990) Evolutionary Paleoecology of Behaviou and Coevolution as the best source for this topic. In this book a number of fossils are described and interpreted in which symbiosis, reproduction, and predation are taking place. A fossil in which a juvenile productid brachiopod is found attrached to a crinoid stem is a clear example of a symbiotic relationship. This lead to the conclusion that these brachiopods spent their early periods attached to a crinoid stem until it grew too large to do so, when it fell to the floor and lived as believed prior to the discovery of such fossils. The most common cases of reproductive fossilization is among the insects preserved in amber. Yet there are some exeptional cases, such as the Jurassic ichthysaur from the Holzmaden shales preserved with a juvenile emerging from the birth canal. Examples of predation are more common, both as specimens that have been preyed upon and as predators with stomach contents preserved. Some extraordinary fossils have been found, among them one of an Eocene fish, Mioplosus, attempting to swallow a Knightia. Although body fossils are the best direct evidence of behaviour, tracks and traces are also valuable clues.

Other direct peleoecological evidence is more scientific in nature, often called paleobiogeochemistry. This study is based on the chemistry of the shell or the bone of the fossil, and often tells a lot more than the fossil on it’s own. Oxygen isotopes ratios within the shells or bones vary with temperature and are, therefore, indicative of the oceanic temperature in which they lived. There are complications with this, of course. Glaciation has the same effect on the ocean isotope levels as temperature does because it retains the fresh rain water, which is O16-rich keeping the oxygen isotope ratio relatively negative in modern climatic conditions. Athough the relationship between temperature and glaciation on the isotope levels of the shells is complicated, oxygen isotopes have become the primary tool of paleoclimatologists and paleoceanographers for determining ancient temperatures. A similar process can be applied to carbon isotopes but the relationship with temperature is not so simple and therefore not so reliable.

Most of paleoecological reconstruction is based on inference from modern organisms and their function in their ecosystem. Although it is not easy to specify the detailed behaviour of an extinct organism, there are certain constraints in the environment that almost certainly applied to the past as they do to the present, since they are largely based on invariant laws of chemistry and physics. In many cases a uniformitarian approach to paleoecology is justified, and we can clearly which conditions an ancient condition must have tolerated and which ones they could not. Important physical parameters of the environment such as temperature, light, salinity, nature of the soil or bottom sediment, and rainfall must have had the same effect on living oraginisms in ancient ecosystems as they do today.

The fossils of living species whose temperature tolerance is known are obviously of value for determining temperatures of ancient seas. However, most fossil species are extinct, and their tolerances are not directly known. Comparing the morphology of the fossils to those of modern organisms can often lead to conclusions concerning their adaptation to a specific climate. For example, the plants of tropical rainforests have large leaves with tips shaped for dripping moisture, and large breathing pores; these features in extinct fossil plants, such as those of the coal forests, are interpreted as indicative of warm, moist climates.