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**PALAECOLOGY**

Paleoecology is the study of interactions between organisms and/or interactions between organisms and their environments across geologic time scales. As a discipline, paleoecology interacts with, depends on and informs a variety of fields including paleontology, ecology, climatology, and biology.

Palaecology is the ecology of the past. It is mainly concerned with the reconstruction of past biota, populations, communities, landscapes, and ecosystem from available geological and biological fossil evidence.

Classic paleoecology uses data from fossils and subfossils to reconstruct the ecosystems of the past. It involves the study of fossil organisms and their associated remains (such as shells, teeth, pollen, and seeds), which can help in the interpretation of their life cycle, living interactions, natural environment, communities, and manner of death and burial. Such interpretations aid the reconstruction of past environments (i.e., paleoenvironments). Paleoecologists have studied the fossil record to try to clarify the relationship animals have to their environment, in part to help understand the current state of biodiversity. They have identified close links between vertebrate taxonomic and ecological diversity, that is, between the diversity of animals and the niches they occupy. Classical paleoecology is a primarily reductionist approach: scientists conduct detailed analysis of relatively small groups of organisms within shorter geologic timeframes.

Evolutionary paleoecology uses data from fossils and other evidence to examine how organisms and their environments change throughout time. Evolutionary paleoecologists take the holistic approach of looking at both organism and environmental change, accounting for physical and chemical changes in the atmosphere, lithosphere and hydrosphere across time. By studying patterns of evolution and extinction in the context of environmental change, evolutionary paleoecologists are able to examine concepts of vulnerability and resilience in species and environments.

Community paleoecology uses statistical analysis to examine the composition and distribution of groups of plants or animals. By quantifying how plants or animals are associated, community paleoecologists are able to investigate the structures of ancient communities of organisms. Advances in technology have helped propel the field, through the use of physical models and computer-based analysis.

There are two major types of paleoecology:

**PALEOAUTECOLOGY**

Paleoautecology is the study of the life habits of a single fossil species and how that species related to its environment. They consist of single species. There are two limiting factors: The physical and biological factors. Physical environment can affect the organism and vice versa

• Physical Factors

(1) TEMPERATURE

 Biological processes affected by temperature

a. Calcification - decreases at low temperature

b. Metabolic activity - movement and activity restricted in cold water

c. Photosynthesis - reduced in cold water.

Example: hermatypic reef corals

 Inferring paleotemperature:

1. Palaeoceanographic patterns

2. Modern indicator organisms

3. Morphologic features: spines and coiling direction

4. Aragonite / calcite ratios

5. O18/O16 ratios

(2) OXYGEN

Availability controls distribution

a. Dissolved O2 in water: aerobic, dysaerobic, anaerobic

b. Infers paleo-oxygen conditions - sediment color, minerals, bioturbation

c. Oxygen depleted basins

(3) WATER DEPTH

 Related to many factors

 Example, deeper water is usually colder, less turbulent, and has a finer substrate

 Paleo indicators? tough to constrain; often measuring by some other factor

Example of this problem: inferring depth in a basin based on O2 levels

 Use relative wave base and frequency of tempestites

(4) TURBULENCE

 Water turbulence can affect the distribution of in many ways:

a. Suspension of sediment - by wave action

b. Unattached organisms

c. Burrowing organisms

d. Attached organisms

e. Infer by using taphonomy data

(5) SALINITY

 Normal salinity: 35 parts per thousand

 Hypo salinity (brackish water) - fresh water influx

Normal salinity; hyper salinity - evaporation

Stenohaline vs. euryhaline organisms

Indicators:

1. physical features: evaporite minerals (gypsum & halite); fluvial activity

2. presence of stenohaline organisms: echinoderms = great indicators

3. stunted growth

4. geochemical indicators: trace elements (boron); Sr/Ca ratios

(6) SUBSTRATE

 Organisms require specific substrates

a. hard vs. firm vs. soft substrates

b. grain size important in soft substrates

- grain size important in burrowing: sculpture in clams

- infer this from sedimentology of the containing rock

• BIOLOGICAL FACTORS

 Biological factors = difficult to prove in the modern world, and even harder in fossil situations;

- can only make observations and make inferences from them

• Most important biological factors:

 Competition - inherent in Darwin's concept of natural selection

 Resource competition - when there's a limiting resource, usually food or space

Example:

- competition for hard substrate space in the rocky intertidal zone

- growth interactions among epibionts

INTERFERENCE COMPETITION - when the activity of one organism precludes the presence of another

Example: burrowing clams in Buzzard's Bay, Cape Cod; the fecal pellets of some species of clam (ones that do not filter feed) turn the substrate to a fine-grained muck; this prohibits the presence of Mercenaria whose filter-feeding gill gets fouled

• Predation - can have a tremendous influence on marine communities

 Example in the fossil record: naticid gastropod borings

• Larval recruitment - what organisms get there first can determine community structure

PALEOSYNECOLOGY

Paleosynecology is the study of paleo communities (community = groups of species that interact within a giving habitat) rather than individual species. They consist of single species as well.

The aim of paleoecology is to build the most detailed model possible of the life environment of previously living organisms found today as fossils. The process of reconstructing past environments requires the use of archives (e.g., sediment sequences), proxies (e.g., the micro or mega-fossils and other sediment characteristics that provide the evidence of the biota and the physical environment), and chronology (e.g., obtaining absolute (or relative) dating of events in the archive). Such reconstruction takes into consideration complex interactions among environmental factors such as temperatures, food supplies, and degree of solar illumination. Often much of this information is lost or distorted by the fossilization process or diagenesis of the enclosing sediments, making interpretation difficult.

Some other proxies for reconstructing past environments include charcoal and pollen, which synthesize fire and vegetation data, respectively. Both of these alternates can be found in lakes and peat settings, and can provide moderate to high resolution information. These are well studied methods often utilized in the paleoecological field.

The environmental complexity factor is normally tackled through statistical analysis of the available numerical data (quantitative paleontology or paleo statistics), while the study of post-mortem processes is known as the field of taphonomy.