Changes in the use of “Ecospace” in the Marine Realm over time

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Ecospace Utilization and Guilds in Marine Communities through the Phanerozoic

The Guild Concept

Diagrammatic representation of ecospace using the three general criteria used in this chapter for defining guilds as axes. A guild would be represented by the species of a community that all fall in the same place on each axis and therefore occupy one small segment of the ecospace "cube," such as a corner.

Bambach (1983)
The Guild Concept

Arbitrary and vague

Not always determinable

Too broad, Mixes dimensions

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Bambach (1983)
An improved methodology for general paleoecological assessment of assemblages and faunas:

Use ecologic axes for which assignment of fossils is feasible:

**Tiering** (spatial position relative to the sea-floor)

**Motility level** (ability to change position, respond to external events)

**Feeding strategy** (method of acquiring energy to maintain life functions and reproduce)

Each axis subdivided to designate the full range of possibilities

From counts of taxa with each combination of properties a quantitative evaluation of the importance of each ecological combination is possible.
3-D Ecospace Use Cube

Bush, Bambach and Daley 2007
216 combinations encompass all possible modes of life
“Complete” Survey of the Living Fauna

- 92 modes of life documented
- 26 others reasonable
- 98 potential modes of life do not seem to be utilized
- 45% of conceivable modes of life are unlikely to be successful.

Bambach, Bush and Erwin 2007
Ecospace — from the Ediacaran to the Cambrian to Now

Faunas including non-skeletal organisms

Bush, Bambach and Erwin in press
Number of modes in each category has systematically increased

“Normal” Phanerozoic marine animal life has a truly different relation to ecospace utilization compared to the Ediacaran fauna

Bush, Bambach and Erwin in press
The “normal” fossil record — just skeletal preservation
Comparing the Paleozoic to the Late Cenozoic

A. Late Ordovician Skeletal

B. Recent—Regularly Preserved Hard Parts

Bambach, Bush and Erwin 2007
Comparison of “communities”
(fossil assemblages from just one habitat)
(Bush and Bambach 2004, and later papers)

- **Late Cenozoic**
  - Plio-Pleistocene
    - 24
  - Miocene
    - 23

- **Middle Paleozoic**
  - Devonian
    - 4
  - Silurian
    - 49
  - Late Ordovician
    - 26

All samples contain over 100 specimens
37 Paleozoic and 38 Cenozoic temperate contain over 200 specimens
182 of the Cenozoic tropical samples are over 200 specimens and 71 are over 800
Rarefaction: Paleozoic vs. Cenozoic alpha diversity

Bush and Bambach (2004), *J. Geol.*
Number of modes of life per paleocommunity increased greatly between the Paleozoic and late Cenozoic.

Number of genera per mode of life did not increase significantly.

[Note overlap of confidence intervals]

Bush et al. in preparation
Environmental conditions in particular habitat settings (in this case the loose-sediment level bottom habitat) encourage habitation by just a restricted range of modes of life.
If there are 21 to 25 modes of life represented in both mid-Paleozoic and late Cenozoic level-bottom marine ecosystems, how, on average, can there be almost twice as many modes of life (9.5) represented in late Cenozoic assemblages as there are in mid-Paleozoic assemblages (5.5)?
In Mid-Paleozoic assemblages
~80% of individuals utilized just two modes of life
~75% of individuals in Cenozoic Temperate assemblages were distributed among six modes of life, not just two.
In late Cenozoic Tropical assemblages, ~80% of individuals were distributed among seven “dominant” modes of life.
The difference in number of modes of life in mid-Paleozoic and late Cenozoic assemblages is a result of drawing from species pools with different distributions of abundance (importance) values.

Note: Overlap of confidence intervals.
Ecospace Use has Changed

Bush et al. (2007)
Genera vs. Modes of Life in Fossil Assemblages

Bush et al. in preparation

\[ r^2 = 0.80 \]
Whence the correlation?

- For each collection, keep the same # of genera and abundances
- Randomly assign modes of life to genera without replacement
- Simulates random ecologic assembly of paleocommunities

Bush et al. in preparation
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Bush et al. in preparation
D. Early & Middle Cambrian

E. Recent Modes with an Extensive Fossil Record

Tiering

1-Pelagic
2-Erect
3-Surficial
4-Semi
5-Shallow
6-Deep
1-Suspension
2-Surf. Deposit
3-Mining
4-Grazing
5-Predatory
6-Absorptive
7-Other

Feeding
Active burrowing disturbs sediment, requiring disturbed organisms to reorient to function effectively.

Many prey organisms tend to move away (flee) or burrow to avoid predators.

Predators pursue prey into the sediment if need be.

Increased needs have been generated by increased predation (need to escape) and increased infaunal activity (need to resist or recover from disturbance).
Questions raised that will require further research:

What has been the actual course of change, the interval by interval pattern? Is it episodic or continuous?

Are there modifications in ecospace use at major events such as mass extinctions, major geochemical anomalies, climate shifts?

Are there biotic controls on local assemblage structure not visible with this rather coarse parsing of ecospace utilization?

FINI -- thank you for your attention --