



# Biogeography of the Recent Brachiopods

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# What are Brachiopods?

- Marine invertebrates that are found in recent seas and oceans with two major forms: articulate and inarticulate
  - 370 species, 116 genera, 26 families
  - 26 new species, 5 subspecies, 9 genera, 1 subfamily, and 2 families described in this research



# What is the purpose of this research?

- To discuss the vertical, latitudinal, and circumcontinental zonality of the distribution of the species, genera, and families of recent brachiopods
- Distortions of latitudinal and meridional symmetry biogeographical structure of ocean are analyzed thus ancient faunas may be reconstructed based on data of structural characteristics of taxocene of recent brachiopods.
- Paedomorphic evolution of brachiopods from different families in extreme habitats are discussed
  - Extreme habitats include: interstitial, underwater caverns, submarine, abyssal depths, hydrothermal areas

- Historical change from brachiopods to bivalves that occurred from the Paleozoic to the Mesozoic and Cenozoic resulted not from competitive exclusion but from complex and global changes in the plankton composition
  - Unfavorable for articulate brachiopods
  - Peculiarities of brachiopod evolution in optimal and extreme habitat conditions are analyzed
  - Possibility of the paleoreconstruction of ancient faunas accounting for the structure and function characteristics of recent brachiopods are discussed

# Articulate Brachiopods

## Why unfavorable?

- Articulate brachiopods have already developed specialized feeding habits, feeding on food that led to the production of almost no metabolic waste products, and even partially lost their alimentary canal
- Adaptation to feeding on decay of dead plankton
- Usually inhabit deeper waters because the muddy bottom is rich in organic matter, but substrate is not suitable and prevents oxygen formation thus restricting them to the littoral and transitional horizon of tropical zone

# Vertical Distribution

- Recent brachiopods inhabit all oceanic depths EXCEPT the deep oceanic trenches this includes tidal (littoral) zone to ocean floor (abyss)
- Inarticulate brachiopods (lingulid and discinid species) inhabit the littoral zone
- *Pelagodiscus atlanticus* reaches the maximum depth in the abyssal zone
- Articulate Brachiopods: North Atlantic *Diestothyris frontalis* & *Megerlina davidsoni* from Indian Ocean inhabit littoral zone
- The range of vertical distribution of species varies from a few meters to 3 or 5 kilometers
  - Vertical range of distribution has been established only for 200 species

General pattern of vertical brachiopods shows that the number of species increases with depth from the water line, reaches its maximum between depths of 100 and 150 m and then decreases



# Vertical Distribution

- 1) Maximum number of species appears and disappears in upper horizons of benthic zone
- 2) Inflection points of curve of total number of species are located below maximum point at levels of 300 and 700 m and corresponds to max. rate of disappearance of species in 200-300m
- 3) Appearance of new species is at max. in upper horizons & discontinues at depth of ~1000m

# Endemism

- Patterns of distribution of recent brachiopods in benthic zone
- 0-300, 300-700, 700-2000, and below 2000 meters
- Fauna of uppermost zone (0-300) shows the greatest development of endemism at species and generic level
- The lowest zone (below 2000) ranks next in number of endemic taxa
- Families of: Lingulidae, Thaumatosiidae, & Thecideidae & 20 others were found within the uppermost zone
- Lower limits of distribution of 17 genera are located at depths of 300-700
- Upper limit of distribution of deep water genera *Neorhynchia*, *Abyssothyris*, *Notorygmia*, & *Leptothyris* are found at depths below 2000 known as abyssal

# Factors determining vertical distribution

- Relief and the depositional regime which is governed by the relief
- Competition for substrate which is strong especially in phytal zone
  - Phytal zone: part of a lake bottom covered by water shallow enough to permit the growth of rooted plants
- Deterioration of feeding conditions with a decrease in depth within the shelf and with an increase in depth with the slope

# Ranges of Brachiopod Fauna

- North Atlantic
- North Pacific
- North circumpolar
- West Atlantic
- East Atlantic
- Amphiatlantic
- Lusitanian-Mauritanian-Mediterranean
- Nouvelle-Amsterdam
- Kerguelen
- Caribbean
- Southern Brazilian-Uruguayan
- West African
- South African
- West Pacific
- Indo-West Pacific
- South Australian
- Californian
- Pacifico-Central American

- South American
- New Zealand
- Macquarie
- Antarctic
- Bipolar transitional regions
- Widely tropical
- Cosmopolitan
- Coastal-deep-water
- The North Atlantic & South American groups of species are very important geographically, but they are not distinguished higher than at the species level.
- North Pacific, Japanese, S. Australian, & New Zealand groups are better characterized in the number of endemic genera

# Latitudinal zonation

- Geographical elements of fauna are arranged more or less symmetrically about the equator
- Zone of cold water species of Northern Hemisphere consists of North Atlantic, North Pacific, & northern circumpolar species
  - Distribution of northern, southern subtropical, lower boreal, & subantarctic species correspond to transitional areas
    - Species of tropical zone meet with species of cold water zones
    - Transitional zone is best pronounced in Northern Hemisphere
- Zone of cold water species of Southern Hemisphere is disjunct and consists of more cold water species with Antarctic type of ranges and moderately cold water species with S. American, Kerguelen, Nouvelle Amsterdam, New Zealand, and Macquarie type of ranges

- In the Pacific Ocean, areas of cold water species coincide with areas of warm water species near the coasts of Japan and California
  - Transitional zones are formed & subtropical species become endemic in these regions
  - Unlike Northern part of Atlantic Ocean, areas of tropical species & northern cold water zone don't overlap
    - Subtropical species occupy northern margin near coast of America; southern margin of cold water zone near coast of Europe and Africa

- Biogeographical structure of brachiopod fauna in bathyal zone (“midnight zone” – 1000-4000m deep) is simplified compared with fauna of sublittoral mainly due to disappearance of endemic faunas of transitional zones at depths of 700m
- Key role of bathyal zone in preservation of marine fauna because it provides available refuge for shallow water and eurybathic fauna
  - Possible that deep water fauna finds better conditions and survives in this zone during periods of hydrological reconstructions

- Ancient & modern brachiopods are convenient and significant indicators of temporal and spatial changes in the environment by phenomena of dwarfism, paedomorphosis, and homeomorphy
  - Thus the depressed brachiopods and other marine invertebrates are considered as indicators of global reconstruction

Interstitial conditions are highly specific for invertebrates that thrive in limited spaces between sediment particles, environmental conditions are unstable leaving the life of biota short

Shallow underwater caverns are exotic biotope with unstable conditions and low range of food conditions

# Brachiopods & Mollusks- same ancestry line?

- No, Brachiopods and bivalves are similar in size and both have hinged two part shells, but are different based on ancestral lines
- They differ from complex changes in hydrological environment in pelagic & benthic zones rather than from competitive replacement
- Modern brachiopods form largest assembly in bathyal zone
- Brachiopods feed on finest suspended material which produces no metabolic waste products unlike mollusks that feed predominantly on living plankton and detritus (waste)

- Filtration rate of articulate brachiopods is  $1/3$  the rate of mollusks and metabolic level of articulates are  $1/2$  of mollusks
- These are consistent with the hypothesis that is based on the consideration of two different taxonomic groups as components of benthic biofilter affected by the change in composition of plankton in oceanic ecosystems during the Phanerozoic