Geoscience Canada

Symposium on Benthonic Foraminifera

C. T. Schafer, G. Vilks et P. Ascoli

Volume 3, numéro 2, may 1976

URI : https://id.erudit.org/iderudit/geocan03_02con06

Aller au sommaire du numéro

Éditeur(s)

The Geological Association of Canada

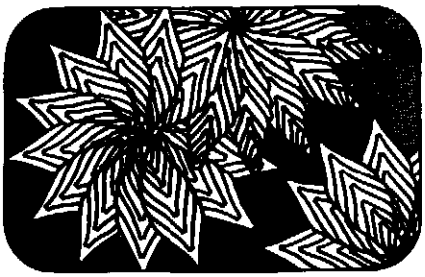
ISSN

0315-0941 (imprimé)
unknown (numérique)

Découvrir la revue

Citer ce document

Schafer, C. T., Vilks, G. & Ascoli, P. (1976). Symposium on Benthonic Foraminifera. *Geoscience Canada*, *3*(2), 119–122.



Symposium on Benthonic Foraminifera

C. T. Schafer, G. Vilks and P. Ascoli
Atlantic Geoscience Centre
Bedford Institute of Oceanography
Dartmouth, Nova Scotia

Introduction

The study of foraminifera can be traced back to the fifth century B.C. Most references discuss nummulites which were particularly well known from the region of the Egyptian pyramids. Since that time the field has developed as a tool for both science and industry. "Benthonics '75," the first international symposium on benthonic foraminifera, was held at Dalhousie University in Halifax during the week of August 25, 1975, to examine the state of development of this science and the required future thrusts in benthonic foraminiferal research. The symposium was sponsored by the Atlantic Geoscience Centre, the National Research Council of Canada, the Geological Survey of Canada, and Dalhousie University. About 200 participants attended the four-day meeting during which 80 detailed papers were presented. Because of the current interest in modern marine environmental relationships, and in Quaternary paleooceanography, many of the 11 organized sessions focused on some aspect of the biology and distribution of Recent species. Nevertheless, there was also a significant emphasis on biostratigraphic and paleoecologic relationships of foraminifera in Mesozoic and Cenozoic sediments. Four keynote speakers were invited to set daily themes in the areas of biology, ecology, paleoecology, biostratigraphy, and taxonomy.

Biology of Foraminifera

Biologists emphasized feeding behaviour and its relationship to test morphology and environment. The observations presented suggest that most feeding strategies are not adapted to particular food types other than small-sized material. Most species feed opportunistically consuming almost anything that they can hold with their pseudopodia. The morphology of the test was shown to be often related to feeding mode. Detrital and bacterial feeders scavenging at or near the sediment-water interface usually have lenticular tests while species which spread their pseudopodia and wait for their food are usually characterized by an elongate test. Specific feeding modes were associated with distinct environments in several instances. At the opposite end of the food chain, it was demonstrated that foraminifera are ingested by many classes of organisms including Polychaeta, Crustacea, Asterioidea, Echinioidea, and Holothuroidea. The tests of arenaceous species are apparently less susceptible to ingestion effects and show no alteration when examined under a scanning electron microscope.

Conditions favourable for reproduction of the foraminifera are still poorly understood for most living species. There is ample evidence in the literature demonstrating that a distinct set of conditions (perhaps a synergistic effect) are required to trigger reproduction in certain species. This fact was reflected by presentations in which the nonsynchroniety of reproduction cycles of species occupying a seemingly similar environment in a particular area was described. Observations of tidepool foraminifera along the Atlantic coast of Nova Scotia showed that only the asexual phase (agamogony) of the life cycle occurs in the tidepool habitat, suggesting that the sexual phase (gamogony), if it exists, occurs in deeper sublittoral waters. The reproduction cycle relationships described above indicate the unique biological characteristics of species that have been defined using a purely taxonomic classification scheme. They also suggest that environmental changes might be reflected and explained in part through correlations of reproductive cycles of several species with observed physical and chemical parameters.

The formation of new chambers and the overall rate of test growth varies between species and from one environment to another. In laboratory cultures of *Heterostegina depressa*, only 15 to 20 hours are required to construct a new chamber by precipitation of $CaCO_3$. Individuals of older age may pause up to two months or more between the formation of two successive chambers for reasons that have not yet been explained. An understanding of the symbiotic relationships between benthonic foraminifera and other organisms may provide some answers to this type of growth pattern.

Ecology of Foraminifera

The potential use of foraminifera as environmental indicators was reflected by numerous investigations that were reported from many parts of the world. Some applications described during the Symposium include: - a) relative organic production, b) water movements, exchange rates and sources, c) relative rates of sediment deposition, d) urban and industrial pollution, e) displacement of sediment, and f) oscillation of sea level. Evidence presented from field experiments suggests that, in tropical habitats, changes in species abundances are not controlled abiotically. However, in the shallow tropical environment of Great Exuma Island in the Bahamas the occurrence of living foraminifera specimens was shown to correlate in a general way with the occurrence of organic detrital material that serves as a food source. In north temperate nearshore environments along the coast of Prince Edward Island, Canadian scientists indicated that the use of foraminifera as indicator organisms in these areas was considered appropriate when population data were used in conjunction with other chemical and biological parameters. In a controlled polluted and an unpolluted pond adjacent to a shallow estuary near Morehead City, North Carolina, it was shown that species diversity and standing crop was higher in the unpolluted pond. It was concluded that the trophic structure which developed in the polluted pond apparently limited the number and size of microhabitats favourable to foraminiferal growth and reproduction thus supporting the general indicator organism hypothesis.

Generally, in many marginal marine areas, the standing foraminiferal stock (number of living specimens per unit area) was shown to be indicative of relative organic production. Small stocks, indicative of moderate organic production, were often associated with continental shelf environments. Large standing stocks could be attributed to a large supply of food and conditions that promote frequent resupply of nutrient trace materials (e.g., upwelling areas and estuaries characterized by moderate to high river flow). On the Georgia continental shelf foraminifera were used as indicators of seasonal water temperature stability. In the Chesapeake Bay region of the Atlantic coast recent foraminifera populations were grouped into two types that reflect differences between nearshore waters and inner shelf waters at depths greater than about 25 m. The distribution of shallow water species was shown to be influenced by salinity and duration of exposure. In the Hudson River estuary the *Ammobaculites* assemblage was associated with bottom water salinities of up to 15 per cent. The *Elphidium-Ammonia* assemblage was described as being more open marine, and was characteristic of bottom water salinities averaging 20 per cent.

In southern California relatively large lagoons in this area tend to support a diverse foraminiferal community. The modern assemblage characteristics appear to be indicative of the amount of tidal water exchange and lagoon entrance size.

During discussions of the indicator relationships presented it was noted than many of these could only be discussed in a semiquantitative sense at this time because of insufficient knowledge concerning the experimentally verified ecological preferences of most species. Ingestion as well as other biological and physical perturbations must be understood to a greater degree before biological indicator data can be interpreted in a strict quantitative sense. In the relatively dynamic environments of the Restigouche estuary, New Brunswick, an analysis of the temporal and spatial distribution of several dominant species suggests that the distribution patterns of the observed species is primarily dependent on water depth (environmental stability) and absolute abundance. In some instances a relatively regular pattern could be ascribed to a greater degree of local postmortem test redistribution. Although the relatively abundant species do not necessarily develop a relatively regular pattern in space and time, their range of variation is usually less so that they have a relatively greater potential usefulness as indicators of environmental variations recorded in Holocene sediments.

Taxonomy of Foraminifera

Foraminiferal experts showed that new species continue to appear in the literature as the result of detailed morphology and ultrastructure studies. The current suprageneric classification includes 19 superfamilies representing more than 40,000 species.

It has recently been shown, for example, that orientation of the crystalline wall structures within the elphidiids and nonioniids observed using modern instrumentation cuts across family and generic divisions.

Quaternary Paleoecology

The marginal marine faunas of the Champlain Sea and the coastline of the Beaufort Sea contain foraminiferal assemblages of low diversity that are dominated by cold water nearshore species of *Elphidium*. As the salinities became lower in the regressing Champlain Sea, the increasing stress on the marine forms is demonstrated by fewer numbers but larger tests of these species.

Gulf of Maine waters were interpreted as being significantly different during the times of continental deglaciation and changing sea levels. A number of horizons in piston cores from this area contain subtropical planktonic foraminifera that occur with cold-water benthonic foraminifera. However, these infrequent incursions of Gulf Stream waters into the Gulf of Maine did not last long enough to influence the benthic community.

Changes in Pleistocene foraminiferal assemblages were reported from beds cropping out at Clyde Inlet in northeastern Baffin Bay. Foraminifera observed in these beds were grouped in three major zones. The *Islandiella* zone contains two assemblages: the *Islandiella islandica* assemblage, which probably was deposited during a Mid-Wisconsin interstadial transgression, and the *Islandiella inflata-Cassidulina teretis* assemblage, which is probably of Sangamonian age.

Some discussions focused primarily on Quaternary foraminiferal stratigraphy problems, especially the Pleistocene-Holocene boundary in Arctic and cold-temperate marine strata. Living species of benthonic foraminifera transgress most of the Quaternary time boundaries established by other criteria, and different faunas reflect changes in oceanographic conditions rather than extinctions or evolution of species. The post-Pleistocene adaptation of foraminiferal faunas to marine environments located in cold-temperate regions is still taking place and at a faster rate in the eastern Atlantic than along the Canadian shore.

Offshore Foraminifera Distributions

The session on offshore Recent foraminifera contained material collected in water depths ranging from 18 to 2100 metres. A number of environmental factors seem to be equally responsible for the distribution of foraminiferal species, regardless of latitude and geography. For example, the amount of dissolved oxygen and the availability of calcium carbonate can be correlated with the distribution of certain taxa in widely separated localities, such as the Indian Ocean and the Gulf of Mexico.

Relict Pleistocene faunas in the offshore sediments of continental shelves often introduce additional problems in areas such as the Scotian Shelf, where the general character of assemblages has not changed since the late Pleistocene. However, in the Gulf of Mexico the Pleistocene assemblages are readily recognizable and the presence of modern species in surface sediments is being used to delineate areas of nondeposition or low sedimentation rates.

Foraminifera and Economics

A source of clean sand is an important economic factor in urbanized coastal areas. Under proper conditions foraminiferal tests can contribute a large fraction to biogenic sand deposits. Sediment production by benthonic foraminifera in the coastal waters on Oahu Island, Hawaii, was estimated as part of a coastal zone management study. A yearly contribution of 0.2 kg

$CaCO_3/m^2$ was estimated with *Amphistegina* producing about 90 per cent of the total.

Transport of Foraminifera Tests

On the Angulhas Bank of the South African continental shelf a large proportion of the living population belongs to the attached genus *Cibicides*, other free-living forms are abraded, especially the relict specimens of early Holocene age. Studies of postmortem transport of foraminiferal tests on the Pedro Bank, southwest Jamaica, indicated only a comparatively small influence on the distribution of foraminiferal species, even though the bank is crossed by a constant current that has had a great influence on sediment distribution.

In the nearshore zone of the Arctic scouring of the sea floor by ice is extensive. Foraminifera found in the sediment can be used to demonstrate some of these scouring effects, primarily the vertical extent of sediment mixing. In the ice-scoured zone of the Byam Martin Channel of the Canadian Arctic 10 cm cores taken by divers showed two distinct zones of foraminifera both in and adjacent to scour marks. The presence of the two zones in many of the cores indicated that, during the scouring process, scouring ice normally compresses or displaces the sediment laterally without overturning it.

Mesozoic and Tertiary Foraminiferal Studies

Most papers described the benthonic microfaunas, biozonations and paleoecological reconstructions of several areas located in different continents. Benthonic foraminifera of Early-Middle Triassic age were reported from the pelitic sequences from Chios (Greece) and Bithynia (Turkey) and are correlated with the Conodont and Ammonoid faunas occurring in the same samples. In the Jurassic of Kutch (India), the foraminiferal benthonic fauna shows Tethyan affinities and is characterized by an overwhelming majority of nodosariids. In the Jurassic Shelf of Israel, two sedimentary facies were recognized: a 'carbonate' ('Tethyan') in the north and a 'terrigenous' ('Ethyopean') in the south.

A comparative study was presented on the relations between the late Jurassic foraminiferal faunas of Western and Eastern Europe. Significant affinities are identified, as well as the fact that the only difference between these two areas is that in the east, part of the western Tithonian-Kimmeridgian species occur earlier in time.

A paleo-environmental analysis of the Liassic benthonic foraminifera from North Wales provided a basis for making good biostratigraphical correlation with the rest of Europe, Arctic Americas and Eastern Canada. The position of this virtually complete early Jurassic section of the Western European Continental Margin makes it a valuable tie-point between North America and Europe.

On the Grand Banks, foraminifera from six deep exploratory wells were classified into eight biostratigraphic zones, ranging in age from Pliensbachian to Tithonian. Early, Middle and Late Jurassic assemblages from Alaska and the Western Interior of North America bear little resemblance to coeval Grand Banks faunas. The latter are predominantly known from Europe and Africa; this is especially true for the rich Grand Banks epistominids and "Globigerina" faunas. The benthonic foraminifera biozonation proposed for the Mesozoic and Cenozoic of the Scotian Shelf is a part of a multiple biozonation which also uses planktonic foraminifera (from Hauterivian to Late Miocene) and Ostracoda (from Callovian to latest Cretaceous). The calcareous species markers were subdivided into 20 informal 'last occurrence' zones from Bathonian to Late Miocene and the arenaceous species into 14 zones from Bathonian to Early Eocene.

Both calcareous and arenaceous foraminifera show the maximum degree of affinity with the European coeval faunas in the Middle-Late Jurassic and Early Cretaceous in the same way as the Grand Banks faunas. In the Late Cretaceous, this European affinity still is strong for the calcareous species, but it looks weak for the arenaceous species. This inversion of European versus American affinity for arenaceous species in the Late Cretaceous is even more emphasized by ostracod data and suggests the establishment of separate faunal provinces at that time.

Distributions in Tertiary Sediments

In a paper illustrating the taxonomy and diversity of Paleocene deep-water benthonic foraminifera from the Western Atlantic, it was shown that Berger's 'backtracking' method, which is based on Slater's age/depth relationship for oceanic crust, can be used to calculate the paleo-depth for each oceanic sample and thereby establish depth changes in species diversity.

A new area for micropaleontological and stratigraphical research is the Labrador Shelf, where biostratigraphical data from three deep exploratory wells has been used to reconstruct the stratigraphy and the paleoecology of the area from Late Cretaceous (Campanian) up to Pliocene. The late Cretaceous is characterized by a deep water environment (upper bathyal). From Paleocene to early Oligocene, the environment varies from upper bathyal to outer neritic. The corresponding arenaceous microfaunas are very similar to those of the North Sea Basin, while the calcareous ones consist mainly of forms described from the Gulf Coast and California. From late Oligocene to Pliocene, the environment is regarded as middle neritic and the microfaunas are the typical ones of Northwest Europe, without marked 'Tethyan' elements.

New Approaches

New methods and developments that can be applied in biostratigraphical and paleoecological research emphasize the importance of studying the Paleoecological Index Benthonic Foraminifera (PIBF). This index includes measurements of functional morphology, wall structure, internal structure and associated biofacies. In the same way, the study of the internal structures by comparative anatomy is emphasized as a tool for understanding evolutionary trends and systematics.

Perhaps the newest and most original method of interpreting paleoecological data has been illustrated in a paper describing the 'Foraminiferal Morphogroup Symbol' for paleoenvironmental interpretation of drill cutting samples in the Albian of Arctic Canada. The development of this new approach has been stimulated because of the many limitations in applying traditional methods when dealing with the environmental conditions which promote the development of siliceous

assemblages in the boreal benthonic realm. When this technique is applied to Recent, Tertiary and Late Cretaceous faunal data, a correlation between chamber shape and arrangement of the Arctic benthonic fauna to major classes of environments is observed. In general, there is a homeomorphic series of species with chamber arrangements from the simple tube, closely coiled, to the globular or subglobular and associated with the more adverse, paralic zone to the undisturbed shelf/slope boundary. On the basis of these relationships, three classes of normal marine environments based upon bathymetry can be distinguished. Using this method, information from hundreds of species of foraminifera are reduced to a workable number of meaningful groups for the purpose of paleoenvironmental interpretation. In areas characterized by the predominance of arenaceous forms (such as the Late Cretaceous and Early Tertiary of the Labrador Shelf) the method will probably be useful for interpreting paleoenvironments. The fact that this area is considered 'hot' for oil and gas exploration emphasizes the immediate applicability of this method.

The value of benthonic foraminifera as reliable biostratigraphic and paleoecologic indicators, as well as tools for short range and long range correlations, has been confirmed in many instances. One of the speakers pointed out that limits of refinement in biostratigraphic correlations should be realized and wide inaccuracy intervals must be allowed. Monographic studies on small taxonomic groups should be encouraged, particularly if significant changes in their evolution seem to play a role. Numerical expression to the observations should be attempted and guidelines must be established for species concepts per taxonomic group, and nonemclature homogenized per region or period. In other words, every effort should be made to overcome as much as possible everybody's subjectivity in species identification. This is the main drawback of the Linnean nomenclatural method, which is still the foundation of modern foraminiferal research after more than 200 years. It was pointed out several times that benthonic foraminifera are often highly environmentally controlled and consequently both calcareous benthonics and arenaceous benthonics (which are affected in different ways by environmental factors) should - as far as possible - be studied together. Microfossil evidence other than benthonic foraminifera should always be kept in mind for implementing as much as possible the value of benthonic foraminifera as biostratigraphic-paleoecologic indicators. In other words, the higher the number of other fossils considered in addition to the benthonic foraminifera, the higher is the degree of chronostratigraphic and paleoecologic resolution. Micropaleontological team work, i.e., combined studies involving benthonic foraminifera and other categories of associated microscopic fossils is suggested as the aim towards which future studies of benthonic organisms should be directed.

MS received February 23, 1976.

Stratigraphie et Géologie du Carbonifère

B. Mamet
Département de Géologie
Université de Montréal
Montréal, Québec

Le «Congrès du Carbonifère» fut longtemps confiné à Heerlen, aux Pays-Bas, où se réunissaient régulièrement les géologues du Paléozoïque Supérieur d'Europe Occidentale. Peu à peu, ce Congrès s'élargit pour devenir représentatif du Carbonifère mondial et depuis peu il inclut des représentants de tous les continents. C'est à l'URSS, après l'Allemagne et précédant les Etats-Unis, qu'a échu cette année la tâche ardue d'organiser cette rencontre.

Il est intéressant de souligner que, pour la première fois depuis la Deuxième Guerre mondiale, un grand nombre de régions normalement interdites aux étrangers, furent accessibles et qu'il fut possible, sous l'égide de l'Académie des Sciences et des services géologiques locaux, de récolter librement des échantillons sur le terrain. Une des raisons principales de cette liberté d'action, fut le fait que l'URSS présentait officiellement la succession stratigraphique du Bassin du Donetz, comme série standard de référence pour les corrélations mondiales. De plus, elle proposait plusieurs étages «russes» en substitution aux étages communément employés en Europe Occidentale. Bien que l'on puisse discuter sur l'utilité de proposer, cent ans après la définition d'un système, une région qui soit sensée le représenter intégralement, et bien que la tendance actuelle soit bien plus de désigner des stratotypes de limites, plutôt que des successions «complètes», il n'en était pas moins