

# PALAEOECOLOGICAL OBSERVATIONS ON MIOCENE COMMUNITIES OF POLAND

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RADWANSKI, A.: Palaeoecological observations on Miocene communities of Poland. *Bull. geol. Soc. Denmark*, vol. 23, pp. 336-340. Copenhagen, December 9th 1974.

This lecture and demonstration, given to the Palaeontological Club on March 4th, 1974, concerns the palaeoecology of the marine organic communities of the Miocene (Tortonian) deposits of the Fore-Carpathian area in southern Poland.

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The extremely rich floral and faunal communities of the Miocene (Tortonian) deposits of the Fore-Carpathian area of southern Poland belong to a set of diversified facies, the development of which was controlled both by the shoreline extent and by bottom conditions. All the Tortonian deposits are lying flat here, and they offer good, widespread exposures both along the erosional incisions of valleys and over the cropland. A great abundance of various readily collectable fossils allows the recognition not only of the intraspecific variability and environmental adaptations of the species, but also of the relationships between species of some distant taxa. This leads to the recognition of the structure of particular communities and their biological requirements.

The littoral communities that settled along the rocky shores composed of Devonian and Mesozoic limestones, and in many places well exposed today with their original morphology, are represented by various rock-borers (sponges, polychaetes, pelecypods, cirripedes, echinoids), the kind and frequency of which depended on hydrodynamic conditions and their duration (Radwanski, 1964-1973). These conditions resulted from the palaeogeographic situation related to the littoral zone and its position in regard to the open sea areas. The rock-borer communities were associated with various epibionts (red algae, corals, serpulids, bryozoans, acorn barnacles, oysters), some of which were etching the substrate to firmly attach their tests or shells (some serpulids, gastropods *Vermetus intortus*, cirripedes *Verruca*). In the places where the latter epizoans were destroyed by subsequent abrasion, the etchings are the only remaining traces of their occurrence. After removal of the shell ma-

terial from the pelecypod borings, these were inhabited by other mollusks (gastropods *Crepidula crepidula*, pelecypods *Sphenia anatina*) which adapted their shape to that of the empty borings. As a result, the shell morphology of these secondary dwellers is variable, and corresponds to a few intraspecific taxa that have been hitherto distinguished in these species.

In many areas of littoral and shallow sublittoral zones, the rocky substrate was inhabited by red algae *Lithothamnium*, the structure of whose colonies and mode of their accumulation reflected hydrodynamic conditions and distance from the shoreline. Although the biology and autecology of these coralline algae are not fully understood yet, it may be stated that in some shallow water areas with clean water (mostly in rocky bays) they formed restricted communities from which most of the benthic animals were eliminated. The latter appear in greater abundance in zones of accumulation of detrital lithothamnian material which was swept along the bottom by waves and currents (Leitha type of facies). In these zones (cf. Radwanski, 1965b) vagile vertebrates become important components of the communities (elasmobranch and bony fish, crocodiles, dolphins).

In the areas where a greater supply of terrestrial material was delivered, the clay or sandy facies developed and other communities settled in.

The clay facies was mainly confined to a relatively small area of the bay protected against strong waves by a chain of islands or submerged ridges. Here, in the world-famous Korytnica basin, a complete pattern of communities is recognized, in both lateral and vertical succession. The synecological analysis of the communities shows that this vertical sequence reflected a progressive decrease of water depth as the basin was gradually filled with clay sediments; the final stages of sedimentation were realized here in lithothamnian meadows that were supposedly rising up to the water table. The lateral succession of facies in the basin resulted from a change of the environmental conditions from full marine to very restricted, lagoon-influenced conditions at the digitate shore where the freshwater inflow from the adjacent land was considerable. All the communities of the Korytnica basin are characterized by an abundance of various mollusks (mostly gastropods – over 600 species, pelecypods, chitons, scaphopods and cuttlefish) accompanied by a nearly complete set of other invertebrates and by some fish (cf. Friedberg, 1911–1938; Radwanski, 1969, 1974b; Baluk, 1971–1974).

The present study of the Korytnica fossils apparently shows that these communities are the richest in the Miocene of Europe. A great number of specimens and the variability of local populations became also a basis for the recognition of some biological rules and species relationships based on statistical grounds. This is shown e.g. by analysis of the proneness of particular mollusks (over 20,000 specimens examined) to the predatory activity of carnivorous gastropods, *Natica* s. l. and *Murex* s. l. and their mutual

competition in the finding and selecting of prey (Hoffman & al., 1974). A similar method is used for investigation of the mortality of particular species, and its biological interpretation (Hoffman, *in prep.*).

The biological requirements of the species are demonstrated in the gastropods by the slipper-limpets, *Crepidula crepidula* (L.), which domiciled not only the borings in the littoral zone, but also all the available empty shells of gastropods occurring offshore. These slipper-limpets adapted their shells to the available space (and therefore various intraspecific taxa distinguished in this species appear to be invalid), and they usually lived in groups that correspond to the sexual dimorphism and change of sex during ontogeny, as shown by a common occurrence of a large female with one or a few associated smaller, "dwarfish" males (Baluk & Radwanski, *in prep.*).

The biological relationship between species is apparent e. g. for creusoid barnacles (*Creusia* = *Ceratoconcha* auct.) and colonial corals (*Tarbelastraea*, *Porites*) in which they lived. Their mode of growth, shell adaptation and occurrence in the coral colonies reveal this relationship as commensal, and not parasitic as previously suggested; the analysed material also allowed the recognition of general life conditions, biology and phylogeny of these rare aberrant cirripedes (Baluk & Radwanski, 1967).

The composition of some communities may be ascertained if the species restricted to special life conditions are recognized. This is exemplified by bivalved gastropods *Berthelina* (the first record in the Miocene – Baluk & Jakubowski, 1968) which at present browse on a seaweed, *Caulerpa*, on rocky, rubble bottom just below low water level. Such bottom conditions occurred as their habitat in the Korytnica basin, and consequently the presence of the *Caulerpa*-type seaweeds may be inferred there. A similar situation is found with the gastropods *Tenagodus* which at present live in the soft tissue of some sponges, the occurrence of which should therefore also be assumed in the basin.

In the sandy facies of other regions, various communities composed of abundant mollusks, cirripedes and echinoderms (starfish and echinoids) characterize a bathymetric range from the intertidal to moderate sublittoral zone. Besides body fossils, common trace fossils, e.g. callianassid-decapod burrows, *Ophiomorpha nodosa* Lundgren, are here the key for facies recognition.

As a general conclusion, it is apparent that many species or genera are strictly comparable to those of present-day tropical or subtropical zones of the southern Red Sea and Indo-Pacific province. This is documented by some gastropods (*Architectonica*, *Parastrophia*, *Terebra*, *Rostellaria*, large-dimensioned species of *Cypraea*, *Conus*, *Strombus*, *Galeodes*, and especially by bivalved *Berthelina*), chitons (*Craspedochiton*, *Cryptoplax*), barnacles (*Creusia*) and elasmobranch fish (shark *Hemipristis* and ray *Aëtobatis*). Similar climatic requirements should be ascertained for these animals in the

Miocene; if so, for the Miocene of Europe the climate must have been much warmer than previously considered (cf. also Gripp, 1961).

All the discussed organic communities in the Fore-Carpathian area are limited within the Tortonian stage to its lower part which followed the transgression from the Vienna Basin. The subsequent history of the basin that underwent a partial evaporation and establishment of lagoonal conditions, as well as the geotectonic setting of the basin are presented separately (Radwanski, 1974a, b, and in press).

## Dansk sammendrag

Foredraget og demonstrationen af materiale i Palæontologisk Klub d. 4. marts, 1974, beskæftigede sig med de meget artsrige samfund i syd-Polens marine miocæne (Tortonien) aflejringer. Palæoøkologiske undersøgelser af disse samfund giver detaljerede oplysninger om deres livsvilkår afhængige af forskellige vanddybder, hydrodynamiske energiforhold og bundtyper.

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