Paleoeocological significance of Anisian (Middle Triassic) brachiopod assemblages from the Balaton Highland, Hungary

J. Pálfy
Hungarian Natural History Museum, Hungary & University of British Columbia, Vancouver, Canada

ABSTRACT: Paleoenvironmental analysis of coeval brachiopod faunas from four localities enables a paleoenvironmental reconstruction for the Anisian of the Balaton Highland. Different energy level and substrate conditions within a shallow water basin developed upon a dissected carbonate platform produced distinct assemblages shaped by adaptive strategies and taphonomic factors. A Mentzelia mentzeli – Tectactinella trigonella association was preserved on a patch-reef foreslope (Kőveskál). The most diverse assemblage records intense reworking by sediment transport on a slope (Aszófő). A Caucasorhynchia altaplecta – Trigonirhynchella attilina association characterizes a small basin (Felsőörs). A Coenothyris vulgaris – Lingula tenuissima association was recognized from marginal shallow water, soft substrate environment (Iszakaszentgyörgy). This assemblage resembles Germanic-type faunas, while the remaining three have clear Alpine affinity. The contrast of the Alpine and Germanic-type brachiopod faunas might have largely been controlled by paleoeocological differences between these paleobiogeographic domains.

1 INTRODUCTION

Important progress has been made in the paleobiology of Mesozoic brachiopoda since the pioneering works of Ager (1965, 1967) but relatively little attention has been paid to the Middle Triassic. Classical faunas of Anisian age from the Balaton Highland have recently been the subject of revision by the author (Pálfy 1986, 1988). In the following contribution a paleoenvironmental reconstruction is attempted using brachiopod paleoecology.

The four localities dealt with in this study are shown in Figure 1. The geology of the Transdanubian Central Range (also referred to as Bakony tectonostratigraphic unit to which the Balaton Highland belongs) has long recognized Alpine affinity but the sequence is relatively undistorted. The Middle Triassic stratigraphy of the area (Figure 2) records the disintegration of the uniform carbonate platform (Meyhegy Dolomite) of Early Anisian age. By Late Anisian time laterally interfering facies of patch-reefs (Tagyon Limestone), persisting fragments of the old platform (Meyhegy Dolomite) and shallow basins with slopes (Felsőörs Limestone) reflect tectonic activity (Galácz et al. 1985) probably related to an aborted rifting phase in western Tethys. The crinoidal-brachiopodal limestone of the lower part of the Felsőörs Limestone grades upward into ammonite-bearing more pelagic facies. Further subsidence is evident by the regional onset of basinal sedimentation of red nodular Nemésvámos Limestone overlain by the Veszprém Marl. The Pelsonian (Late Anisian) age of the
rich brachiopod fauna yielded by the lower member of the Felsőörs Formation thus corresponds to the greatest diversification of the basin topography.

The studied fauna consists of 35 species. Ammonite biostratigraphic data prove Pelsonian, i.e. Balatonicus Zone age (Vörös 1987) of the fauna. Considering the average longevity of a brachiopod species this time frame would not allow major differences between the localities other than those that are ecologically controlled.

2.2 Disarticulation

Since the valves of a brachiopod shell tend to remain together after death due to the articulation mechanism, the increase in the percentage of disarticulated valves reflects post-mortem processes such as reworking by currents, transport or bioturbation (e.g. Vörös 1986). Figure 3 summarizes the observed percentages of disarticulation.

Köveskál exhibits the highest value interpreted as current reworking in a high-energy environment and possible short distance downslope transport.

The relatively high proportion of disarticulated valves at Aszófő can be accounted for by longer post-mortem transport by sediment slumps.

The very low percentage at Felsőörs suggests extremely quiet water bottom conditions, while the nearly 25% in Iszkaszentgyörgy may correspond to a reasonable "background" disarticulation under average circumstances.

2.1 Host-rock lithology

At Köveskál the coarse-grained bioclastic limestone is densely packed with brachiopods and crinoid ossicles forming a coquina. The grainstone texture is indicative of a high-energy environment.

At Aszófő the bioclastic limestone contains intraclasts of various sizes up to 5 cm in diameter. Brachiopods were recovered from both the intraclasts and the matrix but the composition of the assemblages seems to be different. These characteristics suggest reworking of the unconsolidated-semiconsolidated sediment by slumping on a slope.

At Felsőörs the finer grained limestone grades into marlstone in places indicating lower energy regime.

At Iszkaszentgyörgy the host rock is marly limestone closely associated with dolomitic limestone and dolostone.

2.3 Shell size

The size measurements of selected common species may reflect the environmental conditions as well as taphonomy. Both the mean size and the spread have bearing on the paleoecology. Mentzelia mentzeli was the most suitable species to study, since it is common to all localities, although rare at Iszkaszentgyörgy (Figure 4).
Accepting that the size is correlated with the quality of the habitat (Ager 1965) the highest mean size at Köveskál suggests the presence of the most favourable conditions, i.e. well-agitated water, ample nutrient supply and widely available hard substrate for attachment. The large size together with the thick shell has a definite advantage in a high-energy environment to cope with strong currents. The rough, unevenly developed growth lines also might indicate an unstable environment. The high spread reflects poor sorting, both juvenile and adult specimens are equally abundant. This precludes the possibility of long-range current transport which would have resulted in a better sorting.

Aszótfő displays slightly smaller mean size and similarly high spread. In this case the poor sorting is likely to be caused by gravitational reworking together with the sediment. The high mean size indicates advantageous though not optimal life conditions.

The tight cluster of specimens from Felsőörs probably corresponds to a group of smaller sized adults. In the light of other observations it may be interpreted as a quiet, stable environment with low juvenile mortality, but not meeting the ideal ecological requirements of Mentzella mentzeli. The delicate and even growth lines provide further supportive evidence.

2.4 Distribution of higher rank taxa

The method of studying the relative abundance of higher rank taxa was introduced by Fürsich and Hurst (1974) for examining Paleozoic brachiopod faunas. Although their conclusions cannot be directly applied, the method itself can be adapted to Mesozoic assemblages as shown in Figure 5. The main features of the distribution pattern are the following:

If Köveskál is interpreted as the highest and Felsőörs as the lowest energy environment, the spiriferids seem to be positively whereas the rhynchonellids negatively correlated with the increase in energy level.

Aszótfő displays by far the most even distribution which is attributed to the effective mixing of faunas derived from different habitats.

This model cannot accommodate the faunal composition at Iszkaszentgyörgy where other limiting ecological factors such as soft bottom and fluctuating conditions played a more important role.

It should be mentioned, however, that the dominant species of the assemblages has such an overwhelming majority at all localities except Aszótfő that to some extent overprint the picture of distribution of higher rank taxa.

Fig. 5 Relative abundance of higher taxonomic groups at each locality

2.5. Diversity

In evaluating the diversity of different localities one has to cope with the difficulty of distinguishing between life and death assemblages. High species number can be the result of either the availability of different favourable niches or the mixing of faunas derived from various habitats prior to burial.

Köveskál (Figure 6) serves as an example for the first case. Although the diverse death assemblage was produced by current reworking and short-range post-mortem transport, it is still closely resembles the brachiopod paleocommunity of a hard substrate, current-swept, nutrient rich environment.
On the other hand the greatest species number observed at Aszótfő is interpreted as a death assemblage enriched in diversity by the mixing of faunas from bathymetrically different parts of a slope supporting abundant brachiopod communities.

The relatively lower diversity of Felsőörs is accounted for by some limiting factors, probably the lower nutrient supply in less agitated water. The fauna found here is presumed to closely resemble the paleocommunity.

The extremely low diversity along with the great abundance of the dominant species at Iszkaszentgyörgy is a clear indication of environmental stress. The harsh conditions with only few brachiopods could cope include soft substrate, poor nutrient supply and probably slightly fluctuating salinity.

2.6 Associated megafauna

Except for Iszkaszentgyörgy where no other fossil group was found, crinoid ossicles are abundant at all localities.

From Köveskál rare cephalopods and also scarce bivalves (Mysidioptera, Plagiostoma) were recovered.

Aszótfő yielded the most diverse association of other groups: numerous epifaunal and a few infraunal bivalves along with several cephalopods.

At Felsőörs the nektonic cephalopods form the only significant group accompanying the benthic brachiopods and crinoids.

3 DISCUSSION OF ASSOCIATIONS AND THE PALEOENVIRONMENTAL MODEL

The overwhelming abundance of certain species at the different localities enables the delineation of associations characteristic of a specific environment as deduced from the above paleoecological observations. While emphasizing the dissimilarities in the environment and the faunal composition, however, the overall presence of the most common and opportunistic forms is noteworthy. In the study area the most widely distributed species having the greatest ability to tolerate different conditions are Mentzelia mentzelli, Tetractinella trigonella and Coenothea vulgaris.

The brachiopod fauna of Köveskál can be characterized as a Mentzelia mentzelli – Tetractinella trigonella association. It is interesting that two of the most opportunistic forms were most successful in colonization instead of more specialized species. Geological field evidence suggests the proximity of algal-foraminiferal patch-reef bodies of which Köveskál may represent a foreslope environment (Figure 7). Brachiopod paleoecology provides evidence for high energy, hard substrate, nutrient rich environment with short distance transport and current reworking.

Aszótfő occupies a position further away from the reefs. The brachiopods were carried downslope by sediment movements intensely mixing various associations.

Felsőörs is characterized by a distinctive Caucasorhynchia altapecta – Trigonirhynchella attilina association. The postulated environment is a local topographic depression with quiet bottom water and therefore somewhat limited nutrient supply, scarcity of hard substrate, but otherwise stable conditions. The association is thought to represent a paleocommunity adapted to an unusual setting, since these species are known from only a few other localities worldwide. The clarification of the controlling ecological parameters as well
as the interpretation of the adaptive advantages of the functional morphology of these small rhynchonellids needs further study.

A Coenothyris vulgaris - Lingula tenuissima association was recognized from Iszkaszentgyörgy. This represents a marginal shallow water, soft substrate brachiopod paleocommunity. The most successful adaptive strategies are the infaunal mode of life of Lingula tenuissima (e.g. Emig 1986) and the gregarious nature of Coenothyris vulgaris.

This paleoenvironmental reconstruction is compatible with the stratigraphic evidence which indicates a tectonically disrupted, shallow carbonate platform with varied substrate morphology, patch-reefs and small local basins flanking the persisting fragments of the platform.

4 PALEOBIOGEOGRAPHICAL IMPLICATIONS

The Triassic brachiopod faunas of Europe fall into two distinct categories: the highly diverse Alpine assemblages contrast with the low diversity Germanic-type. Dagis (1974) pointed out that the areas of Germanic-type faunas do not constitute a separate faunal province since they lack endemic forms; they should be regarded as impoverished, low diversity/high density assemblages derived from an Alpine source area.

The study area clearly belongs to the Alpine domain based on the rich brachiopod fauna as well as the firm stratigraphic evidence. Iszkaszentgyörgy, however, convincingly shows all the typical features of a Germanic-type assemblage having the same species content as found in classical Germanic-type localities and the conspicuous low diversity/high density pattern. This is an indication that the separation of the Alpine and Germanic paleobiogeographic domains is largely paleoecologically controlled. In the Balaton Highland over a distance of a few tens of kilometers, similar environmental differences existed which effectively precluded the colonization of all but the most opportunistic species in a less hospitable marginal shallow water setting with lime-mud substrate. The impoverished Germanic-type faunas are therefore regarded as the result of selective ecological filtering from the Tethyan shelf to the German epigean sea rather than a true biogeographical barrier.

Coeval brachiopod faunas reported from the Meck Mountains of southern Hungary (e.g. Detre 1970) also has remarkable Germanic affinity. Its present-day inverted geographic position with respect to the Balaton Highland (i.e. Germanic faunas with more northerly epicontinental origin now south of the Alpine faunas with more southerly Tethyan origin) (Pálfy and Török in press) support recent tectonic models of Hungary suggesting the juxtaposition of different tectonostratigraphic units by large-scale strike-slip movement as a result of the continental escape of the Bakony Unit during the Alpine orogeny (Kázmér and Kovács 1985)

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245


