

Trace fossils on molluscs from the Molluscan Clay (Late Oligocene, Egerian) — a comparison between two localities (Wind Brickyard, Eger, and Nyárjas Hill, Novaj, NE Hungary)

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Trace fossils, found on shells of gastropods, bivalves and scaphopods from Molluscan Clay exposures (Oligocene, Egerian) at Eger (Wind brickyard) and Novaj (Nyárjas Hill) (NE Hungary), were studied. The relative abundance of different types of borings, traces of bioerosion and palaeopathological phenomena indicate micro-environmental differences between the two localities.

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Introduction

At various outcrops in NE Hungary Late Oligocene (Egerian) deposits are visible. The clay-pit of Wind Brickyard at Eger (Fig. 1) is the type locality of the Egerian Stage. The lithological sequence in the Eger area was described by Báldi (1986, p. 49):

- lower Rhyolite Tuff (dated 19-21 Ma BP);
- alternation of coarse sand, lagoonal, variegated, carbonaceous clay and a thin gravelly intercalation (40-50 m);
- alternation of shallow marine clayey silt and sandstone layers (30 m);
- molluscan clay (40-60 m);
- glauconitic, tuffaceous sandstone and sandy marl with a one metre thick intercalation of lithothamnian limestone and *Lepidocyclina* Marl.

At Nyárjas Hill, Novaj (Fig. 1), the first Egerian deposit overlies a Late Kiscellian deposit. It is the same glauconitic, tuffaceous sandstone as at Eger, inclusive of the lithothamnian limestone and *Lepidocyclina* Marl intercalations. These sediments are overlain by the Molluscan Clay, and the succession ends with the Rhyolite Tuff.

Samples from the Molluscan Clay exposed at these two localities were studied for

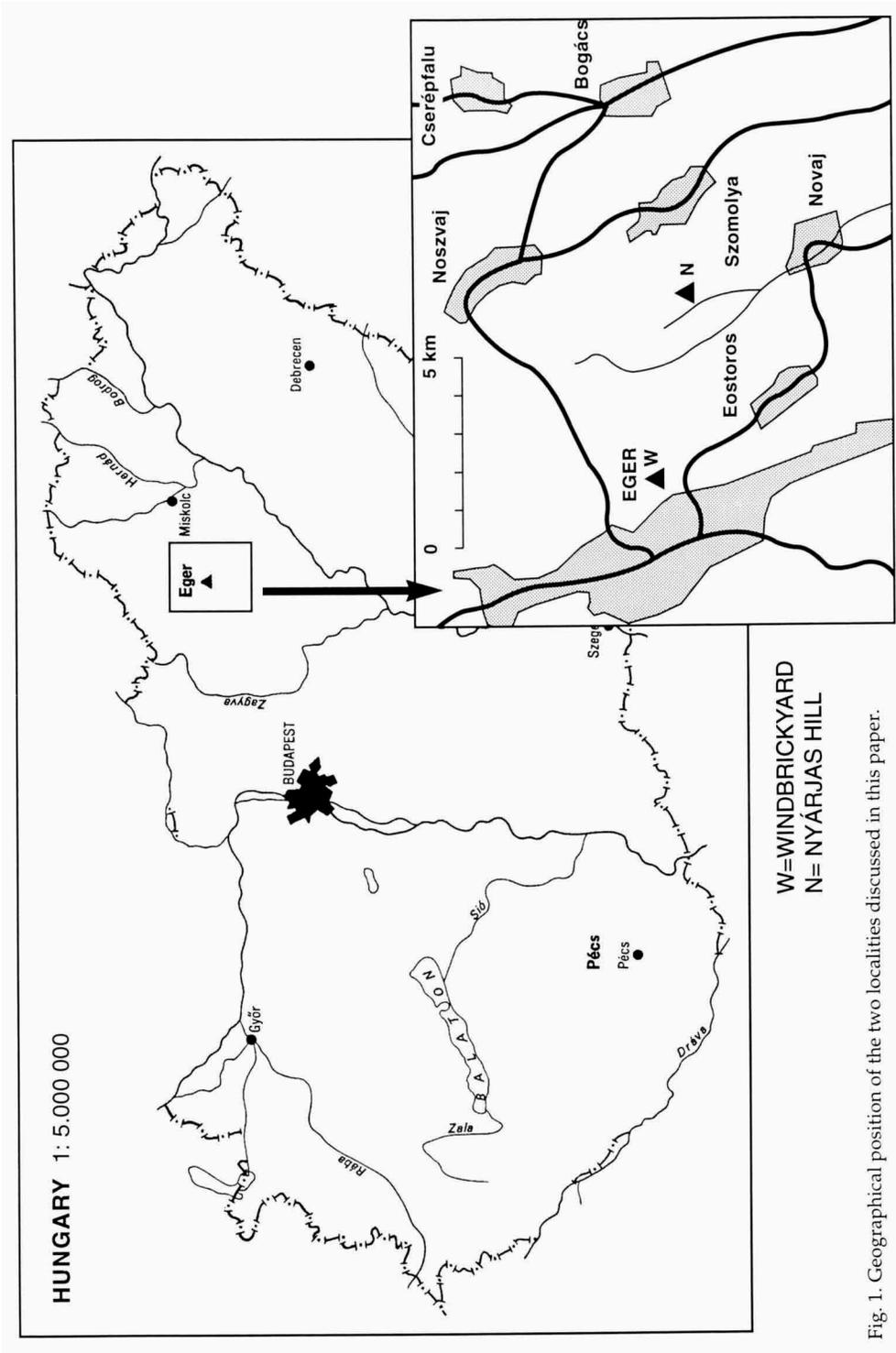


Fig. 1. Geographical position of the two localities discussed in this paper.

their contents of trace fossils on mollusc shells. The residues contain well preserved specimens of gastropods, bivalves and scaphopods. The associations belong to the *Hinia-Cadulus* fossil community (Báldi, 1973, p. 124), indicating similar palaeoenvironments for the two samples. Sea depth must have been more than 120 m and the bottom existed of clayey sediments (Báldi, op. cit., p. 125).

This study aims at giving an inventory of types, numbers and distribution of trace fossils on mollusc shells present in the two samples and an evaluation of possible differences in micro-environment. Trace fossils found on molluscan shells have palaeoecological importance. Their presence or absence may be indicative for different environmental conditions.

Methods

At both localities a sample of 15 kg of sediment was collected from the Molluscan Clay. After drying, the sediment was disintegrated with hot water and hydrogen peroxide, and subsequently washed on a 0.5 mm mesh. The molluscan shells were sorted from the non-Mollusca (e.g. Foraminifera, Decapoda, Echinoidea, bony fish remains).

Most of the molluscs are fragmentary, but also many complete specimens and specimens in cast preservation were found. The differences in the preservation of the material from both samples is as follows.

	Eger	Novaj
complete specimens	18%	22%
fragmentary specimens	62%	41%
cast preservation	20 %	37%

The complete shells and identifiable fragments were inspected for the presence of trace fossils. Each single valve of the Bivalvia is counted for one specimen. In the case of scaphopods the figures represent the number of fragments found in the collected material. In the case of casts recognition of trace fossils is often uncertain and doubtful, if possible at all.

The material on which this study is based is kept in the collection of the Teachers Training College, Department of Geography, at Eger. Identification of the molluscs and trace fossils was done by the author.

Description of trace fossils

Wind Brickyard

The molluscan remains recovered from this sample comprise 486 individuals, belonging to 41 species (Table 1). In 19 species (41 specimens) trace fossils were found, belonging to eight different types (Table 4). Of the mollusc species bearing trace fossils 84.2% belong to the endobenthos. The distribution of trace fossils according to the feeding habit of the mollusc species is as follows:

deposit feeders 5.2%

suspension feeders 26.4%

Table 1. Numbers of mollusc species and their feeding habits in a sample of 15 kg clay from the Late Oligocene (Egerian) of Wind Brickyard, Eger. a: deposit feeder; b: suspension feeder; c: predator; d: scavenger; e: browser (algae eater); f: parasite.

Species	number of individuals	feeding habit					
		a	b	c	d	e	f
1. <i>Nuculana anticeplicata</i> (Telegdi-Roth, 1914)	1	x	-	-	-	-	-
2. <i>Nuculana psammobiaeformis</i> Telegdi-Roth, 1914	1	x	-	-	-	-	-
3. <i>Yoldia raulini</i> Cossmann & Peyrot, 1912	3	x	-	-	-	-	-
4. <i>Glycymeris</i> sp.	1	-	x	-	-	-	-
5. <i>Limopsis anomala</i> (von Eichwald, 1830)	2	-	x	-	-	-	-
6. <i>Flabellipecten burdigalensis</i> (de Lamarck, 1809)	4	-	x	-	-	-	-
7. <i>Chlamys csepregheznericsae</i> Baldi, 1961	2	-	x	-	-	-	-
8. <i>Astarte gracilis degrangei</i> Cossmann & Peyrot, 1912	6	x	-	-	-	-	-
9. <i>Crassatella bosqueti</i> von Koenen, 1893	42	-	x	-	-	-	-
10. <i>Lucinoma borealis</i> (Linne, 1767)	1	-	x	-	-	-	-
11. <i>Cardium</i> sp.	4	-	x	-	-	-	-
12. <i>Venus multilamella</i> (de Lamarck, 1818)	1	-	x	-	-	-	-
13. <i>Angulus posterus</i> (Beyrich, 1867)	1	x	-	-	-	-	-
14. <i>Corbula gibba</i> (Olivi, 1792)	21	-	x	-	-	-	-
15. <i>Cuspidaria neoscalarina</i> Baldi, 1966	1	-	-	x	-	-	-
16. <i>Teinostoma egerensis</i> (Baldi, 1966)	25	-	-	-	x	-	-
17. <i>Theodoxus buekkensis</i> (de Ferussac, 1825)	1	-	-	-	-	x	-
18. <i>Alvania</i> sp.	36	-	-	-	x	-	-
19. <i>Turritella</i> sp.	2	-	x	-	-	-	-
20. <i>Mathilda schreiberi</i> von Koenen, 1894	1	-	-	-	x	-	-
21. <i>Bittium spina agriense</i> Baldi, 1966	14	-	x	-	-	-	-
22. <i>Cerithiella</i> sp.	5	-	-	-	x	-	-
23. <i>Natica millepunctata tigrina</i> (Defrance, 1825)	10	-	-	x	-	-	-
24. <i>Hinia schlotheimi</i> (Beyrich, 1854)	76	-	-	-	x	-	-
25. <i>Volutilithes permulticostata</i> Telegdi-Roth, 1914	2	-	-	-	x	-	-
26. <i>Odostomia</i> sp.	2	-	-	-	x	-	-
27. <i>Niso minor</i> (Philippi, 1843)	1	-	-	-	x	-	-
28. <i>Turbonilla</i> sp.	1	-	-	-	x	-	-
29. <i>Melanella spina</i> (de Grateloup, 1838)	3	-	-	-	-	-	x
30. <i>Melanella naumanni</i> (von Koenen, 1867)	9	-	-	-	-	-	x
31. <i>Syrnola laterariae</i> Baldi, 1867	4	-	-	-	-	-	x
32. <i>Ringicula auriculata paulucciae</i> Morlet, 1878	46	-	-	-	x	-	-
33. <i>Cylichna cylindracea raulini</i> (Cossmann & Peyrot, 1932)	7	-	-	x	-	-	-
34. <i>Rhizorus acuminatus</i> Bruguiere, 1792	3	-	-	x	-	-	-
35. <i>Retusa canaliculata</i> (Say, 1826)	2	-	-	x	-	-	-
36. <i>Dentalium fissura</i> de Lamarck, 1818	53	-	-	x	-	-	-
37. <i>Dentalium simplex</i> Michelotti, 1861	33	-	-	x	-	-	-
38. <i>Fustiaria taurogracilis</i> (Sacco, 1897)	24	-	-	x	-	-	-
39. <i>Cadulus gracilina</i> (Sacco, 1897)	30	-	-	x	-	-	-
40. <i>Entalina tetragona</i> Brocchi, 1814	5	-	-	x	-	-	-
Total	486						

browsers 5.2%

scavengers and predators 52.6%

parasites 10.6%

Naticid borings are observed in 25 individuals of 12 species (bivalves 3, gastropods 8, scaphopods 1). Of these borings 18 are complete, 1 is nonfunctional and 6 are unfinished. With 'nonfunctional' a situation is meant in which the shell is completely perforated, but in which the opening in the inner shell wall is still not sufficiently large to insert the proboscis (Kitchell et al., 1986).

A specimen of *Theodoxus buekkensis* demonstrates a muricid borehole, located close to the umbilicus. This gastropod species is indicative of shallow marine environments, so presumably it was transported.

Possible biting traces of an unknown organism are present in two bivalve species, viz. five specimens of *Crassatella bosqueti* and one valve of *Astarte gracilis degrangei*.

Bryozoan borings were found on a specimen of *Natica millepunctata tigrina* (Dávid, 1991, p. 13).

Traces of bioerosional activity of boring sponges (Clionidae) are present on the inner side of a *Corbula gibba* right valve.

Echinoid bioerosion is found on a fragment of *Flabellipecten burdigalensis* (compare Warne, 1975).

Repairs of damage presumably caused by crab predation (Martinell et al., 1982, p. 11) were found in four gastropod species. Decapod remains were indeed present in the sample.

Specimens of the scaphopods *Fustiaria taurogracilis* and *Cadulus gracilina* show signs of fractures and subsequent repair. In the case of *F. taurogracilis* the fractures can be distinctly observed at both ends of a 15 mm long fragment. The damage was caused by an unknown external impact.

Nyárjas Hill

The residue of this sample contained 275 molluscan individuals, belonging to 32 species (Table 2). A total of 15 trace fossils of four different types (Table 3) was counted in 13 specimens of 8 species. The trace fossils can be arranged in four groups (Table 3), 87.5% of them are infaunal. The distribution of the trace fossils according to the feeding habit of the molluscs is:

deposit feeders	—
suspension feeders	62.5%
browsers	—
scavengers and predators	12.5%
parasites	25.0%

Twelve naticid borings were found in shells of ten specimens belonging to six species. Among them are eight completed borings, three are incomplete and one is nonfunctional. A right valve of *Corbula gibba* shows two incomplete borings. A specimen of *Niso minor* also demonstrates traces of multiple predation in the form of a completed and an incomplete naticid boring.

Muricid borings were observed in a fragment of *Flabellipecten burdigalensis*.

The crescent shape of what is supposed to be a biting trace was found on the margin

Table 2. Numbers of mollusc species and their feeding habits in a sample of 15 kg clay from the Late Oligocene (Egerian) of Nyárjas Hill, Novaj. a: deposit feeder; b: suspension feeder; c: predator; d: scavenger; e: browser (algae eater); f: parasite.

Species	number of individuals	feeding habit					
		a	b	c	d	e	f
1. <i>Yoldia raulini</i> Cossmann & Peyrot, 1912	1	x	-	-	-	-	-
2. <i>Glycymeris</i> sp.	1	-	x	-	-	-	-
3. <i>Limopsis anomala</i> (von Eichwald, 1830)	2	-	x	-	-	-	-
4. <i>Flabellipecten burdigalensis</i> (de Lamarck, 1809)	6	-	x	-	-	-	-
5. <i>Chlamys csepregyemeznericsae</i> Báldi, 1961	8	-	x	-	-	-	-
6. <i>Astarte gracilis degrangei</i> Cossmann & Peyrot, 1912	4	x	-	-	-	-	-
7. <i>Crassatella bosqueti</i> von Koenen, 1893	25	-	x	-	-	-	-
8. <i>Cardita</i> cf. <i>ruginosa</i> Cossmann & Peyrot, 1912	-	x	-	-	-	-	-
9. <i>Cavilucina droueti schloenbachi</i> (von Koenen, 1868)	-	x	-	-	-	-	-
10. <i>Cardium</i> sp.	14	-	x	-	-	-	-
11. <i>Venus multilamella</i> (de Lamarck, 1818)	3	-	x	-	-	-	-
12. <i>Angulus posterus</i> (Beyrich, 1867)	15	x	-	-	-	-	-
13. <i>Corbula gibba</i> (Olivi, 1792)	1	-	x	-	-	-	-
14. <i>Turritella</i> sp.	1	-	x	-	-	-	-
15. <i>Architectonica mariae</i> (Báldi, 1961)	-	-	x	-	-	-	-
16. <i>Bittium spina agriense</i> Báldi, 1966	112	-	x	-	-	-	-
17. <i>Cerithiella</i> sp.	3	-	-	-	x	-	-
18. <i>Natica millepunctata tigrina</i> (DeFrance, 1825)	1	-	-	x	-	-	-
19. <i>Hinia schlotheimi</i> (Beyrich, 1854)	12	-	-	-	x	-	-
20. <i>Aquilofusus loczyi</i> (Noszky, 1936)	4	-	-	x	-	-	-
21. <i>Olivella clavula vindobonensis</i> Csepregy-Meznerics, 1954	1	-	-	x	-	-	-
22. <i>Turricula leganyii</i> Báldi, 1966	2	-	-	x	-	-	-
23. <i>Niso minor</i> (Philippi, 1843)	4	-	-	-	x	-	-
24. <i>Turbonilla</i> sp.	6	-	-	-	x	-	-
25. <i>Melanella spina</i> (de Grateloup, 1838)	1	-	-	-	-	-	x
26. <i>Melanella depressosuturata</i> (Báldi, 1966)	4	-	-	-	-	-	x
27. <i>Synmola laterariae</i> Báldi, 1867	4	-	-	-	-	-	x
28. <i>Ringicula auriculata paulucciae</i> Morlet, 1878	7	-	-	-	x	-	-
29. <i>Cylichna cylindracea raulini</i> Cossmann & Peyrot, 1932)	5	-	-	x	-	-	-
30. <i>Dentalium simplex</i> Michelotti, 1861	7	-	-	x	-	-	-
31. <i>Fustiaria taurogracilis</i> (Sacco, 1897)	10	-	-	x	-	-	-
32. <i>Cadulus gracilina</i> (Sacco, 1897)	9	-	-	x	-	-	-
Total	275						

of a *Crassatella bosqueti* minor valve.

A fragmentary specimen of *Cadulus gracilina* bears characteristic traces of fungal borings.

Conclusions

On the molluscan shells collected at the Wind Brickyard exposure at Eger 50 trace fossils, belonging to eight different types, were found. They were present on 47.5% of

Table 3. Numbers of mollusc species and individuals according to feeding habit in samples from the Wind Brickyard at Eger, and from Nyarjas Hill at Novaj, Hungary (Late Oligocene, Egerian).

feeding habit	Wind Brickyard, Eger				Nyarjas Hill, Novaj			
	species number	%	individuals number	%	species number	%	individuals number	%
deposit feeders	5	12.5	12	2.5	3	9.4	20	7.3
suspension feeders	11	27.5	94	19.3	12	37.5	177	64.4
predators/scavengers	17	42.5	360	74.1	12	37.5	59	21.5
parasites	6	15.0	19	3.9	5	15.6	19	6.8
browsers (algae eaters)	1	2.5	1	0.2	-	-	-	-
Total	40	100.0	486	100.0	32	100.0	275	100.0

Table 4. Trace fossil types and distribution on molluscan species in samples from the Late Oligocene (Egerian) from the Wind Brickyard, Eger (E), and Nyárjas Hill, Novaj (N), Hungary; a: naticid borings; b: muricid borings; c: Clionidae borings; d: fungi borings; e: Bryozoa borings; f: presumed biting traces; g: grazing traces of echinoids; h: crab predation repairs; i: external impact fracture repair. E1, N3 etc.: number of cases found per locality.

Name	a	b	c	d	e	f	g	h	i
1. <i>Limopsis anomala</i>	E1	-	-	-	-	-	-	-	-
2. <i>Flabellipecten burdigalensis</i>	-	N1	-	-	-	-	E1	-	-
3. <i>Astarte gracilis degrangei</i>	-	-	E1	-	-	E1	-	-	-
4. <i>Crassatella bosqueti</i>	E10	-	-	-	-	E5	-	-	-
5. <i>Crassatella minor</i>	N5	-	-	-	-	N1	-	-	-
6. <i>Cardium</i> sp.	N1	-	-	-	-	-	-	-	-
7. <i>Corbula gibba</i>	E3N3	-	E1	-	-	-	E3	-	-
8. <i>Teinostoma egerensis</i>	E1	-	-	-	-	-	-	-	-
9. <i>Theodoxus bueckensis</i>	-	E1	-	-	-	-	-	-	-
10. <i>Bittium spina agriense</i>	E1N1	-	-	-	-	-	-	-	-
11. <i>Cerithiella</i> sp.	-	-	-	-	-	-	-	E1	-
12. <i>Natica millepunctata tigrina</i>	E1	-	-	-	E1	-	-	E3	-
13. <i>Hinia schlotheimi</i>	E3	-	-	-	-	-	-	-	-
14. <i>Odostomia</i> sp.	-	-	-	-	-	-	-	E2	-
15. <i>Niso minor</i>	N2	-	-	-	-	-	-	-	-
16. <i>Melanella naumanni</i>	E1	-	-	-	-	-	-	-	-
17. <i>Synola laterariae</i>	E2N1	-	-	-	-	-	-	-	-
18. <i>Retusa canaliculata</i>	-	-	-	-	-	-	E1	-	-
19. <i>Volutilithes permulticostata</i>	E1	-	-	-	-	-	-	-	-
20. <i>Dentalium fissura</i>	-	-	-	-	-	-	-	-	E1
21. <i>Fustiaria taurogracilis</i>	E1	-	-	-	-	-	-	-	E1
22. <i>Cadulus gracilina</i>	-	-	-	N1	-	-	-	-	E2

the number of species, and on 10.08% of the number of individuals, with a mean value of one trace fossil per 5.2 individuals.

At Nojav these numbers are considerably lower: 16 trace fossils were found, belonging to four types, on 25% of the number of species and 4.72% of the number of individuals (mean one trace fossil per 13.4 individuals)

Further differences between the two samples include the absence of fungal borings at Eger, and the absence of clionid and bryozoan borings, echinoid grazing traces, crab predation repair and external impact fracture repair at Novaj.

The bioerosional activity of clionids on two bivalve shells from Eger (Table 4) are both present on the inner shell surface, indicating clionid larval settlement after the death of the bivalves. The presence of both clionid and bryozoan borings may indicate agitated water, which might also be the case for the external impact fracture repair. Grazing traces of echinoids and the relatively large number of crab predation repairs point to relatively shallower water.

The differences in types and distribution of the trace fossils indicate small environmental differences for the two samples. At Eger the fauna from the studied sample presumably lived in the upper part of the deep sublittoral zone, where some influx of material from a shallower part of the sea could take place, as indicated by the presence of *Theodoxus*. At Novaj the reduced numbers of types, as well as individuals of trace fossils indicate that the association lived in a deeper part of the same zone, where little water movement occurred.

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