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TADEUSZ MERTA

Arthropod and mollusk traces in the varved clays of Central Poland

ABSTRACT: Nine morphotypes are recognized among biogenic traces recorded in the varved deposits at Plecewice (Mazovia Lowland, Central Poland). Their formation is attributed to life activities of mollusks (pelecypods and gastropods) and arthropods. A comparison of the trace-bearing deposits from Plecewice to those Mazovian varved deposits devoid of biogenic traces is suggestive of more favorable conditions for both organic life and trace preservation having been in distal and perhaps the external part of intermediate zone than in proximal zone of varve sedimentation.

GEOLOGICAL SETTING

Varved sedimentary sequence exposed at Plecewice, Mazovia Lowland, Central Poland (see Text-fig. 1), accumulated in one of several ice-dammed lakes having existed in the Mazovia Lowland during the Late Pleistocene. Its detailed stratigraphic position remains thus far unknown, and its formation is attributed to either the Middle Polish (= Riss) Glaciation (Różycki 1961), or the Baltic (= Würm) one (Karaszewski 1974).

With the recent idea of six glaciations having occurred in Poland (Różycki 1978) taken for granted, the Riss Glaciation is equivalent to both the Odranian and the successive in time Wartanian glaciations. Then, the varved deposits of the Mazovia Lowland assigned previously (Różycki 1961, 1972) to some younger glacistadials of the Middle Polish (= Riss) Glaciation are to be attributed to the Wartanian Glaciation.

The varved deposits attain some 17 m in total thickness in the vicinity of Plecewice (Halicki 1932, 1933) but only the topmost part of the section (some 7 m in thickness) is now accessible in the brickyard exposure. The exposed part of the section shows typical varves with silty light layers equal to or sometimes a little thicker than dark ones.

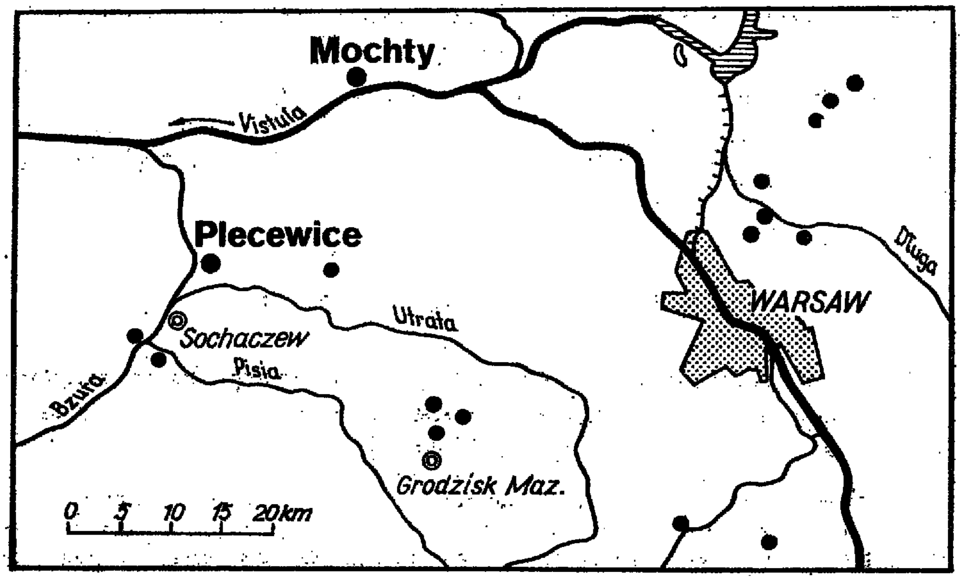


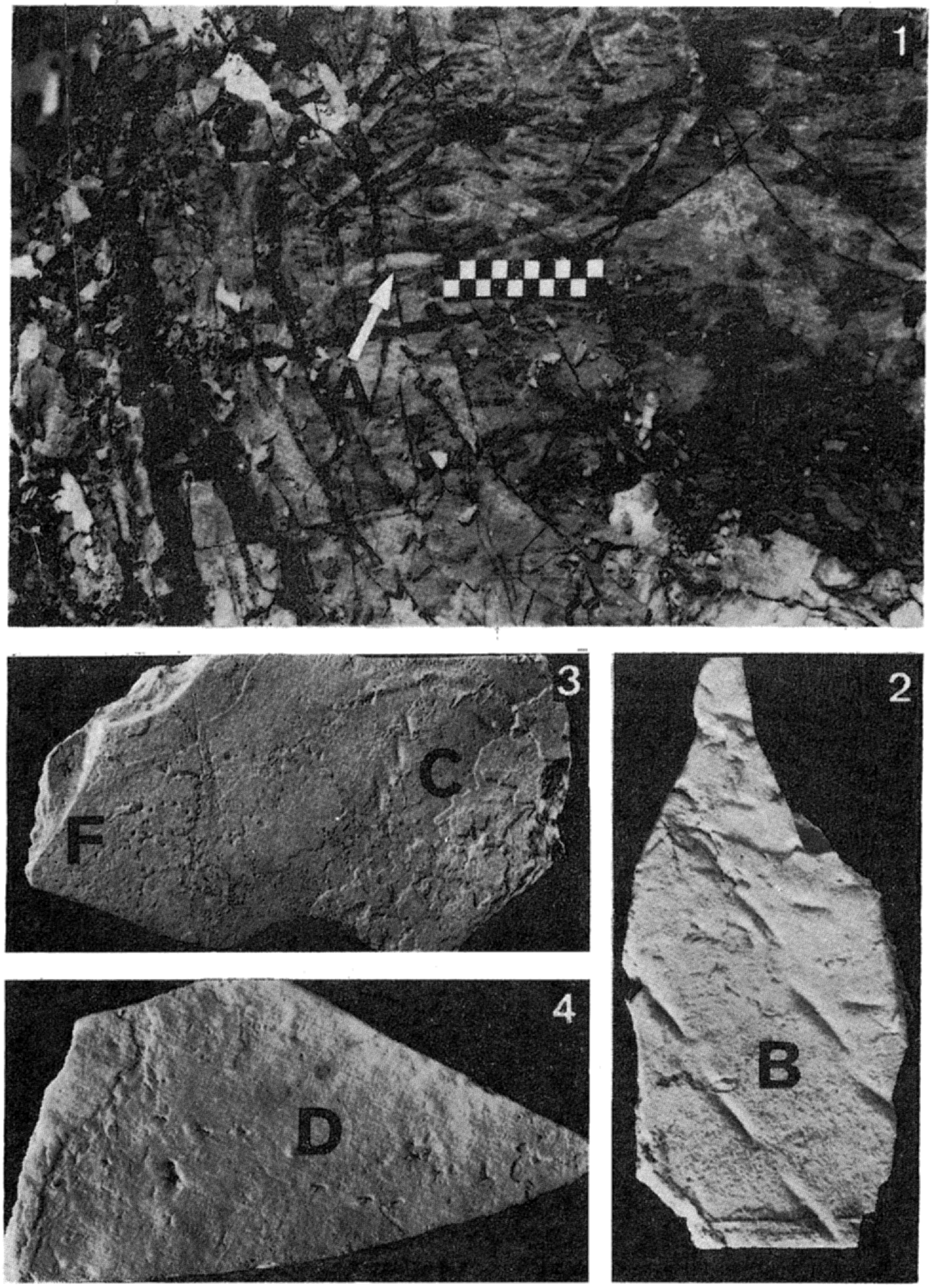
Fig. 1. Location map of the trace-bearing varved sequences at Plecewice and Mochty in the Mazovia Lowland, Central Poland; other profiles devoid of trace fossils are marked by dots (*cf.* Merta 1978, Text-fig. 1)

Total thickness of a single varve rarely exceeds 2 cm. Fine directional structures of current origin occur here and there in the light, subordinately laminated layers of varves. The pattern of these structures is indicative of an extraglacial source of the sediment (Merta 1978).

TRACE-BEARING LAMINAE

Organic traces are confined to light varve layers, namely to the top surface of darker or lighter, subordinate laminae (for the only exception see below). The best preserved traces occur in very light laminae tending naturally to split and peel off when rapidly dried up.

The light laminae referred to above differ from other subordinate, silty-clayey laminae in that they consist almost exclusively of dusty quarz along with considerable amounts of detrital calcite, which results in their loess-like nature. Any structure of current origin has never been recorded in those laminae. The trace-bearing laminae may actually have accumulated from gravitationally falling down sedimentary grains rather than from nearbottom, silty-clayey suspension "clouds" (*cf.* Kuenen 1951, Merta 1978). One may suppose that the source (or at least a source) for these laminae were eolian dusts blown into the basin. This is indeed corroborated by the occurrence of wave ripples in the

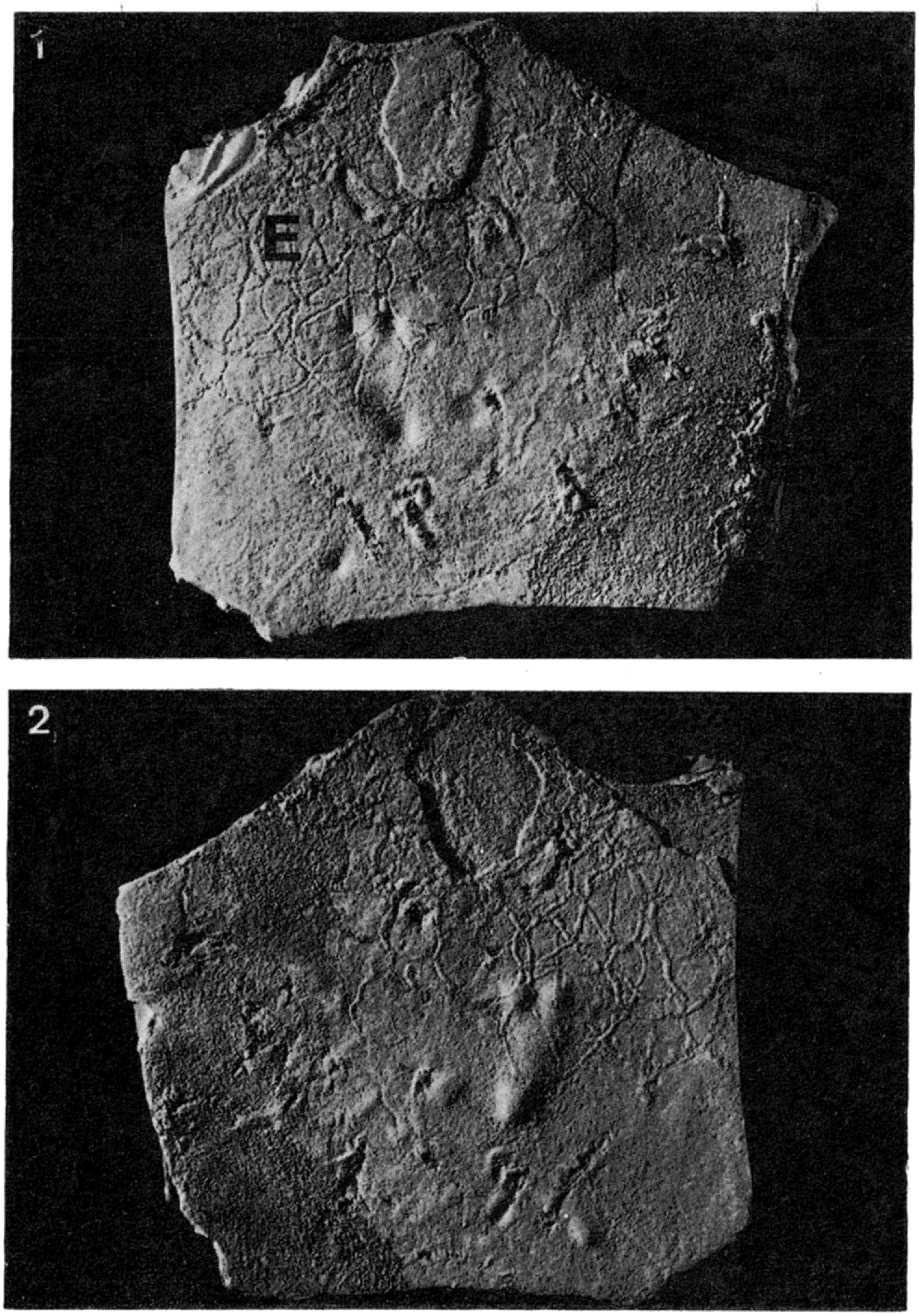


1 — Top surface of the layer displaying the trace (morphotype *A*, arrowed) produced by a pelecypod; Plecewice, scale in cm (taken *from:* Merta 1978, Pl. 10, Fig. 1)

2 — Trace produced probably by a water beetle swimming and regularly scratching the bottom (morphotype *B*); Plecewice, enlarged x 1.5

3 — Scratchmark (morphotype *C*) and tiny drop-shaped traces (morphotype *F*) on the top row of fine scratches; Mochty, x 1.5

4 — Walking trace of a pretty large-sized arthropod (morphotype *D*); visible is only one row of fine scratches; Mochty, x 1.5



1 — Trace produced by a small-sized gastropod (morphotype *E*); Plecewice, enlarged ×1.5

2 — Counterpart (hieroglyph) of the trace presented in Fig. 1, preserved at the bottom side of overlying layer varved deposits here and there in the Mazovia Lowland (Merta 1975, 1978).

Trace-bearing laminae range from 2 to 4 in number in a single light varve layer, being most commonly confined to the top part of the layer. They may be interconnected with one another through fine, vertical bioturbations.

MORPHOLOGICAL CLASSIFICATION

Some morphotypes have been distinguished among the investigated biogenic traces basing upon their dimensions and morphological characteristics (*see* Text-figs 2—3 and Pls 1—4).

MORPHOTYPE *A*. Trace approximating 1 cm in width, groove-like in cross section, somewhat meandering, observed at some tens of centimeters in distance (Pl. 1, Fig. 1). It is not confined to a single lamina but cuts across the sediment at a few millimeters in depth. This is a typical crawling trace of a moderately sized pelecypod.

MORPHOTYPE *B*. Trace consisting of some couples of parallel, relatively long lines with 9.5 mm in distance inbetween (Pl. 1, Fig. 2). A scratchmark meeting the trace axis at an angle occurs at one or the other side of each couple of lines. The trace can be attributed to a water beetle (? the diving beetle) swimming just above the bottom and regularly catching against the sediment with its limbs.

MORPHOTYPE *C*. Fragmentary traces attributable to scratching the sediment by a pretty large-sized arthropod, perhaps with a single row of limbs (Pl. 1, Fig. 3 and Pl. 3, Fig. 1). This morphotype occurs very rarely in the investigated deposits.

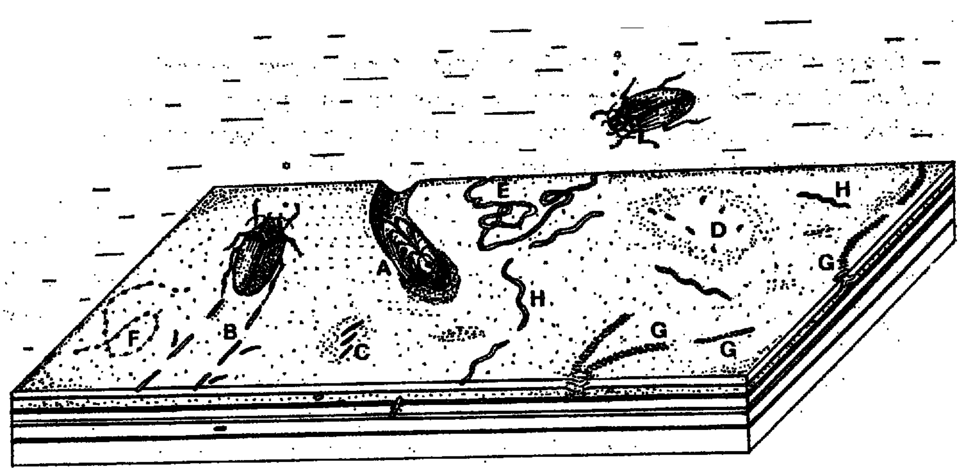


Fig. 2. Idealized bottomscape of the varve basin, to show the arthropod and mollusk traces (morphotypes *A*—*H*) and some of their markers

MORPHOTYPE *D*. Trace consisting of two parallel, continuous rows of fine lines with 8.5 to 9.5 mm in distance inbetween (Pl. 1, Fig. 4). This is doubtless a walking trace of a pretty large-sized arthropod.

MORPHOTYPE *E*. Crawling trace irregular in outline, often crossing with one another, ranging from 0.32 to 0.58 mm in width (Pl. 2, Figs 1—2). Almost indistinguishable traces were recorded in the proglacial varved deposits of Moor Mill, England, and attributed to small-sized gastropods (Gibbard & Stuart 1974). Such traces occur in masses at Plecewice.

MORPHOTYPE *F*. Bowl-shaped depressions of 0.58 mm in diameter, regularly spaced every 1.6 mm (or less commonly 2.4 mm), arranged in singular rows irregular in outline (Pl. 1, Fig. 3 and Pl. 3, Fig. 2). Sometimes, the trace becomes continuous, resembling the morphotype *E*. Traces of this type occur in masses in the investigated deposits.

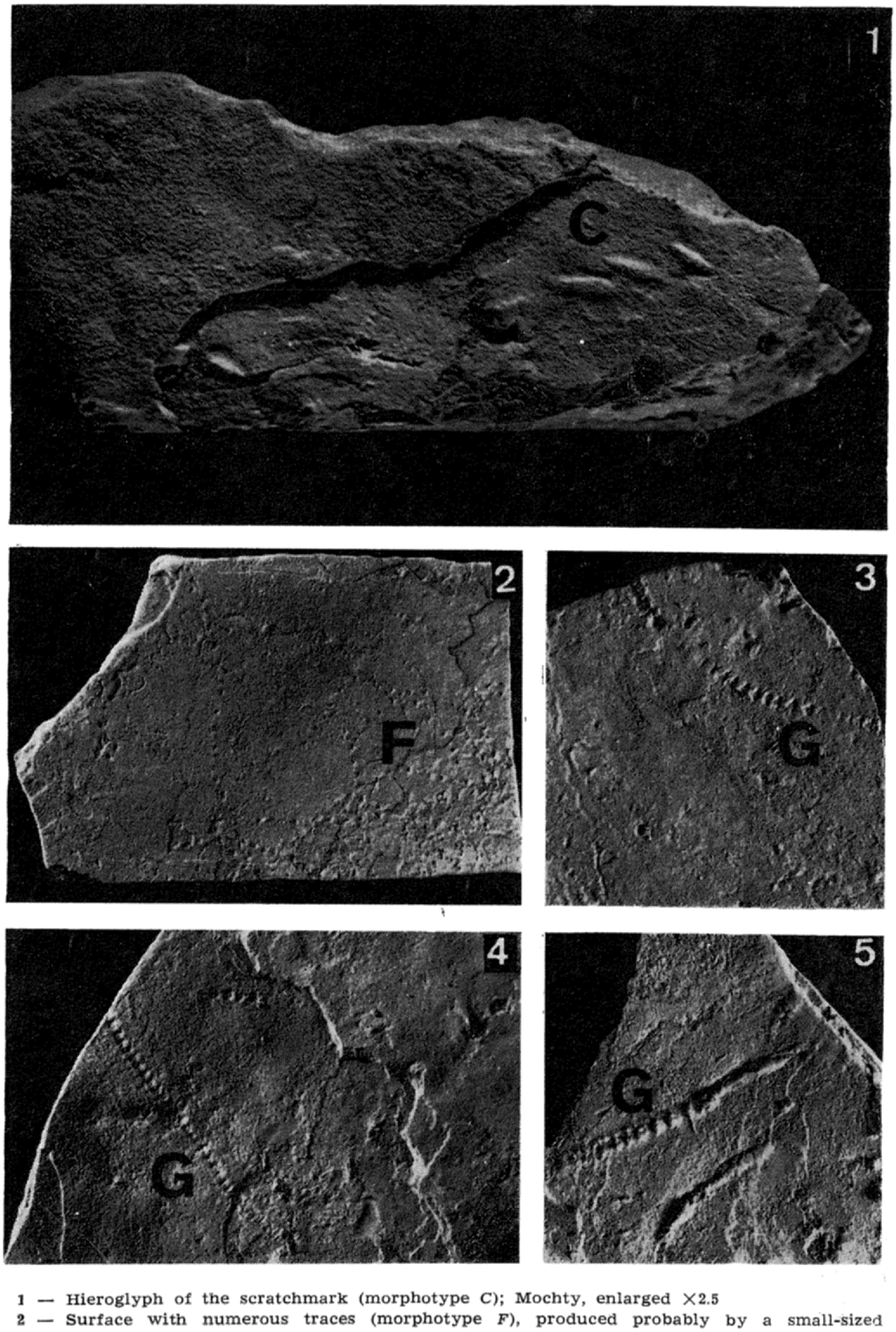
MORPHOTYPE *G*. A single row of elongate depressions, each up to 1.5 mm in length, with their long axis normal to the trace axis (Pl. 3, Figs 3—5 and Pl. 4, Figs 1—3). The trace is slightly arched to straight in outline. Two traces of this type, each up to 1.5 cm in length, may diverge radially out of a single place showing a bioturbation. One may suppose that this is a track left by a crustacean.

MORPHOTYPE *H*. Continuous trace sinusoidal in outline, with up to 0.5 mm in width and constant amplitude and wave length (Pl. 4, Figs 4—6). The amplitude and wave length range in the investigated material from 1 to 2 mm and from 2 to 4 mm, respectively. The wave length/amplitude ratio is always 2, which suggests that the traces have been produced by crawling organisms variable in size but not in form, possibly conspecific with one another. The traces may be attributed to moving insect larvae, as it is accepted for similar traces recorded in the varved deposits of Moor Mill, England (Gibbard & Stuart 1974).

MORPHOTYPE *I*. A fairly large-sized, semilunar depression associated with four lines decreasing in length outwards of the depression and parallel to each other (Text-fig. 3). The observed association of two such traces one very close to the other may be indicative of their organic origin but their marker remains unknown.

The distinguished morphotypes can be divided into two associations. One of these includes the morphotypes *E* to *H* (see *a* in Text-fig. 4) and represents traces marked by small-sized crawling organisms (gastropods, insect larvae, crustaceans) wandering at or just below the surface of silty bottom sediments. Those vagrant organisms must have been permanently associated with the sediment-water interface which is the cause for their predominance in the ichnofossil assemblage. It is noteworthy that either *EFH*, or less commonly *GH* ichnocoenoses occur usually at a single trace-bearing surface.

The other association includes traces marked by considerably larger-sized organisms (*b* in Fig. 4). All these traces are doubtless related to limbed organisms. These were probably arthropods (? water beetles; *cf.* Schwarzbach 1938) that marked the traces only sporadically, either having walked at the bottom (morphotype *D*), or having swum close to the bottom and scratched it with their appendages (morphotypes *B* and *C*).



1 — Hieroglyph of the scratchmark (morphotype *C*); Mochty, enlarged ×2.5
2 — Surface with numerous traces (morphotype *F*), produced probably by a small-sized gastropod; Plecewice, ×1.5
3 — Slightly arched trackway of a crustacean (morphotype *G*); Plecewice, ×1.5
4 — Another trackway left by a crustacean; Plecewice, ×1.5
5 — Hieroglyph of the crustacean trackway; Plecewice, ×1.5

exception because only a few trace fossils (morphotypes *D* and *E*) have been recorded at Mochty (*cf.* Text-fig. 1).

At both localities, the trace-bearing sequences show varves with rather thin silty light layers, infrequent small-scale structures of current origin, and very scarce (Mochty) or absent at all (Plecewice) wave ripple marks. These characteristics are indicative of sedimentation outside the area affected by currents and wave action, that is in the external part of the intermediate zone (Mochty) or in the distal zone (Plecewice) of varve sedimentation in an ice-dammed lake (*cf.* Merta 1978). No trace fossils have been recorded in those areas of the Mazovia Lowland where the varved deposits include more or less thick, sandy-silty light layers with frequent current and wave structures. The latter characteristics are indicative of more turbulent waters typical of the internal part of the intermediate zone and/or the proximal zone of varve sedimentation (*cf.* Merta 1978). On may conclude that the environmental conditions were less favorable in those area for benthic life; moreover, organic traces formed there during short breaks-down of the sediment influx must have undergone destruction during a successive period of current transport of the sediment or its wave reworking.

Absence of organic trace fossils from some varved sequences may thus reflect notasmuch an azoic nature of the environment, as unfavorable fossilization conditions.

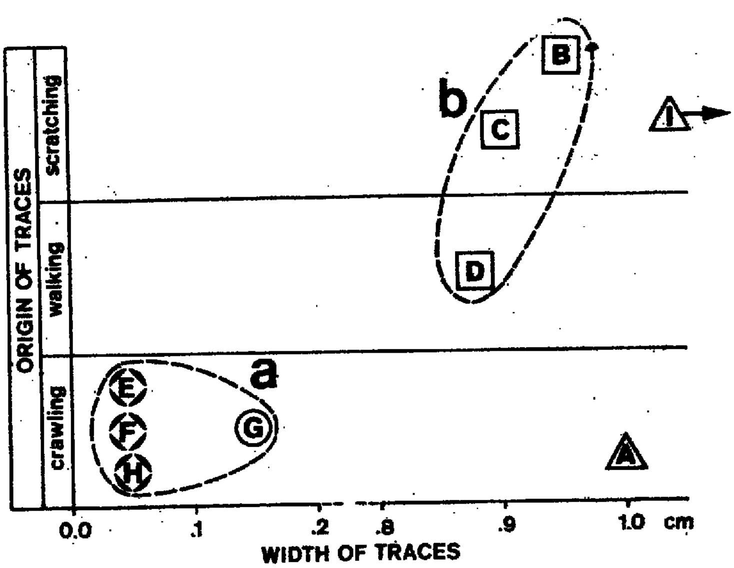


Fig. 4. Comparison of size, origin and frequency of the investigated organic traces; a — association of traces produced by small-sized crawling animals, b — association of traces produced by larger-sized, limbed animals
Frequency: *triangles* — single traces, *quadrats* — rare, *circles* — common, *angled circles* — mass occurrence
A-I — particular morphotypes discussed in the text

GENERAL REMARKS

The sedimentary environment of varved deposits was up to a very recent time considered as devoid of any organic life. This notion was persistent even despite some records of trace fossils. The apparent neglection of trace-fossil evidence was probably due to the fact that the notes on trace fossils found in varved clays were included in papers intended to discuss either the time relationships (Sauramo 1925), or the origin (Schwarzbach 1940) of varved deposits.

Some body fossils do also occur in varved deposits, namely such fish as the pike-perch (Hörner 1948) and the vitling (Munthe 1924). These records are however confined to the late-glacial varved deposits (Yoldia Sea time) accumulated in a large, deep (100—150 m or even more), brackish basin (Hörner 1948; *cf. also* Hansen 1940) widely different from a shallow and fresh water ice-dammed lake.

Thus far, only a few trace-bearing varved suquences have been found. Trace fossils recorded in the Early Pleistocene varved clays by Zagórze (formerly Erlenbusch) in the Sudetes were attributed exclusively to arthropods (Schwarzbach 1938, 1940). A more diverse ichnocoenose was found in younger (Anglian Glaciation) proglacial varved deposits of England; the trace fossils were attributed not only to arthropods but also to some gastropods (Gibbard & Stuart 1974).

The Plecewice sequence has thus yielded the richest known ichnofossil assemblage from the varved deposits, including traces left by mollusks (pelecypods, gastropods) and arthropods (insect larvae among others). Nevertheless, this assemblage does probably not point to all organic groups that were able to live in an ice-dammed lake.

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Institute of Geology
of the Warsaw University,
Al. Żwirki i Wigury 93,
02-089 Warszawa, Poland

REFERENCES

GIBBARD PH. L. & STUART A. J. 1974. Trace fossils from proglacial lake sediments. *Boreas,* 3 (2), 69—74. Oslo.

HALICKI B. 1932. Sur un de l'applications de la méthode géochronologique en Pologne. *Rocznik PTG (Ann. Soc. Géol. Pologne),* 8 (2), 193—197. Kraków.

— 1933. Argiles rubanées à Plecewice sur la Bzura. *Monum. Nat. Inanimée,* 2, 86—90. Warszawa.

HANSEN S. 1940. Varvighed i danske og skaanske senglaciale Aflejringer. *Danm. Geol. Unders., 2 Raekke*, **63**, 478 pp. København.

HÖRNER N. G. 1948. A Late-Glacial specimen of *Lucioperca lucioperca* and its environment. A study of some Uppsala clay varves. *Bull. Geol. Univ. Uppsala*, **32**, 195—276. Uppsala.

KARASZEWSKI W. 1974. Age of the Warsaw Ice-Dammed Lake sediments. *Bull. Acad. Polon. Sci., Sér. Sci. Terre*, **22** (3/4), 151—156. Varsovie.

KUENEN PH. H. 1951. Turbidity currents as the cause of glacial varves. *J. Geol.*, **59** (5), 507—508. Chicago.

MERTA T. 1975. Application of rippled surfaces as correlation horizons in ice--barred sediments. *Bull. Acad. Polon. Sci., Sér. Sci. Terre*, **22** (2), 77—81. Warszawa.

— 1978. Extraglacial varved deposits of the Warsaw Ice-Dammed Lake (younger Pleistocene), Mazovia Lowland, Central Poland. *Acta Geol. Polon.*, **28** (2), 241—272. Warszawa.

MUNTHE H. 1924. Ett fynd av vitling i Mälardalens Yoldiamärgel. *Geol. Fören. Förhandl.*, **46**, 356—357. Stockholm.

ROŻYCKI S. Z. 1961. The Quaternary in the Warsaw Basin. Guidebook of Excursion in the Vicinity of Warsaw. *VIth INQUA Cong.*, 7—17. Łódź.

— 1972. The Pleistocene of Middle Poland [*in Polish*], 2nd *ed. PWN*; Warszawa.

— 1978. From Mochty to a synthesis of the Polish Pleistocene. *Rocznik PTG (Ann. Soc. Géol. Pologne)*, **48** (3/4), 445—478. Kraków.

SAURAMO M. 1925. Geochronologische Studien in Russland. *Geol. Fören. Förhandl.* **47** (4), 521—522. Stockholm.

SCHWARZBACH M. 1938. Tierfährten aus eiszeitlichen Bändertonen. Ein Beitrag zur Biologie der glazialen Stauseen. *Zt. Geschiebeforsch.*, **14**, 143—152. Leipzig.

— 1940. Das diluviale Klima während des Höchstandes einer Vereisung. Ermittelt aus den Tageswarwen der Bändertone. *Zt. Deutsch. Geol. Ges.*, **92** (10), 565—582. Berlin.