Annales Societatis Geologorum Poloniae (1991), vol. 61: 61 – 75
PL ISSN 0208-9068

"SHALLOW WATER" TRACE FOSSILS IN PALEOGENE FLYSCH OF THE SOUTHERN PART OF THE MAGURA NAPPE, POLISH OUTER CARPATHIANS

Alfred Uchman

Jagiellonian University, Institute of Geological Sciences, Oleandry str. 2a, 30-063 Cracow

Uchman, A., 1991. "Shallow water" trace fossils in Paleogene flysch of the southern part of the Magura Nappe, Polish Outer Carpathians. *Ann. Soc. Geol. Polon.*, 61: 61 – 75.

Abstract: Trace fossil taxa commonly referred to as shallow-water ones occur in the Paleogene flysch in the southern part of the Magura Nappe. They are represented by *Rhizocorallium* ichnosp., *Ophiomorpha nodosa*, *Ophiomorpha* ichnosp. indent. morphotypes A and B, *Thalassinoides* ichnosp., and *Pelecypodichnus* ichnosp. Their occurrence in flysch, including thin-bedded facies, together with "deep-water" forms such *Paleodictyon*, *Spirorhaphe*, *Urohelminthoida*, indicates that bathymetric interpretation of trace fossils should be done with caution.

Key words: Trace fossils, bathymetry, Paleogene, flysch, Carpathians.

Manuscript received March 15, 1988 accepted March 26, 1991

INTRODUCTION

During the last nearly two decades, trace fossil genera *Skolithos*, *Rhizocorallium*, *Ophiomorpha*, and *Thalassinoides*, interpreted as a shallow-water ones by Seilacher (1967), are repeatedly reported from flysch deposits (Crimes *et al.*, 1981, with references). They frequently occur together with typical forms classified as "deep-water" ones, e.g., *Paleodictyon*, *Megagrapton* (e.g., Kern & Warme, 1974; Crimes *et al.*, 1981). Some of the supposedly shallow-water trace fossils occur in the Paleogene flysch of the southern part of the Magura Nappe (Fig. 1) (Uchman, 1988, 1990).

The aim of this publication is to present the "shallow-water" trace fossils in the studied area, based on the present author's observations in field and on the Prof. Książkiewicz's collection. The Prof. Książkiewicz's collection is housed in the Museum of Geology of the Jagiellonian University in Cracow.

GEOLOGICAL SETTING

The presented material has been collected from deposits of two facies

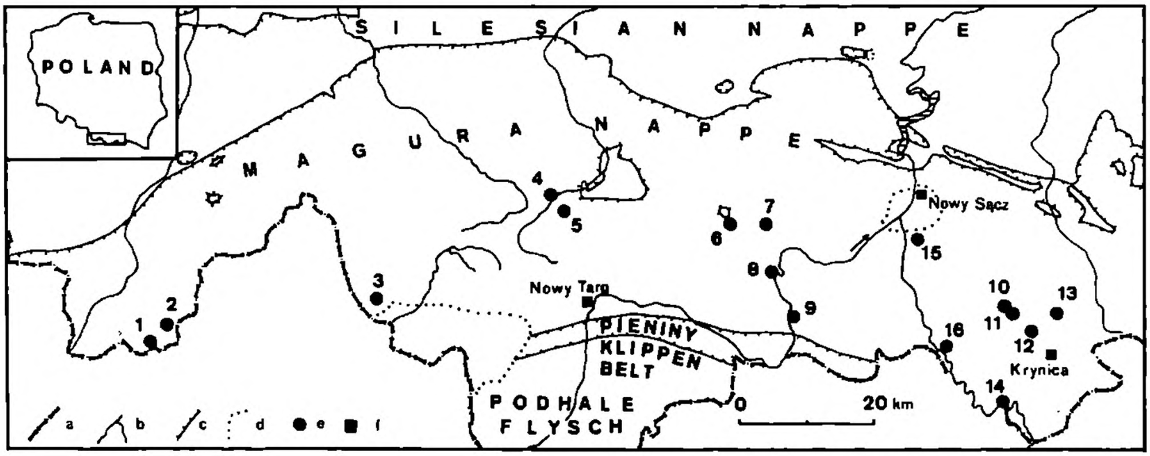


Fig. 1 Location of described sections; *a* – state boundary, *b* – main rivers and lakes, *c* – main overthrusts, *d* – outline of the Neogene post-tectonic cover, *e* – quoted localities (1 – Soblówka, 2 – Glinka, 3 – Lipnica Wielka, 4 – Rabka-Zaryte, 5 – Ponice, 6 – Zasadne, 7 – Zbludza, 8 – Tylmanowa, 9 – Krościenko-Łąkcica, 10 – Łabowiec, 11 – Uhryń, 12 – Roztoka, 13 – Berest, 14 – Milik, 15 – Żeleźnikowa Wielka, 16 – Wierchomla Wielka), *f* – main towns

zones of the Magura Nappe, namely the Krynica (Čerchov) zone and the Nowy Sącz (Bystrica) zone. The strata exposed there, except for the part of the Krynica zone adjacent to the Pieniny Klippen Belt, are Senonian – Oligocene in age (Książkiewicz, 1960, 1977a; Birkenmajer & Oszczypko, 1988, 1989; Oszczypko *et al.*, 1990). They are about 4.000 m thick and consist mainly of siliciclastic, thin to thick-bedded flysch. The Nowy Sącz zone occupies a more northerly position; it is distinguished by the domination of variegated shales in the Upper Paleocene – Lower Eocene as well as by the presence of thick beds of marls (so called Łącko marls) in the Middle – Upper Eocene. The sequence is dated mainly on foraminifers and nannoplankton (Oszczypko *et al.*, 1990, with references).

DESCRIPTION OF TRACE FOSSILS

Ichnogenus: *Rhizocorallium* Zenker, 1836
Ichnospecies: *Rhizocorallium* ichnosp.

(Pl. III: 3)

Material: 3 specimens in collection and 1 in the field.

Description: horizontal *"spreite"* – like structure, 30 – 55 mm wide, up to 12 cm long, stretched between U-shaped canals which are 10 – 12 mm wide, occuring on the top of turbidite beds, 2.0 – 3.5 cm thick.

Occurrence: thin- and medium-bedded flysch deposits of the Szczawnica Formation (Paleocene – Lower Eocene), Krościenko-Łąkcica.

Remarks: The presence of a distinct, wide marginal canal is the main difference between

Rhizocorallium and incompletely preserved *Zoophycos insignis* Squin. According to Seilacher (1967), *Rhizocorallium* is a typical form of the Cruziana ichnofacies, frequent in near-shore deposits (e.g., Fürsich, 1975, with references). However, this form has been also described from deep water, mainly flysch, deposits (Hayward, 1976; Crimes, 1977; Crimes *et al.*, 1981; Pickerill *et al.*, 1982). *Rhizocorallium* described as "*Rhizocorallium*" has been noted in deposits of the Magura Nappe by Książkiewicz (1977b), in the Paleocene variegated shales (Błądzonka) and in the Magura Beds (Klimkówka), on the upper surfaces of sandstone beds.

Ichnogenus: *Ophiomorpha* Lundgren, 1891
Ichnospecies: *Ophiomorpha nodosa* Lundgren, 1891
(Pl. III: 2, V: 2)

Material: 80 specimens

Description: cylindrical, endichnial fillings of vertical to oblique to horizontal canals (Pl. V: 2), 10 – 20 mm in diameter, with oval knobs, sometimes preserved on their walls, which are diagnostic of *Ophiomorpha*. Some of the horizontal specimens are slightly flattened due to compaction. Some of the specimens show internal meniscate structure.

Occurrence: mudstones in thin-thick bedded flysch intercalated within the Piwniczna Sandstone Member (Eocene) – Tylmanowa, Milik (Fig. 1), as well as thick-bedded sandstones of the same member at Wierchomla Wielka (Fig. 1).

Remarks: *Ophiomorpha* is produced by arthropods, mainly shirmps, and it occurs mainly in shallow-water, nearshore (beach) deposits (e.g., Frey *et al.*, 1978; Ekdale & Bromley, 1984). However, this ichnotaxon occurs also in deep-sea flysch deposits (Kern & Warme, 1974; Crimes, 1977; Crimes *et al.*, 1981) and even in terrestial deposits (Gradziński, 1969, p. 222; Merrill, 1984).

Granularia Pomel, differing from *Ophiomorpha* in its smaller dimensions, is regarded as a small "flysch version" of *Spongeliomorpha* (Seilacher, 1977) which in turn is related to *Ophiomorpha* (Frey *et al.*, 1978).

In the Piwniczna Sandstone Member at Tylmanowa and Milik, the small and bigger specimens occur together. Their dimensions correspond to those of *Granularia* as well as *Ophiomorpha*. In this case, it is difficult to separate these two ichnotaxa. It is possible that the smaller specimens are produced by juvenile tracemakers of *Ophiomorpha*. In this case, *Granularia* would be a synonym of *Ophiomorpha* (cf. Häntzschel, 1975).

Some of the bigger specimens of *Sabularia rudis* Książkiewicz, including its holotype, strongly resemble the described material. This ichnotaxon has been separated from *Granularia* (Książkiewicz, 1977; Crimes *et al.*, 1981). However, its specimens in the Książkiewicz's collection are not covered with knobs which could escape preservation. The knobs which are pellets reinforcing of canal walls, do not cover the whole surface of the *Ophiomorpha* burrows (cf. Frey *et al.*, 1978).

The distinctive three-dimensional pattern of the *Ophiomorpha* burrows is discernible in most cases in the field.

Ichnospecies: *Ophiomorpha* ichnosp. indet. morphotypes A and B
(Fig. 2C, Pl: I: 1-2, II: 1)

Material: 4 specimens in collection and a dozen observations in the field.

Description: preserved on the sole of beds as relatively large fullreliefs and semireliefs (the latter are casts of canals exposed by erosion).

Form A (Pl. I: 1, II: 1): meandering, convex semireliefs or fullreliefs, 35 – 40 mm wide, occuring on sandstone soles. Their surfaces are covered with irregular knobs.

Form B (Pl. I: 2, Fig. 2C): convex semireliefs, above 1 cm thick, preserved on soles of sandstone beds, forming irregular nets. Meshes of the nets are above a few cm in diameter.

Occurrence: thin- and medium-bedded flysch of the Beloveža Beds (Middle Eocene). Form A: Łabowiec, Żeleźnikowa Wielka. Form B: Berest, Roztoka, Zasadne, Rabka-Zaryte.

Remarks: Form A resembles *Ophiomorpha irregulaire* Frey et Howard (Frey *et al.*, 1978, fig. 1F, 2H, 12A-B, 14A-B). Form B could be a cast of canals exposed by erosion, forming polyhedral, multistorey system of burrows, belonging to various ichnospecies of *Ophiomorpha* (*op. cit.*, fig. 2A-H) or *Thalassinoides*. Forms transitional from *Ophiomorpha* to *Thalassinoides* are known, and in this case a precise determination of ichnogenera is problematical (cf. Frey *et al.*, 1978). Material similar to form A, occurring in the flysch of the Polish Outer Carpathians, has been described by Książkiewicz (1977b) as *Helmithopsis abeli* and *Helmithopsis granulata*. However, they differ from the described above form A, in their smaller dimensions, and in the case of *Helminthopsis abeli*, by the smooth burrow surface. *Helminthopsis granulata* is distinctive by the regularity of the knobs of the burrow surface, arranged in characteristic rows.

OTHER FORMS RELATED TO *Ophiomorpha*

1. *Arthrophycus annulatus*, described from the Polish Outer Carpathians (Książkiewicz, 1977b) has been included lately (Frey & Howard, 1985) to synonymy of *Ophiomorpha annulata* which, according to the authors, is covered with elongate knobs, perpendicular to the main axis of the burrow. However, specimens from the Prof. Książkiewicz's collection, including the holotype, lack the elongate knobs, and instead they show perpendicular segmentation. Hence, the relation of this ichnotaxon to *Ophiomorpha* is problematical.

2. *Tubulichnium incertum* (Książkiewicz, 1977b, Pl. 11: 14-15, Text-fig. 29) shows substantial similarity to *Ophiomorpha*. This ichnotaxon is common in the flysch deposits of the Szczawnica Formation (Paleocene–Lower Eocene). It forms concave semireliefs, 15-20 mm wide, on upper surfaces of thin and medium-bedded turbidite sandstone beds. The reliefs are covered with muddy pellets, up to 1 mm in diameter (Pl. V: 3). Reinforcement of the burrow walls is diagnostic of *Ophiomorpha* (eg., Frey *et al.*, 1978). In the case of *Tubulichnium incertum* the pellets are small, so Książkiewicz (1977b, s. 142-144) has not included this form to *Ophiomorpha*, but distinguished the new monospecific ichnogenus. However, small pellets, less than 1 mm in diameter, are reported from burrow surface of *Ophiomorpha* (Frey *et. al.*, 1978). Vertical orientation of the *Tubulichnium incertum* is not observed, so its relation to *Ophiomorpha* is an open question.

Ichnogenus: *Thalassinoides* Ehrenberg, 1944
Ichnospecies: *Thalassinoides* ichnosp.

(Pl. III: 1, IV: 1-2, V: 1, Fig. 2 A-B, D-F)

Material: 7 specimens and 2 field observations.

Description: horizontal, convex semireliefs and fullreliefs, above 10 mm wide, showing characteristic Y–shaped, frequently swalled bifurcations. An unlabelled specimen from the Prof. Książkiewicz's collection (apparently from the Beloveža Beds, Outer Carpathians, Eocene), is a fragment of a thin sandstone bed covered with hypichnial semireliefs showing well experessed *Thalassinoides* morphology (Fig. 2E), with Y–shaped, swallen bifurcations.

Occurrence: thin - and medium bedded flysch of the Beloveža Beds (Lower-Middle Eocene) – Uhryń, Soblówka, Roztoka, thick bedded flysch deposits of the Magura Formation (Upper Eocene) – Lipnica Wielka, Ponice (Fig. 1).

Remarks: *Thalassinoides*, produced mainly by decapod crustaceans (Frey *et al.*, 1984) occurs most frequently in shallow-water deposits (eg. Fürsich, 1975; Ekdale & Bromley, 1984) and is reported, as a typical form of the Cruziana ichnofacies (eg., Frey & Seilacher; Frey & Pemberton, 1985, with references). This ichnotaxon has been described also from flysch (Crimes *et al.*, 1981) and Holocene deep-sea sediments (Wetzel, 1983). Some specimens of the described material resemble *Thalassinoides suevicus* Reith and one of them shows overlapping burrows forming *"spreite"*–like

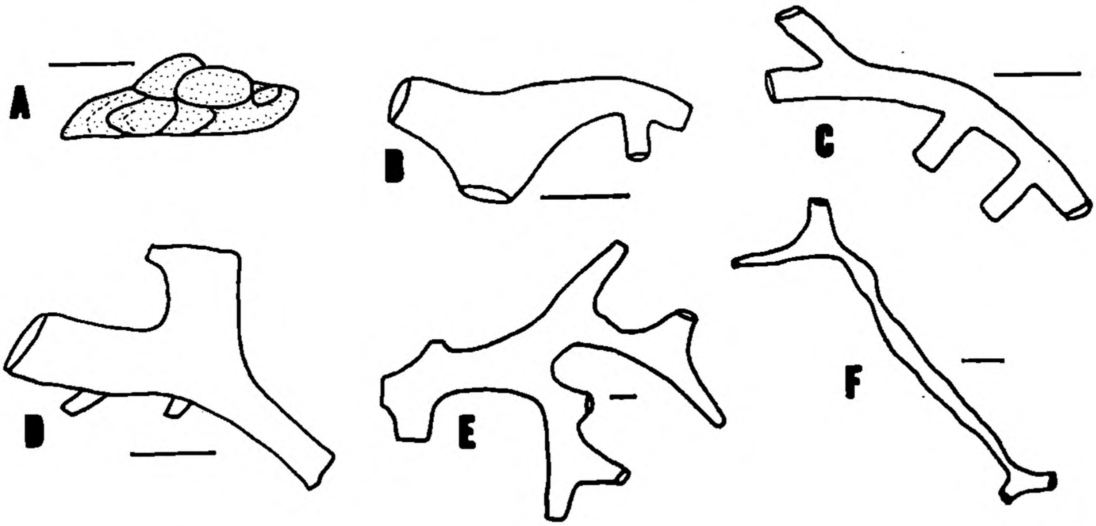


Fig. 2 Drawings of selected specimens. *A* – cross-section of sample with *?Thalassinoides* ichnosp. showing "spreite"-like structure, Beloveža Beds (Lower – Middle Eocene), Uhryń, *B* – *Thalassinoides* ichnosp., Magura Formation (Upper Eocene), Lipnica Wielka, *C* – *?Ophiomorpha* ichnosp., Beloveža Beds (?) (Lower – Middle Eocene), Rabka-Zaryte, *D* – *Thalassinoides* ichnosp., Magura Formation (Upper Eocene), Ponice, *E* – *Thalassinoides* ichnosp., Beloveža Beds (Lower – Middle Eocene), uncertain locality, Museum of Geology, Jagiellonian University, *F* – *Thalassinoides* ichnosp., Beloveža Beds (Lower – Midle Eocene), Roztoka. Scale bar = 2 cm

structure (Fig. 2A) (eg., Frey & Howard, 1985). Most of specimens of *Sabularia ramosa* Książk. described from the Polish Outer Carpathians (Książkiewicz, 1977b) show morphological features of smaller specimens of *Thalassinoides*.

Ichnogenus: *Pelecypodichnus* Seilacher, 1953
Ichnospecies: *Pelecypodichnus* ichnosp.
(Pl. II: 2, III: 4)

Material: 3 specimens in collection and 4 in the field.

Description: convex semireliefs forming elongate, oval, smooth moulds, about 30 mm long, about 15 mm wide, up to 8 mm high (a specimen from Zbludza), occuring on sandstone soles.

Occurrence: thin- and medium-bedded flysch of Beloveža Beds (Middle Eocene) – Zbludza, Glinka, Żeleźnikowa Wielka (Fig. 1).

Remarks: *Pelecypodichnus* is a cubichnial trace of pelecypods (Seilacher, 1953) and is regarded as a from typical of deltaic sediments *sensu lato* (*vide* Crimes *et al.*, 1981). It occurs in shallow-marine and brakish (eg., Pieńkowski, 1985), and even in continental deposits (Bromley & Asgaard, 1979). It has been reported, however, also from deep-sea flysch deposits (Crimes, 1977; Crimes *et. al.*, 1981). It has not been hitherto reported from the Polish Outer Carpathians.

GENERAL OBSERVATIONS

The ichnotaxa described above, mainly in the Beloveža Beds and Szczawnica Formation, occur together with the diversified "typical deep-water" ichnofauna including *Paleodictyon*, *Urohelminthoida*, and *Spirorhaphe*, typical froms of the deep-water Nereites ichnofacies (Seilacher, 1967; Frey & Seilacher, 1980). Additionally, *Zoophycos* and *Phycosiphon*, ichnotaxa typical of Zoophycos ichnofacies (cf. Frey & Seilacher, 1980), occur commonly in the Szczawnica Formation.

DISSCUSSION

The described above ichnotaxa – *Rhizocorallium*, *Ophiomorpha*, *Thalassinoides*, *Pelecypodichnus* – occur most frequently in shallow-marine sediments, and the first three ones represent the littoral Skolithos and Cruziana ichnofacies (Frey & Seilacher, 1980, with references). Their occurrence in deep-sea sediments is a big dilemma of ichnology. According to Crimes *et al.* (1981), this ichnotaxa could occur in proximal flysch deposits of the main and distributary channel zone of submarine fans, where hydrodynamic conditions typical of high energy shallow-water environments periodically occur. However, many of the described forms occur in sequences of thin- and medium-bedded flysch, few hundred metres thick, namely in the Beloveža Beds and the Szczawnica Formation. These deposits are more distal and have been laid down in comparatively low-energy conditions (cf. Oszczypko, 1986). So it seems that the occurrence of the "shallow-water" forms is largely independent of the flysch subfacies and these forms are a normal component of various flysch ichnoassociations.

The occurrence of the "shallow-water" ichnotaxa together with the "deep-water" ones, is one of the numerous facts (see Byers, 1982, and references therein) contradicting the concept of a strong bathymetric control of trace fossil distribution, expressed in the Seilacher's (1967) model. The numerous observations accumulated up to date allow one to infer that the "shallow-water" trace fossils, such as those described in this publication, as well as others, e.g., *Skolithos*, can occur in flysch, perhaps not in a very high density which remains typical of littoral sediments (cf. Frey & Pemberton, 1985). An exception is *Ophiomorpha*, which may be abundant in thick-bedded flysch (cf. Kern & Warme, 1974; observations reported herein – the Piwniczna Sandstone Member at Wierchomla Wielka). It may be concluded, that the inferences on paleodepth on the basis of trace fossils should be done with caution.

On the other hand, typical "deep-water" forms, such as *Helminthopsis* and *Paleodictyon* are noted sporadically in shallow marine sediments (e.g., Archer & Maples, 1984).

Trace fossil occurrence is controlled by many complex factors (eg., Byers, 1982), including oxygenation of sediment (Ekdale, 1988, with references). Seilacher's (1967) model seems to embrace the basic ichnofacies archetypes showing a tendency to frequent repetitions at certain depth intervals though without any close and direct depth control (Frey & Pemberton, 1985, Frey *et al.*, 1990).

Acknowledgements

The present author would like to express his cordial thanks to Prof. N. Oszczypko and Dr M. Cieszkowski (Institute of Geological Sciences, Jagiellonian University) for introduction to the field, to Prof. A. Radomski and collaegues from the Institute of Geological Sciences, Jagiellonian University, as well as to Dr G. Pieńkowski (State Geological Institute, Warsaw) and Dr G. Haczewski (Polish Academy of Sciences), for valuable remarks during the preparation of the manuscript.

REFERENCES

Archer, A.W. & Maples, Ch. G., 1984. Trace fossil distribution across a marine - to - nonmarine gradient in the Pensylvanian of South Western Indiana. *J. Paleont.*, 58: 448 – 466.

Birkenmajer, K. & Oszczypko, N., 1988. New lithostratigraphic standart for the Paleogene of the Magura Flysch Basin (southern part), Carpathians. *Ann. Soc. Geol. Pol.*, 36: 253 – 259.

Birkenmajer, K. & Oszczypko, N., 1989. Cretaceous and Paleogene lithostratigraphic units of the Magura Nappe, Krynica Subunit, Carpathians. *Studia Geol. Pol.*, 59: 145 – 181.

Bromley, R. G. & Asgaard, U., 1979. Triassic fresh water ichnocoenosis from Carlsberg Fjord, East Greenland. *Palaeogeogr. Palaeoclimat. Palaeoecol.*, 28: 39 – 80.

Byers, Ch. W., Geological significance of marine biogenic sedimentary structures. In: Mc Call, L. P. & Tevesz, M. J. S. (Eds.), *Animal – sediment relations. The biogenic alternation of sediments.* Plenum Press. New York-London, pp. 221 – 256.

Crimes, T. P., 1977. Trace fossils of an Eocene deep-sea fan, northern Spain. In: Crimes, T. P. & Harper, J. C. (Eds.). *J. Geol. Spec. Issue*, 9: pp. 71 – 90.

Crimes, T. P., Goldring, R., Homewood, P., Stuijvenberg, J., van & Winkler, W., 1981. Trace fossil assemblages of deep sea – fan deposits, Gurnigel and Schliren flysch (Cretaceous–Eocene), Switzerland. *Eclogae Geol. Helv.*, 74: 953 – 995.

Ekdale, A. A., 1988. Pitfalls of paleobathymetric interpretations based on trace fossil assemblages. *Palaios*, 3: 268 – 278.

Ekdale, A. A. & Bromley, R. G., 1984. Comparative ichnology of shelf-sea and deep-sea chalk. *J. Paleont.*, 58: 322 – 332.

Frey, R. W., Howard, J. D. & Pryor, W. A., 1978. Ophiomorpha: its morphologic, taxonomic, and environmental significance. *Palaeogr. Palaeoclimat. Palaeoecol.*, 23: 199 – 229.

Frey, R. W. & Seilacher, A., 1980. Uniformity in marine invertebrate ichnology. *Lethaia*, 13: 183 – 207.

Frey, R. W., Curran, A. H. & Pemberton, G. S., 1984. Tracemaking activities of crabs and their environmental significance: the ichnogenus *Psilonichnus*. *J. Paleont.*, 58: 333 – 350.

Frey, R. W. & Howard, J. D., 1985. Trace fossils from the Panther Member, Star Point Formation (Upper Cretaceous Coal Creek Canyon, Utah). *J. Paleont.*, 59: 370 – 404.

Frey, R. W. & Pemberton, G. S., 1985. Biogenic structures in outcrops and cores. I. Approaches to Ichnology. *Bull. Canad. Petr. Geol.*, 33: 72 – 115.

Frey, R. W., Pemberton, G. S. & Saunders, Th. D. A., 1990. Ichnofacies and bathymetry: a passsive relationship. *J. Paleont.*, 64: 155 – 158.

Fürsich, F. Th. 1975. Trace fossils as environmental indicators in Corallian of England and Normandy. *Lethaia*, 8: 151 – 172.

Gradziński, R., 1969. Sedimentation of dinosaur-bearing Upper Cretaceous deposits of the Nemegt Basin, Gobi Desert. *Palaeontol. Polonica*, 21: 147 – 229.

Häntzschel, W., 1975. Trace fossils and problematica. In: Teichert, C, (Ed.), *Treatise on Invertebrate Paleontology, Part W, Miscellanea.* Geol. Soc. America, The University of Kansas, pp. W1 – W296.

Hayward, B. W., 1976. Lower Miocene bathyal and submarine canyon ichnocenoses from Northland, New Zeland. *Lethaia*, 9: 149 – 152.

Kern, J. Ph. & Warme, J. E., 1974. Trace fossils and bathymetry of the Upper Cretaceous Point Loma Formation, San Diego, California. *Bull. Geol. Soc. Amer.*, 85: 893 – 900.

Książkiewicz, M., 1960. Pre-orogenic sedimentation in the Carpathian geosyncline. *Geol. Rundschau*, 50: 8 – 31.

Książkiewicz, M., 1977a. The tectonics of the Carpathians In: *Geology of Poland. Vol. IV. Tectonics*. Pub. House Wyd. Geol. Warsaw, pp. 476 – 669.

Książkiewicz, M., 1977b. Trace fossils in the Flysch of the Polish Carpathians. *Palaeontol. Polonica*, 36: 1 – 208.

Merrill, R. G., 1984. *Ophiomorpha* and other nonmarine trace fossils from the Eocene Ione Formation, California. *J. Paleont.*, 58: 542 – 549.

Oszczypko, N., 1986. Wycieczka B. 16. Żeleźnikowa (In Polish). In: Birkenmajer, K. & Poprawa, D. (Eds.). *Przewodnik LVII Zjazdu Polskiego Towarzystwa Geologicznego. Pieniny, 1986*. Pol. Tow. Geol., pp. 123 – 127.

Oszczypko, N., Dudziak, J. & Malata, E., 1990. Stratigraphy of the Cretaceous trough Paleogene deposits of the Magura Nappe in Beskid Sądecki Range, Polish Outer Carpathians (In Polish, English summary). *Studia Geol. Polon.*, 97: 109 – 181.

Pickerill, R. K., Hurst, J. M. & Surlyk, F., 1982. Notes on Lower Palaeozoic flysch trace fossils from Hall Land and Peary Land, North Greenland. Grønlands Geol. Unders., 108: 25 – 29.

Pieńkowski, G., 1985. Early Liassic trace fossils assemblages from the Holy Cross Mountains, Poland: their distribution in continental and marginal marine environments. In: Curran, A. H. (Ed.), *Biogenic Structures: Their Use in Interpreting Depositional Environment. SEPM Spec. Publ.*, 35: pp. 37 – 51.

Seilacher, A., 1953. Studien zur Palichnologie. II. Die fossilen Ruhespuren (Cubichnia). *N. Jb. Geol. Pal. Abh.*, 98: 87 – 124.

Seilacher, A., 1967. Bathymetry of trace fossils. *Marine Geol.*, 5: 413 – 426.

Seilacher, A., 1977. Pattern analysis of Paleodictyon and related trace fossils. In: Crimes, T. P. & Harper, J. C. (Eds.), *Geol. J., Spec. Issue*, 9: pp. 289 – 334.

Uchman, A., 1988. "Shallow water" trace fossils in Paleogene flysch, Carpathians Mts., Poland. In: *9th IAS Regional Meeting of Sedimentology – Leuven 88*. Abstracts, p. 199

Uchman, A., 1990. Skamieniałości śladowe w strefie krynickiej i bystrzyckiej płaszczowiny magurskiej (polskie Karpaty zewnętrzne). Praca doktorska (PhD Thesis), Archiwum Biblioteki Jagiellońskiej w Krakowie, pp. 1 – 135.

Wetzel, A., 1983. Biogenic structures in modern slope to deep-sea sediments in the Sulu Sea Basin (Philippines). *Palaeogeogr. Palaeoclimat. Palaeoecol.*, 42: 285 – 304.

Streszczenie

"PŁYTKOWODNE" SKAMIENIAŁOŚCI ŚLADOWE W PALEOGEŃSKIM FLISZU POŁUDNIOWEJ CZĘŚCI PŁASZCZOWINY MAGURSKIEJ, POLSKIE KARPATY ZEWNĘTRZNE

Alfred Uchman

W paleogeńskich utworach fliszowych, w południowej części płaszczowiny magurskiej, znaleziono skamieniałości śladowe (Fig. 1) uważane powszechnie za płytkowodne, takie jak: *Rhizocorallium* ichnosp., *Ophiomorpha nodosa* Lund., *Ophiomorpha* ichnosp. indet. typ A i B, *Thalassinoides* ichnosp. i *Pelecypodichnus* ichnosp. (Fig. 2, Pl. I-V). Należą one zgodnie z batymetrycznym modelem rozmieszczenia skamieniałości śladowych Seilachera do płytkowodnych ichnofacji Skolithos i Cruziana (Seilacher, 1967).

Coraz częściej jednak spotyka się je, jak w opisywanym przypadku, w głębokomorskich utworach fliszowych (por. np. Crimes *et. al.*, 1981) wraz z typowymi przedstawicielami głębokowodnej ichnofacji Nereites (w opisywanym przypadku: *Paleodictyon*, *Urohelminthoida*, *Spirorhaphe* i inne). Jest to jedno z wielu odstępstw (np. Byers, 1982) od powszechnie stosowanego modelu Seilachera (1967) Według nowszych poglądów (np. Frey *et. al.*, 1990) model ten przedstawia jedynie archetypy ichnofacji, które mają tendencję do występowania w pewnych przedziałach batymetrycznych, lecz bez ścisłego, bezpośredniego z nimi związku. Obecnie coraz więcej faktów świadczy o tym, że "płytkowodne" skamieniałości śladowe mogą występować niezbyt licznie w utworach fliszowych (por. Frey & Pemberton, 1985). Wyjątkiem jest tu *Ophiomorpha*, występująca licznie w niektórych profilach, na przykład w gruboławicowych piaskowcach ogniwa piaskowców z Piwnicznej (og). Skłania to do dużej ostrożności w interpretacji batymetrii na podstawie pojedynczych okazów, bez uwzględnienia złożonych czynników kontrolujących rozmieszczenie ichnofauny, zwłaszcza, że także "typowo głębokowodne" ichnorodzaje takie jak: *Helminthopsis* czy *Paleodictyon* notowane są sporadycznie z utworów płytkowodnych (np. Archer & Maples, 1984).

Według Crimes'a *et al.*, (1981) "płytkowodne" ichnorodzaje występują w proksymalnych częściach utworów fliszowych. Wiele z opisanych w niniejszej publikacji form zostało znalezionych jednak w co najmniej kilkusetmetrowych sekwencjach cienko- i średnioławicowego fliszu, to jest w utworach warstw beloweskich (eocen) i formacji szczawnickiej (fm) (paleocen – eocen dolny), które uważane są za bardziej dystalne (por. np. Oszczypko, 1986). Wydaje się więc, że "płytkowodne" skamieniałości śladowe mogą się pojawiać niezależnie od subfacji fliszu.

EXPLANATION OF PLATES

Plate I

1 — *Ophiomorpha ?irregulaire*. Beloveža Beds (Lower – Middle Eocene), Łabowiec. Photo by P. Radzicki

2 — *Ophiomorpha – Thalassinoides* ichnosp. Beloveža Beds (Lower – Middle Eocene), Zasadne

Plate II

1 — *Ophiomorpha ?irregulaire*. Beloveža Beds (Lower – Middle Eocene), Żeleźnikowa Wielka

2 — *Pelecypodichnus* ichnosp. (P), *Circulichnis* ichnosp. (C), *Sabularia simplex*. (S). Beloveža Beds (Lower – Middle Eocene), Żeleźnikowa Wielka

Plate III

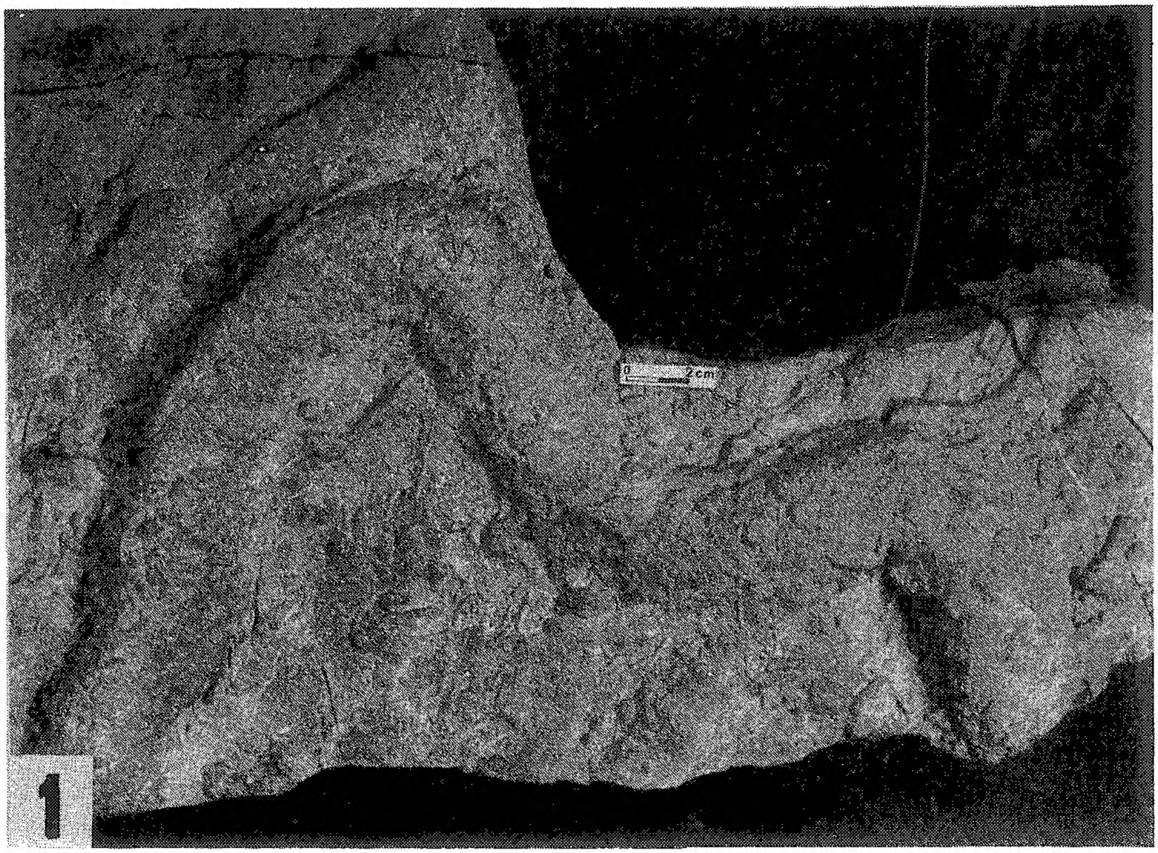
1 — *Thalassinoides* ichnosp. Beloveža Beds (Lower – Middle Eocene), Uhryń. Photo by P. Radzicki
2 — *Ophiomorpha nodosa*. Piwniczna Sandstone Member (Eocene), Milik. Photo by P. Radzicki
3 — *Rhizocorallium* ichnosp. Szczawnica Formation (Paleocene – Lower Eocene), Krościenko - Łąkcica. Photo by P. Radzicki
4 — *Pelecypodichnus* ichnosp. Beloveža Beds. (Lower – Middle Eocene), Glinka. Photo by P. Radzicki

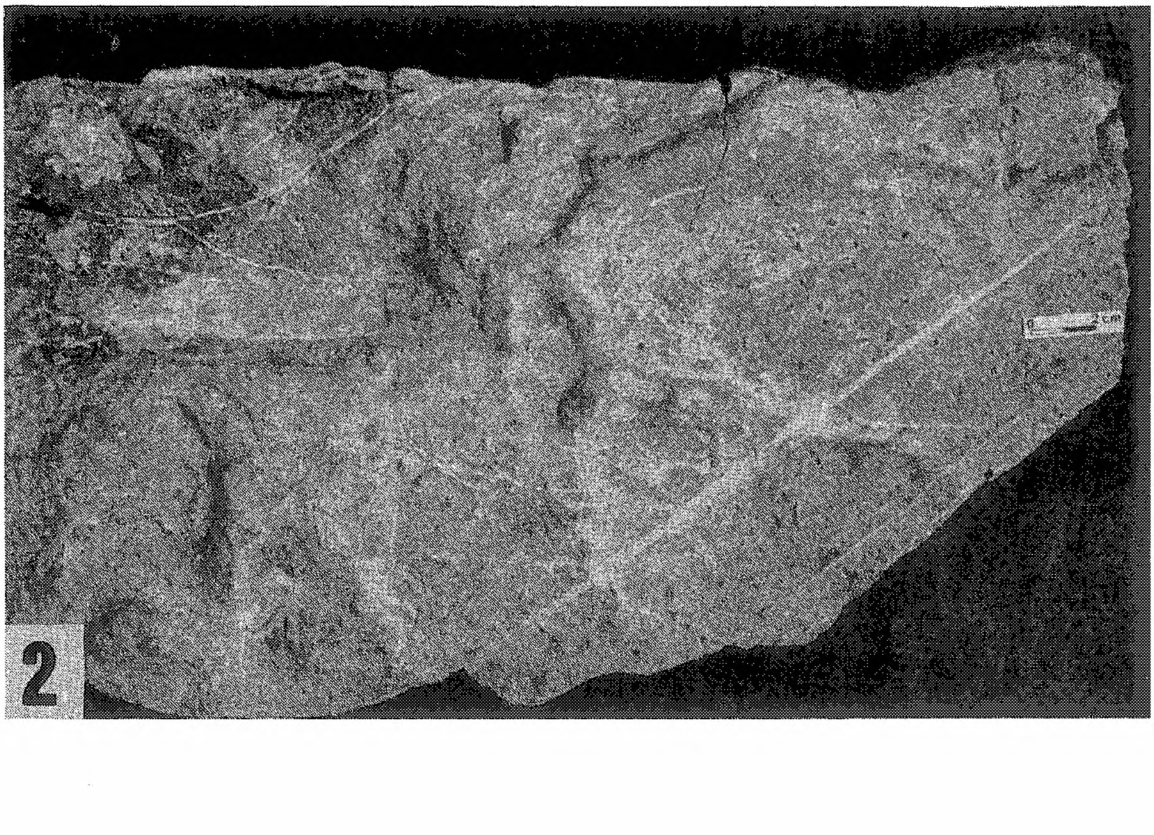
Plate IV

1 — *Thalassinoides* ichnosp. Beloveža Beds (Lower – Middle Eocene), Żeleźnikowa Wielka
2 — *Thalassinoides* ichnosp. Beloveža Beds (Lower – Middle Eocene), Soblówka. Photo by P. Radzicki
3 — *Tubulichnium incertum*. Szczawnica Formation (Paleocene – Lower Eocene), Krościenko - Łąkcica. Photo by P. Radzicki

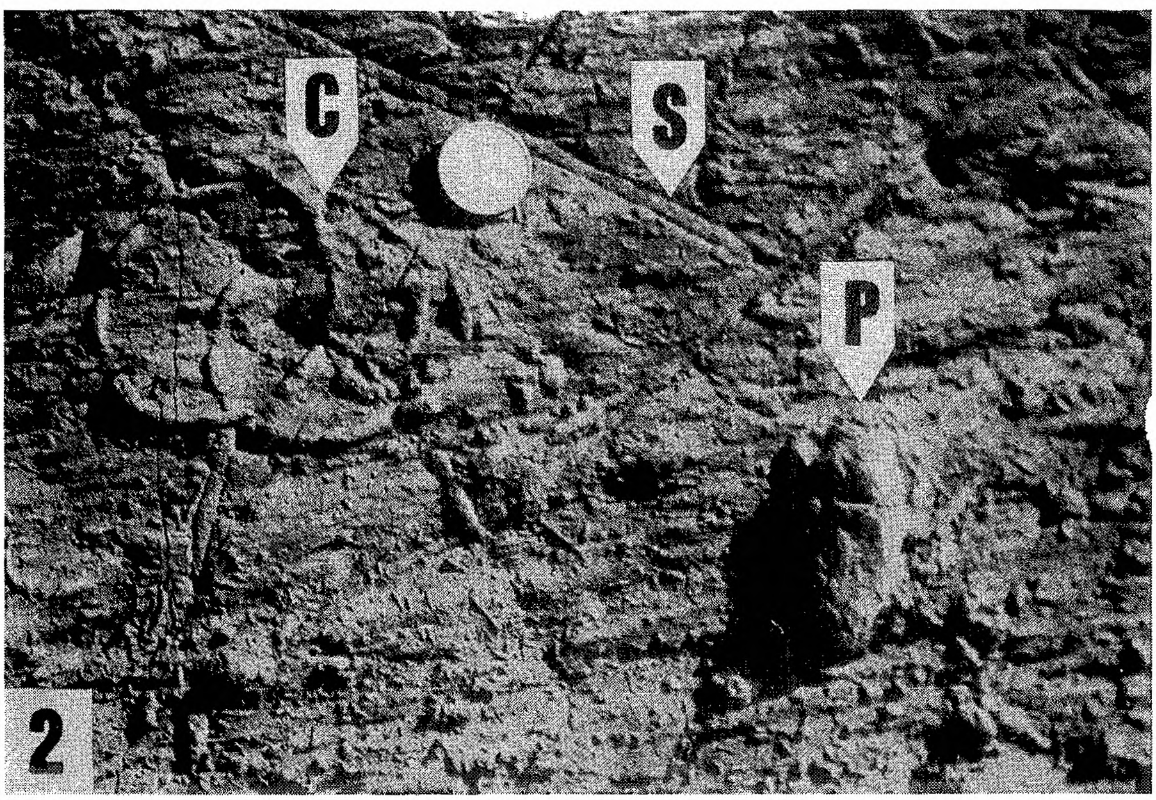
Plate V

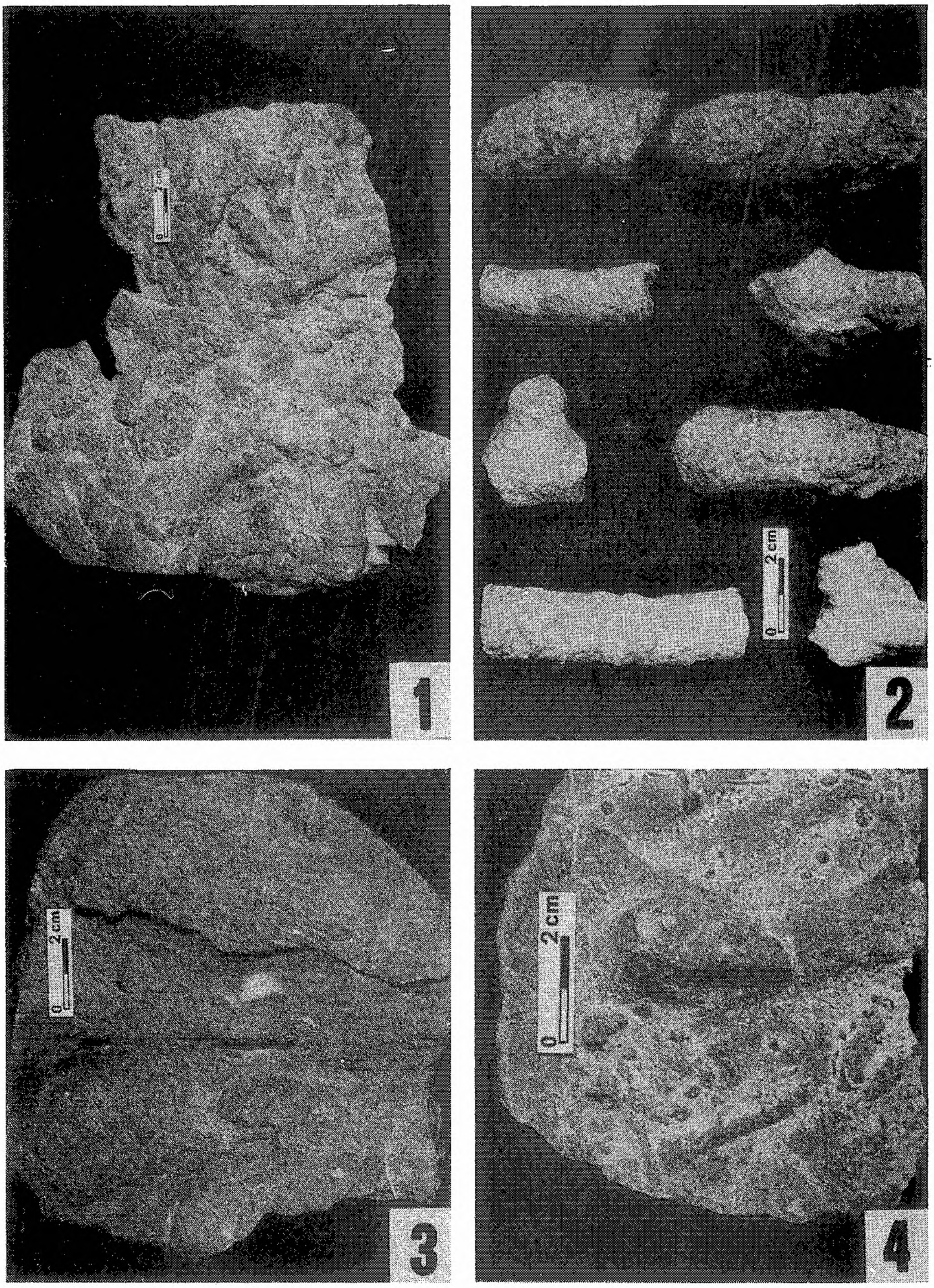
1 — *Thalassinoides* ichnosp. Beloveža Beds (Lower – Middle Eocene), Roztoka
2 — *Ophiomorpha nodosa* in thick-bedded sandstones from the Piwniczna Sandstone Member (Eocene), Wierchomla Wielka; *b* – bedding surface. Scale bar = 20 cm

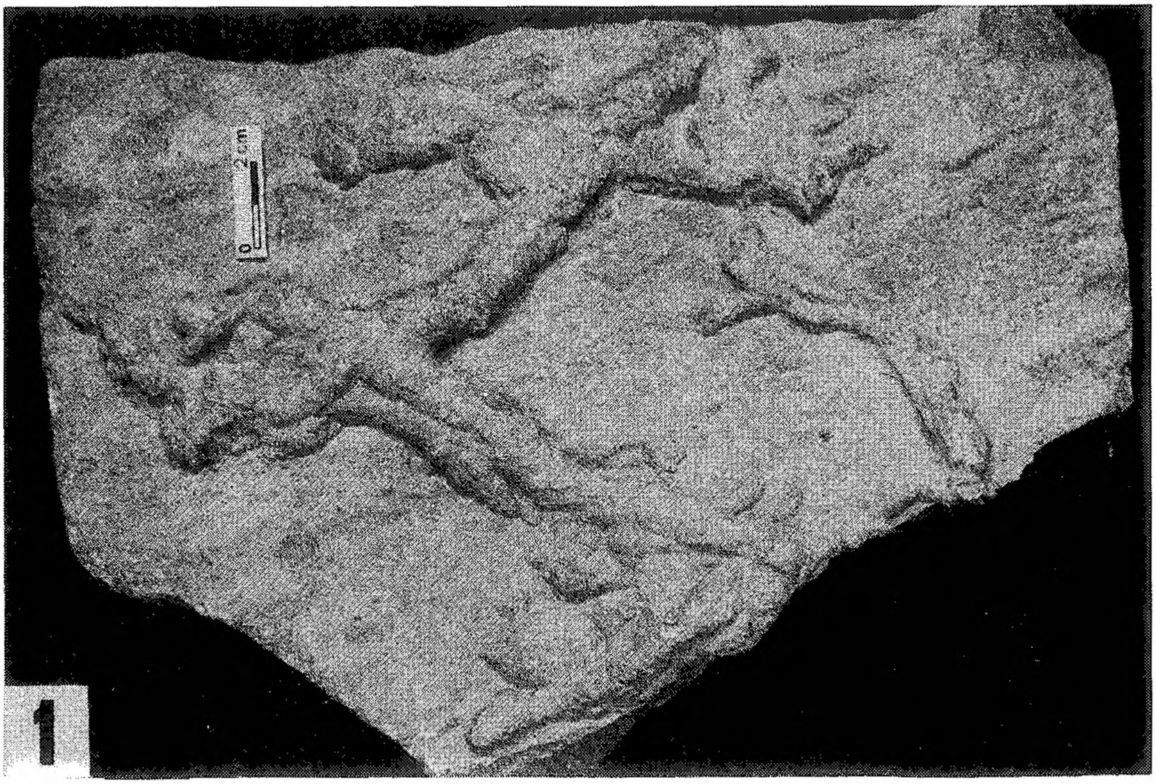

0
2 cm

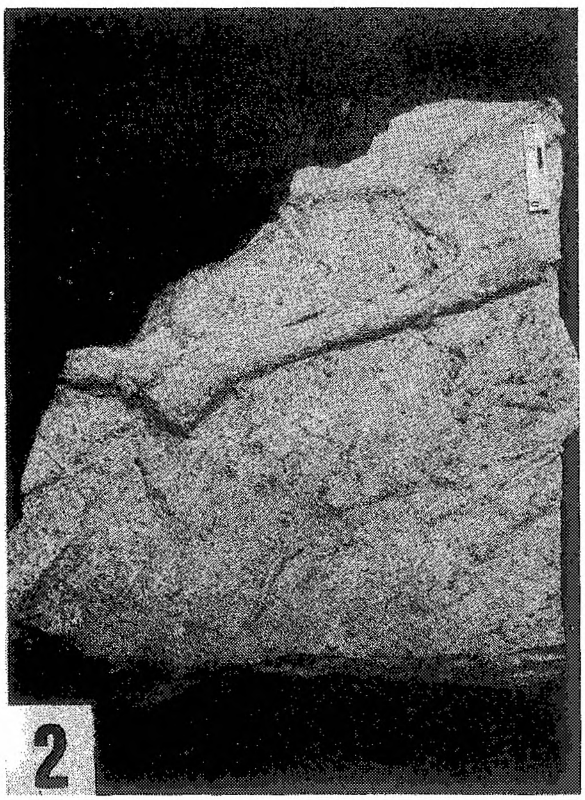

2 cm

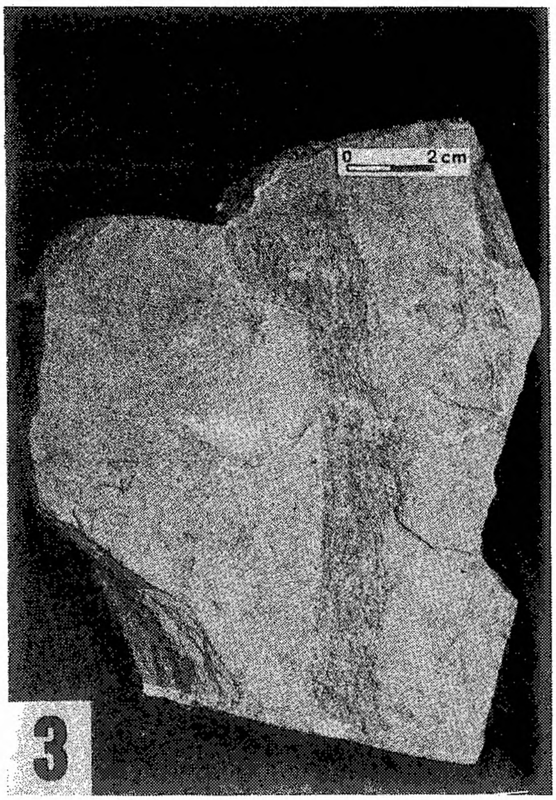

1

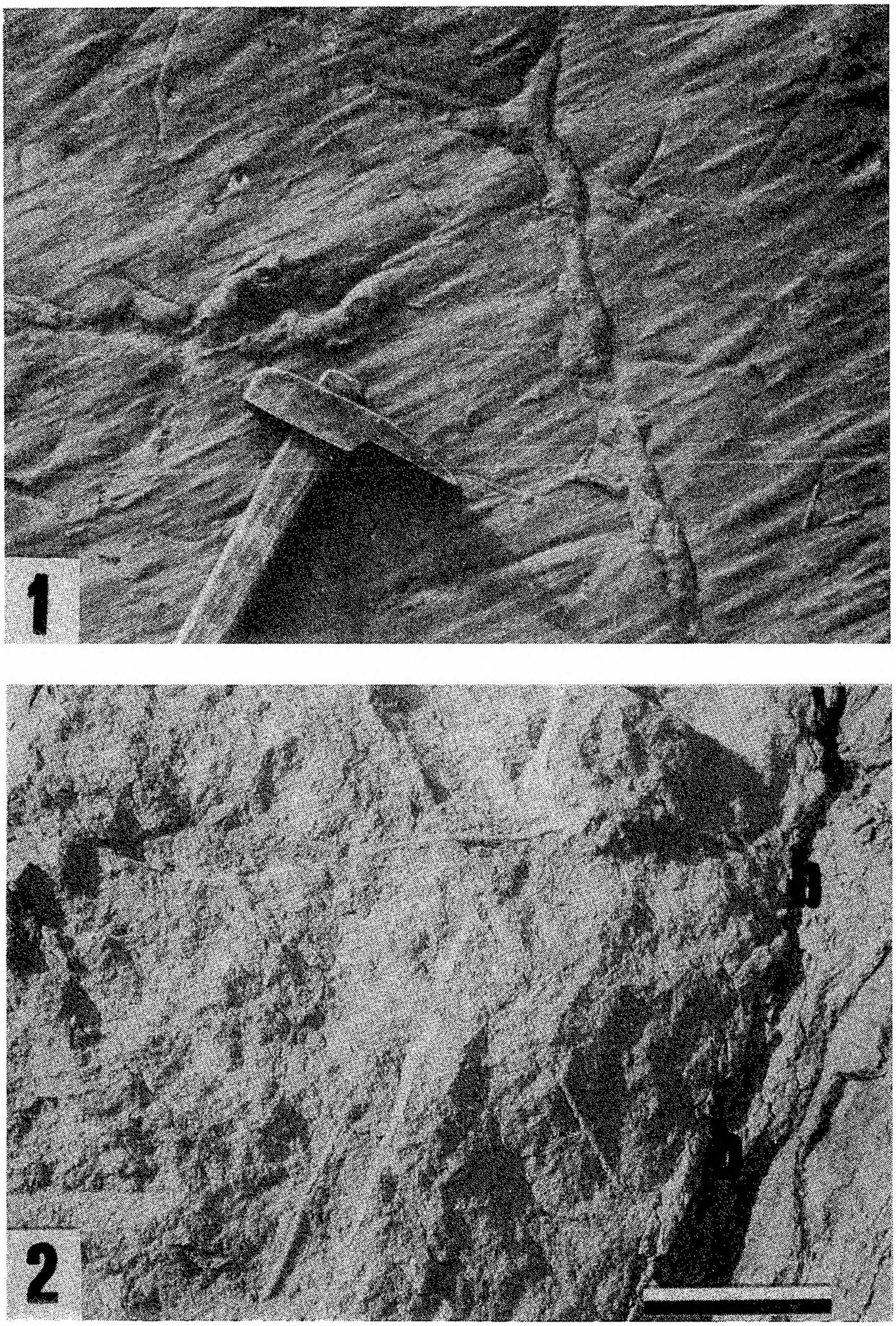

C
S
P
2


1
2
3
4


1
0
2 cm


2


3
0
2 cm


1
2