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Cephalopod arm hooks from the Muschelkalk of Poland

ABSTRACT: Cephalopod arm hooks from the Muschelkalk of Poland are described and illustrated in the present paper, which also gives their stratigraphic position in correlation with the ceratitid and conodont stratigraphy. The arm hooks under study have been assigned to the Phragmoteuthida, an only order of the Triassic Coleoidea having such hooks.

INTRODUCTION

Arm hooks occur in several groups of the Coleoidea, both fossil and Recent. The Phragmoteuthida have hooks on all arms. Among the Teuthida, the arms of only some of the Recent squids are provided with hooks (Naef 1922, Jeletzky 1966, Kulicki & Szaniawski 1972, Young 1972). In the Triassic, the Coleoidea are represented by two orders, the Aulacocerida and Phragmoteuthida. The stratigraphic range of the Phragmoteuthida, including the Permian, Trassic and probably the Lower Jurassic, has not so far been documented paleontologically (Jeletzky 1966). Taking into account the present state of knowledge of the Triassic Coleoidea, all hooks found in the deposits of this age should be assigned to the representatives of the order Phragmoteuthida. Among several papers on this order (*cf.* Kulicki & Szaniawski 1972), giving descriptions and illustrations of hooks, either detached, or connected with the impressions of the soft body and hard parts (jaws and shells), we should mention those of Bronn (1859), Mojsisovics (1902), Wilczewski (1967), Kozur (1967, 1970, 1971), Rieber (1970), Jansonius & Craig (1971) and Pinna (1972).

Kozur (1967, 1970, 1971), followed by Jansonius & Craig, described and illustrated Triassic arm hooks, assigning them to the scolecodonts (*cf.* Kulicki & Szaniawski 1972).

Kulicki & Szaniawski (1972) compared the arm hooks of the Coleoidea with the scolecodonts and, *i.a.* determined a diagrammatic structure of fossil arm hooks similar in many morphological details to those of Recent arm hooks. These investigators formed a parataxonomic system and presented, within its range, twenty-two morphological types of hooks from the Jurassic and Cretaceous of Poland.

A hundred and twelve specimens of arm hooks were obtained, in addition to other fossils (conodonts, scolecodonts), by dissolving limestones, dolomites and sandy calcareous shales in the acetic acid; all these specimens come from the Muschelkalk of Poland (Figs 1 and 2).

Acknowledgements. The writer's thanks are extended to Professor R. Kozłowski for enabling her to study and illustrate the arm hooks by means of an appropriate set of optical apparatus. She also feels indebted to C. Kulicki, M. Sc., and Dr. H. Szaniawski for a discussion and making available a collection of the Jurassic and Cretaceous, as well as some Recent arm hooks.

STRATIGRAPHIC POSITION OF ARM HOOKS IN THE PROFILES

All specimens of arm hooks come from samples collected from boring cores (Fig. 2). The oldest hooks were found in two samples from the Gogolin Beds in the Wierchlesie boring, where also conodonts and

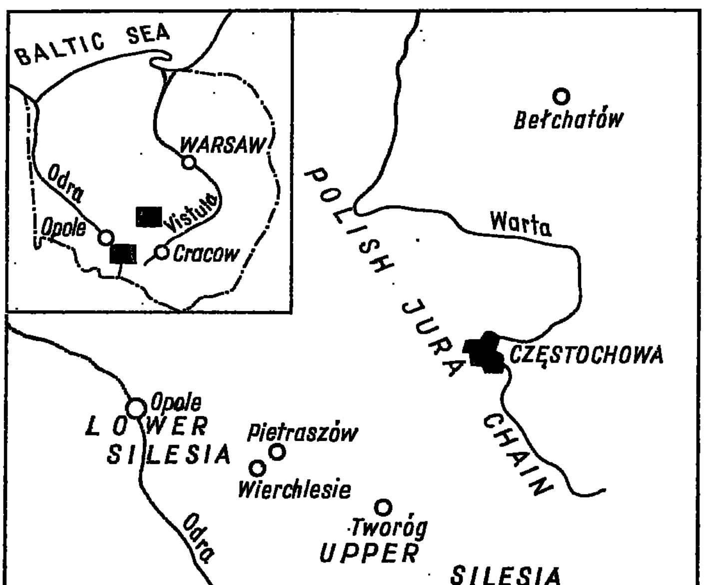

Fig. 1
Location of boreholes sampled for investigated arm hooks

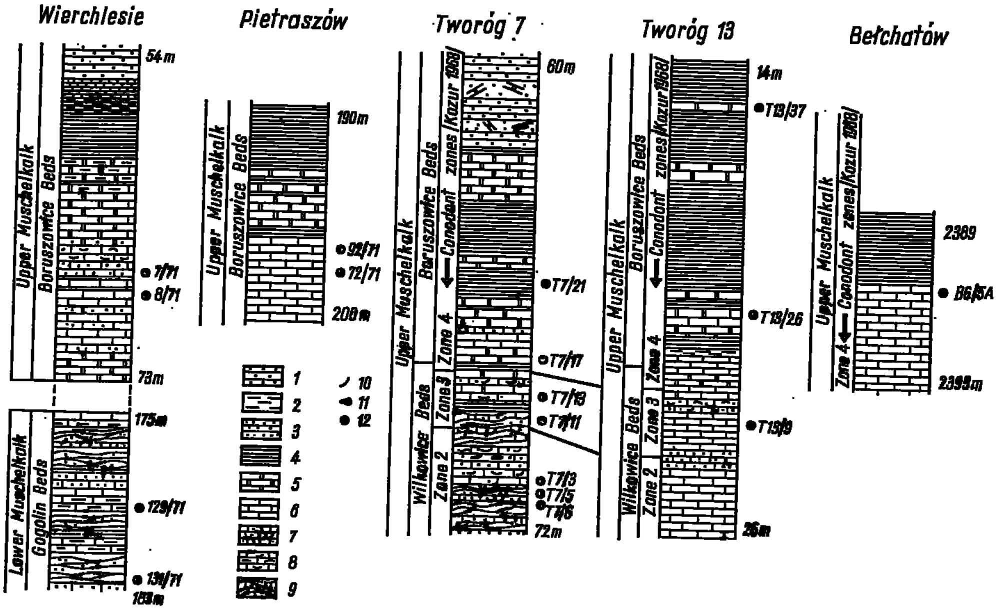

Fig. 2

Investigated profiles of the Muschelkalk in Poland
1 sandstones, *2* mudstones, *3* sandy shales, *4* claystone, *5* dolomites, *6* pelitic limestones, *7* calcarenites, *8* marly limestones, *9* wavy bedded limestones, *10* shell debris, *11* intraclasts, *12* positive samples

Zone 2 — *Gondolella mombergensis mombergensis* Tatge
Zone 3 — *Gondolella mombergensis media* Kozur
Zone 4 — *Gondolella haslachensis* Tatge

scolecodonts occurred. Each of the two samples contained a complete hook (Pl. 1, Figs 2 and 5). The remaining hooks come from the Upper Muschelkalk of the Wilkowice and Boruszowice Beds. In correlation with the ceratitid and conodont stratigraphy, their position is shown in Figs 2 and 3. Of seventeen samples, containing hooks, six display more than one specimen (T7/17 — three, T1/6 — ten, 72/71 — twenty-four, B6/5A — forty-seven, T13/37 — twelve and 92/71 — five specimens).

PRESERVATION OF ARM HOOKS

As compared with the scolecodonts, the Triassic hook arms under study display striking differences in the state of preservation and character of surface; these differences have already been observed by earlier authors (*cf.* Kulicki & Szaniawski 1972). The surface of hooks is very rarely smooth and only in the distal part of uncinus; on the whole, it displays a distinct granulation. Most frequently, hooks are brown, but there also happen black ones the surface of which is as a rule smoother. Many specimens are impregnated with pyrite which, filling the pseudo-pulp cavity, splits the hook from inside (Pl. 2, Fig. 6, pyrite occurring within black areas). The hooks are always more or less cracked, but, on the other hand, they

		CONODONT ZONES /KOZUR 1968/	CERATITES ZONES /RIEDEL 1916/	LITHOSTRATIGRAPHICAL UNITS IN SILESIA
UPPER MUSCHELKALK	ZONE 7	Gondolella watsnaueri watsnaueri	Discoceratiten	Lettenkohle
	ZONE 6	Gondolella watsnaueri watsnaueri Gondolella watsnaueri praecursor	C. nodosus	
	ZONE 5	Gondolella watsnaueri praecursor Gondolella haslachensis		
	ZONE 4	Gondolella haslachensis	C. enodis C. laevigatus C. spinosus	Boruszowice beds
	ZONE 3	Gondolella mombergensis media	C. evolutus C. compressus	Wilkowice beds
	ZONE 2	Gondolella mombergensis mombergensis	Lower Ceratites beds	Tarnowice beds
	ZONE 1	G. mombergensis mombergensis Cornudina breviramulis breviramulis Parachirognathus pandodentata Diplododella meissneri Chirodella dinodoides		Tarnowice beds

Fig. 3

Correlation of the Upper Muschelkalk of Silesia and Germany

display a certain plasticity. They were observed in sandy shales, in which they were embedded among relatively large grains of detrital quartz, to which shape they adapted themselves.

MORPHOLOGY OF ARM HOOKS

All the morphological terms here used have been adopted by the writer after Kulicki & Szaniawski (1972).

The morphological scheme of the arm hooks described corresponds on the whole to that presented by Kulicki & Szaniawski (1972, Fig. 4), except of course for differences in general shape and the lack of spur. The size of hooks varies from about 0.9 mm in the largest samples (T13/37 — in Pl. 4, Fig. 4 and T7/6 in Pl. 4, Fig. 6) to about 0.4 mm in the smallest (131/71 in Pl. 1, Fig. 2 and 129/71 in Pl. 1, Fig. 5). The fact should be emphasized that the two smallest specimens come from the Lower Muschelkalk (Gogolin Beds).

Nearly all specimens have an orbicular scar, wich is invisible in only very poorly preserved specimens. It is usally marked as a line dividing the hook into two parts. Less freqeuently it occurs as a fine but distinct scar (Pl. 1, Figs 2, 6 and 8; Pl. 3, Fig. 3), which trace in similar an all specimens. From the base of shaft it runs towards uncinus and the outer margin of shaft, passing onto the other side, where its trace is identical. Sometimes, a sinus scar on the outer margin of hook occurs in the place of a distinct curve of this edge (Pl. 1, Fig. 2; Pl. 3, Figs 3 and 5; Pl. 4, Fig. 1), much the same as in the genera *Paraglycerites* Eisenack and *Urbanekuncus* Kulicki & Szaniawski.

Longitudinal ridges may be observed in all hooks. They run along the outer margin of hook, beginning with the proximal part of shaft up to the apex of uncinus. Usually, only one, mostly right-hand, longitudinal ridge is visible. Sometimes, two closely spaced longitudinal ridges may be observed, but only in the proximal part of the shaft (Pl. 1, Fig. 8; Pl. 2, Fig. 3; Pl. 4, Fig. 6). A deep crack is mostly visible in the place, where the longitudinal ridge is supposed to run. If two such ridges are present, the right-hand one is always more prominent. At the base of shaft, the interridge surface extends and forms a sort of a short, subrectangular process projecting above the base of hook (Pl. 1, Figs 2 and 6; Pl. 4, Fig. 6), one of its corners being as a rule somewhat larger. An elongate elevation of the interridge surface, probably corresponding to the median longitudinal ridge (Pl. 2, Fig. 3; Pl. 4, Fig. 6) may sometimes be observed between longitudinal ridges in the proximal part of shaft.

According to Kulicki & Szaniawski (1972), the longitudinal ridges represent a boundary between the part of hook covered with soft tissues and that devoid of it, while the orbicular scar is a line of the base of hood.

The base of hook is elongate and obliquely truncate, much the same as in all other Recent hooks, the supraopening area, taking nearly a half of the length of base being relatively long.

The basal opening is narrow and elongate. The pseudopulp cavity is visible from the proximal part of base up to the distal part of uncinus.

The general shape of hooks and the size proportions of uncinus, shaft and base are variable. Forms, having a long, sickle-shaped uncinus, gradually turning into shaft, are predominant. They are similar to the fossil genus *Falcunus* Kulicki & Szaniawski. A distinct bend of the outer edge of hook, similar to that in the genus *Paraglycerites* Eisenack, occur in several forms. The uncinus of some hooks are arranged at an almost right angle to the shaft, being similar in this respect to the genus *Deinuncus* Kulicki & Szaniawski, 1972 (Pl. 2, Fig. 3; Pl. 4, Figs 1 and 6). A small, dumpy form from the Gogolin Beds (Pl. 1, Fig. 5) is similar to the hooks described by Wilczewski (1967) form the Upper Muschelkalk of Germany.

All the hooks are secondarily flattened and their walls most frequently adhere to each other. Hooks like a narrow ellipse in transverse section are rare.

TAXONOMIC POSITION

The hooks, described in the present paper, display the greatest similarity to the genus *Arites* Kozur, 1967, originally assigned to the scolecodonts and to the arm hooks of *Phragmoteuthis? ticinensis*, described by Rieber (1970) from the Anisian Ladinian boundary in Switzerland. The assignment of the genus *Arites* to the arm hooks of cephalopods (*cf.* Kulicki & Szaniawski 1972) does not now seem to arouse any doubts.

In 1972, G. Pinna described a well-preserved specimen of Coleoidea from the Sinemurian of Lombardy, which bears impressions of nine arms with double rows of hooks. Some of these hooks may be identified with the species of the genus *Arites* (*A. vulgaris* and *A. keuperianus* Kozur), some other are similar to *Phragmoteuthis? ticinensis* and *Phragmoteuthis bisinuata* (Bronn). The lastnamed species was found in the Raibl Beds (Bronn 1859).

On the above discussed basis it may be suggested that the arm hooks under study belong to Triassic representatives of the order Phragmoteuthida.

REMARKS ON STRATIGRAPHIC VALUE OF ARM HOOKS

The so far described representatives of the order Phragmoteuthida include species whose arm hooks differ in size and shape. However, it is only the shape which is subject to differentiation within one and the same species, e.g. *Phragmoteuthis? ticinensis* and *P. bisinuata* (*cf.* Kulicki & Szaniawski 1972). These authors believe that, in this connection, the arm hooks of the Phragmoteuthida may be of a stratigraphic importance.

On the other hand, some of the Phragmoteuthida display a far-reaching differentiation in size and shape of hooks even within the range of one row of hooks on particular arms (Pinna 1972).

In addition, it may be expected that, much the same as Recent calmars, the Phragmoteuthida might display a sexual dimorphism expressed also in a differentiation of hooks. It seems, therefore, that, with the present state of knowledge of the Phragmoteuthida, the arm hooks of these Coleoidea cannot be used for stratigraphic purposes.

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HACZYKI GŁOWONOGÓW Z WAPIENIA MUSZLOWEGO POLSKI

(Streszczenie)

W dolnym i górnym wapieniu muszlowym południowej Polski, w materiale pochodzącym z wierceń (fig. 1 i 2) stwierdzono obecność 112 haczyków głowonogów. Występują one w warstwach gogolińskich (wiercenie Wierchlesie) oraz w warstwach wilkowickich i boruszowickich (wiercenia Pietraszów, Tworóg i Bełchatów), w rozmaitych typach osadów (*por.* fig. 1—3).

Plan budowy badanych haczyków jest podobny do schematu podanego przez Kulickiego i Szaniawskiego (1972, s. 387, Fig. 4). Każdy z haczyków posiada wałeczek okrężny (*orbicular scar*), który jest linią podstawy kaptura, oraz krawędzie podłużne (*longitudinal ridges*) będące granicą między częścią haczyka okrytą tkankami miękkimi a pozbawioną ich (*por.* Kulicki & Szaniawski 1972).

Wielkość i kształt haczyków są zróżnicowane (pl. 1—4). Niektóre posiadają pewne cechy morfologiczne podobne do cech kopalnych rodzajów *Deinuncus* Kulicki & Szaniawski, *Urbanekuncus* Kulicki & Szaniawski oraz *Paraglycerites* Eisenack (*por.* pl. 1, fig. 2; pl. 2, fig. 3; pl. 3, fig. 3, 5; pl. 4, fig. 1, 6). Wykazują jednak największe podobieństwo do rodzaju *Arites* Kozur, 1967, oraz do haczyków *Phragmoteuthis? ticinensis* opisanego przez Riebera (1970) z pogranicza anizyku i ladynu Szwajcarii.

Uwzględniwszy obecny stan wiedzy o Phragmoteuthida można stwierdzić, że opisywane tu haczyki należą prawdopodobnie do którejś z form tego rzędu kopalnych Coleoidea.

Wydaje się ponadto, że do celów stratygraficznych haczyki głowonogów nie mogą być obecnie użyte, gdyż istnieją formy Phragmoteuthida posiadające haczyki jednakowego kształtu na wszystkich ramionach [*Phragmoteuthis bisinuata* (Bronn) i *Phragmoteuthis? ticinensis* Rieber] oraz inne, gdzie haczyki wykazują zasadnicze różnice morfologiczne nawet w obrębie jednego ramienia (Pinna 1972).

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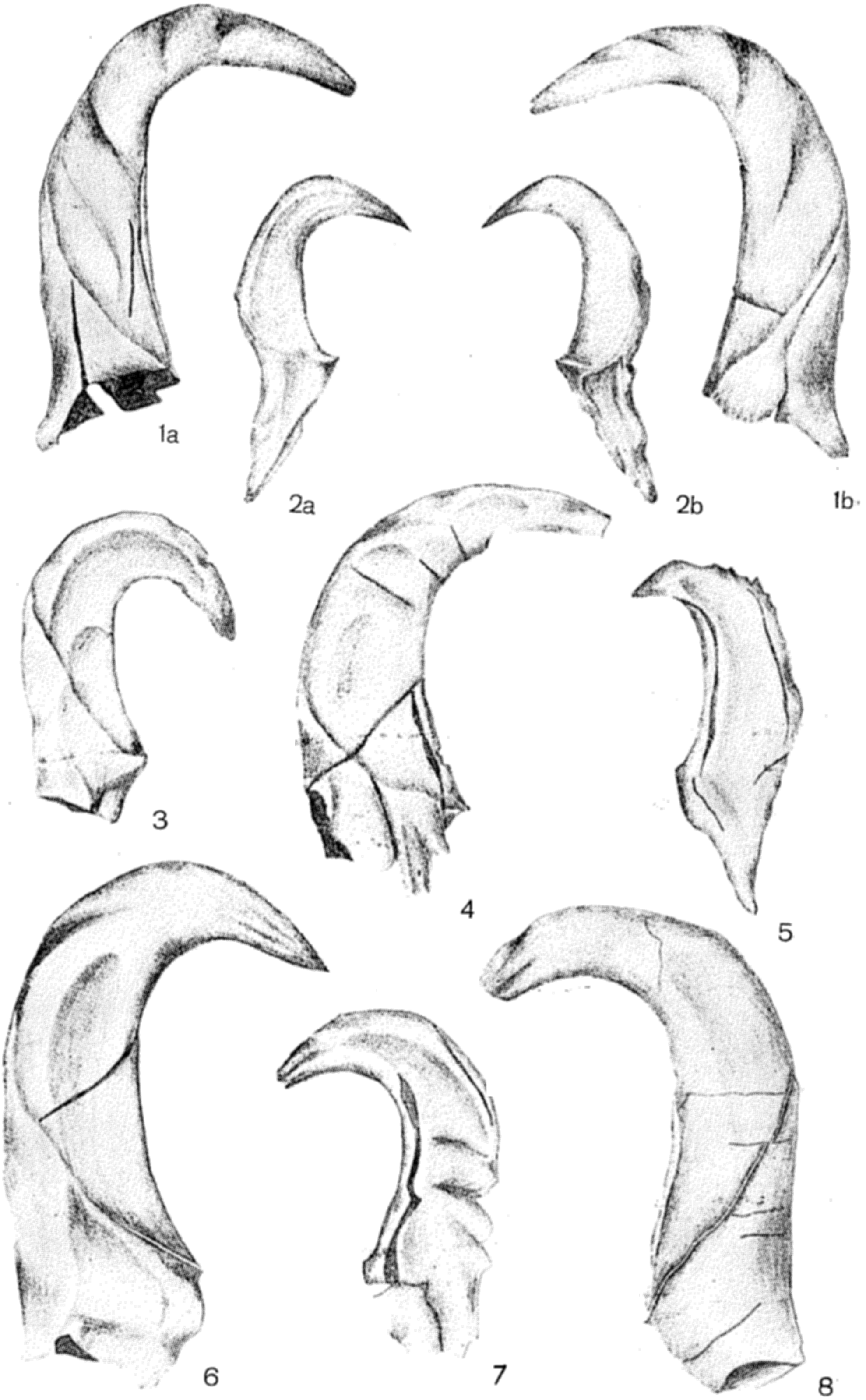
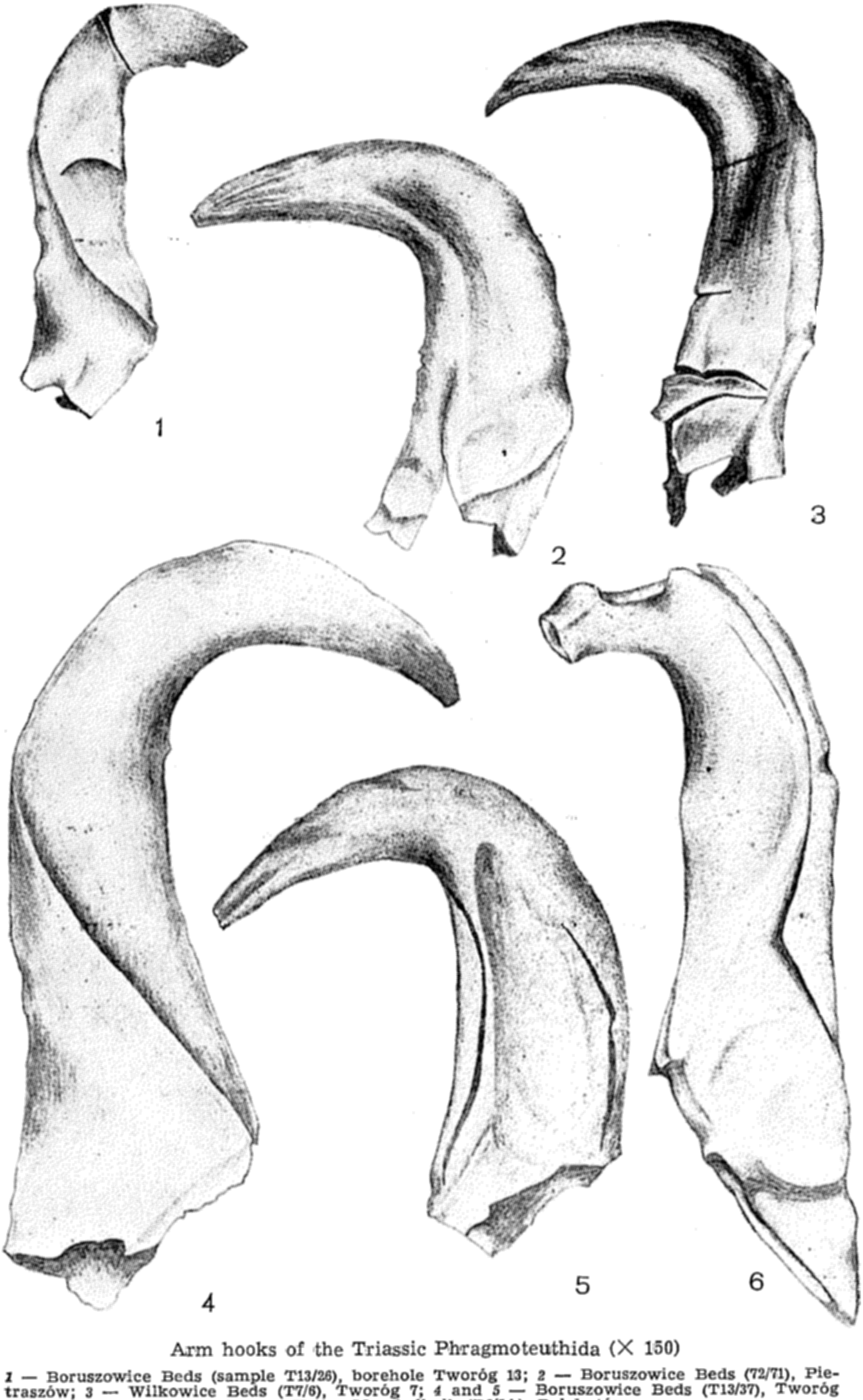


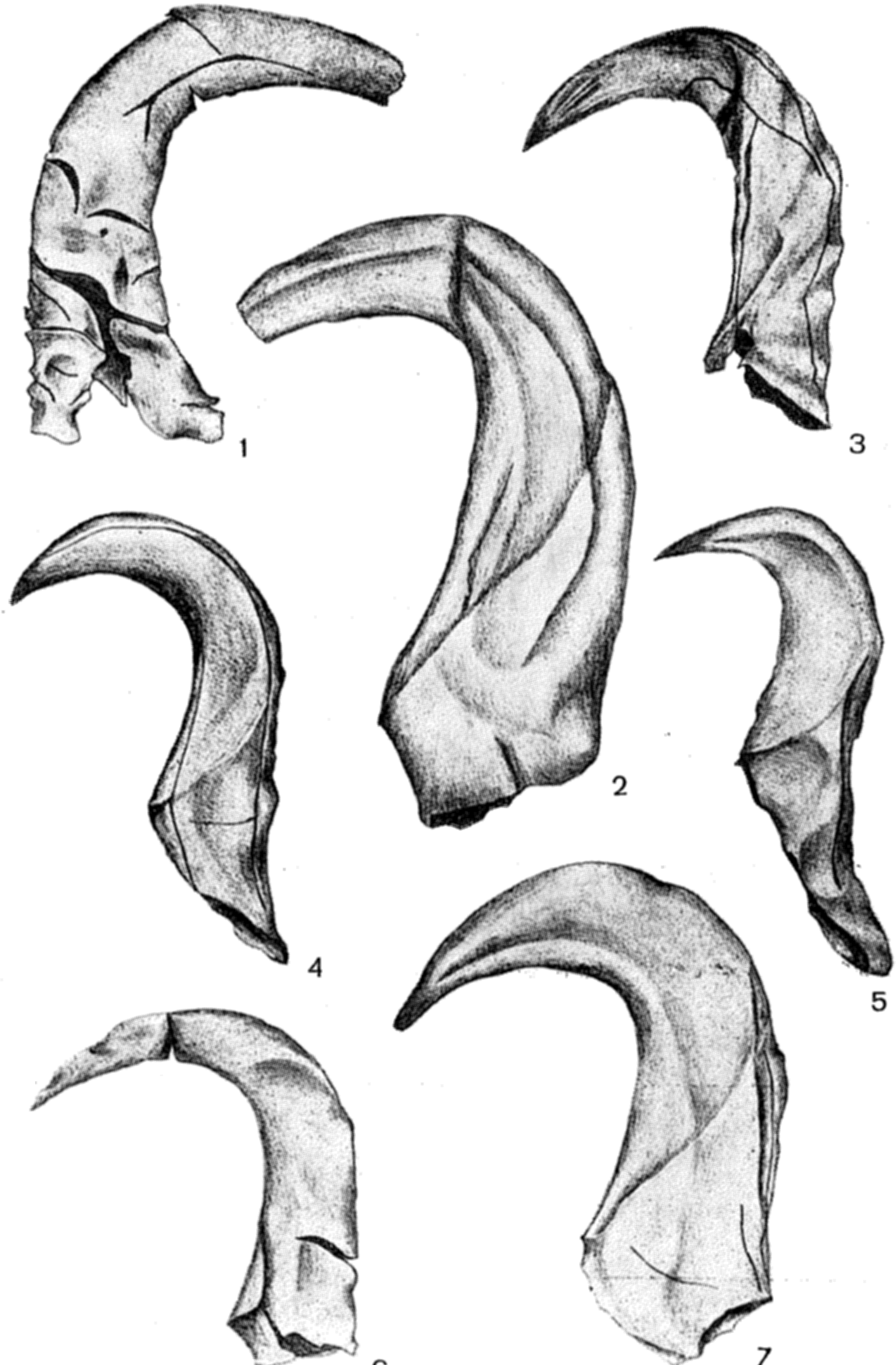
Arm hooks of the Triassic Phragmoteuthida (× 150)

1 — Wilkowice Beds (sample T7/13), borehole Tworóg 7; *2* — Gogolin Beds (131/71), Wierchlesie; *3* — Wilkowice Beds (T7/6), Tworóg 7; *4* — Boruszowice Beds (92/71), Pietraszów; *5* — Gogolin Beds (129/71), Wierchlesie; *6* — Boruszowice Beds (72/71), Pietraszów; *7* — Boruszowice Beds (92/71), Pietraszów; *8* — Wilkowice Beds (T13/9), Tworóg 13



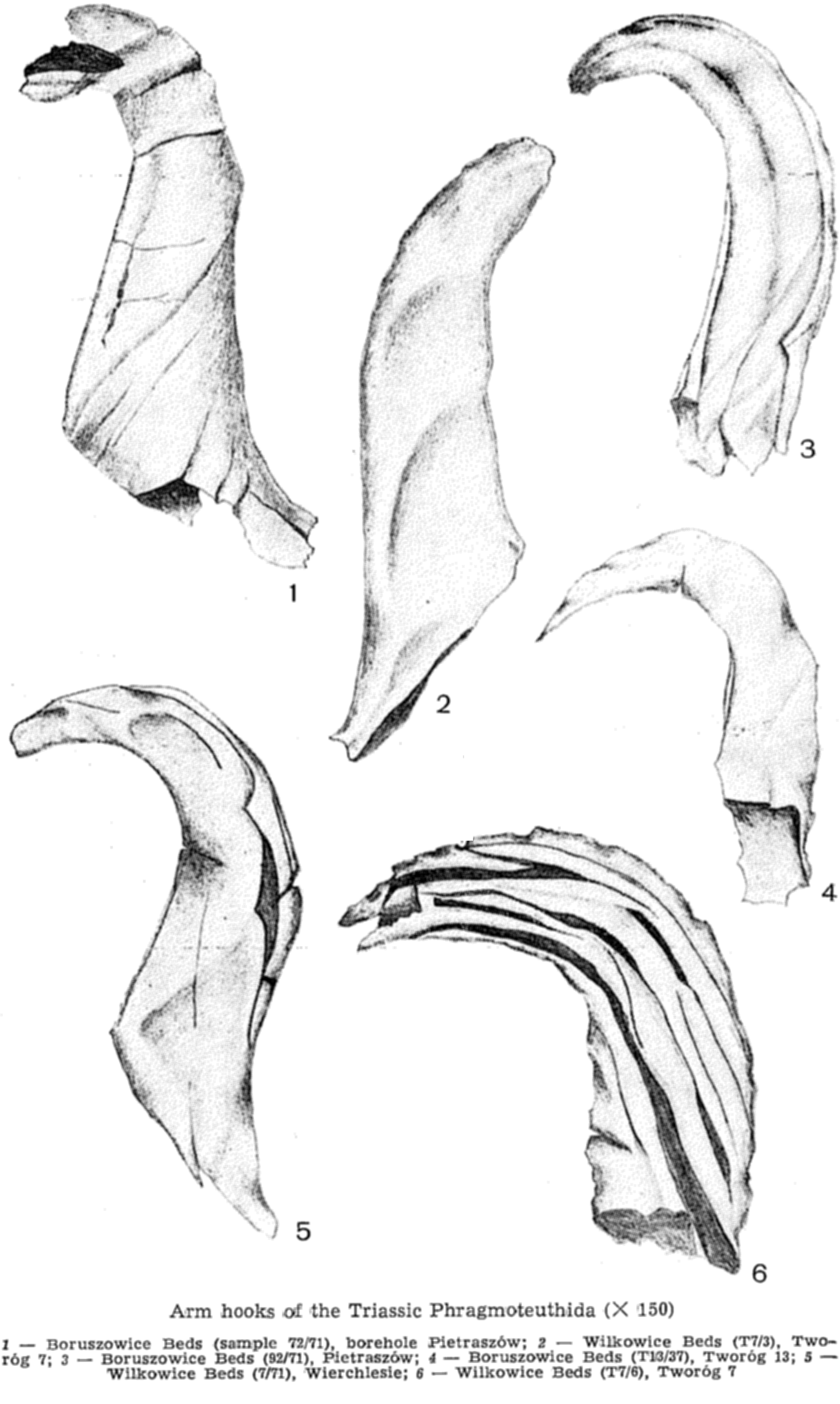
Arm hooks of the Triassic Phragmoteuthida (× 150)

1 — Boruszowice Beds (sample T13/26), borehole Tworóg 13; *2* — Boruszowice Beds (72/71), Pietraszów; *3* — Wilkowice Beds (T7/6), Tworóg 7; *4* and *5* — Boruszowice Beds (T13/37), Tworóg 13; *6* — Upper Muschelkalk (B6/5A), Bełchatów



Arm hooks of the Triassic Phragmoteuthida (× 150)

1 — Upper Muschelkalk (sample B6/5A), borehole Bełchatów; *2* — Wilkowice Beds (T7/6), Tworóg 7; *3* — Boruszowice Beds (T13/37), Tworóg 13; *4* — Boruszowice Beds (T7/21), Tworóg 7; *5* — Wilkowice Beds (T7/6), Tworóg 7; *6* — Boruszowice Beds (T13/37), Tworóg 13; *7* — Wilkowice Beds (T7/6), Tworóg 7



Arm hooks of the Triassic Phragmoteuthida (× 150)

1 — Boruszowice Beds (sample 72/71), borehole Pietraszów; *2* — Wilkowice Beds (T7/3), Tworóg 7; *3* — Boruszowice Beds (92/71), Pietraszów; *4* — Boruszowice Beds (T13/37), Tworóg 13; *5* — Wilkowice Beds (7/71), Wierchlesie; *6* — Wilkowice Beds (T7/6), Tworóg 7