Middle Triassic juvenile terebratulids

*Angustothyris angustaeformis* (Boeckh) from the Żebrak borehole, eastern Poland

**ABSTRACT:** Four early stage of brachidium development are recognizable in juvenile terebratulids attributable to the species *Angustothyris angustaeformis* (Boeckh) from the Middle Triassic (Lower Muschelkalk) pierced by the Żebrak borehole, Podlasie region, viz.: (1) precentronelliform, (2) centronelliform, (3) close to quasipremagadiniform and (4) close to quasimagadiniform.

**INTRODUCTION**

The sedimentary sequence of the upper part of the Lower Muschelkalk in the borehole Żebrak IG-1 near Siedlce, Podlasie region, eastern Poland (Text-fig. 1), contains numerous juvenile terebratulids, the length of which ranges from 0.25 to 4.0 mm. Their preservation state enabled the studies of the internal morphology, as such young specimens of Triassic terebratulids were found for the first time in Poland (Popiel-Barczyk & Senkowiczowa 1981). They are also rare in other countries; for instance, the smallest juvenile terebratulids of Lower and Middle Triassic age in the Soviet Union (north-western Caucasus, south-eastern Pamir) and Bulgaria, analyzed by Dagis (1972), were slightly over 1 mm long.

The juvenile terebratulids are also known from the Paleozoic formations: Upper Carboniferous Magdalena Formation of New Mexico (United States) where primitive terebratulids of the family *Mutationellidae* Cloud, 1941, were found (Cooper 1957), and Permian of the Caucasus (Soviet Union), for which Dagis (1972) described the representatives of the family *Labaiidae* Lakharev, 1960.
The Mesozoic formations contain also the juvenile terebratulids. The family Zeilleridae Röller, 1915, is known from the Middle Jurassic deposits of England (Baker 1972), whilst within the Upper Cretaceous chalk of the Isle of Rügen, the representatives of the families Terebratulidae Gray, 1840, Cancellothyridae Thomson, 1928, Dallinidae Beecher, 1893, and Terebratellidae King, 1850, were recognized (Steinich 1965).

In the borehole Zebrak IG-1 the Middle Triassic sediments with juvenile terebratulids occur at the depth of 976.0—1010.0 m and are represented by limestones, marls and clayey marlstones. At the depth of 1005.0 m there occurs a shelly conglomerate, composed of shell pieces of the terebratulids, spiriferids and of the pelecypods, particularly Plagiostoma striatum (Schlotheim), associated with such abundant microfossils as Spirorbis valvata Berger, holothurian sclerites, crinoid ossicles, echinoid spines, fragments of ophiuroids, spicules of calcareous sponges, and foraminifers, ostracodes, fish scales and teeth (Senkowiczowa 1958, 1972). The sedimentary area of the Podlasie region was located (Senkowiczowa & Szyperko-Sliwczynska 1972) within a littoral zone at the eastern shores of the Middle Triassic sea that occupied Central Europe at that time (Text-fig. 1).

The analyzed collection is stored in the Museum of the Geological Survey of Poland, Warsaw, at a catalogue number MUZ IG 1398 II. Photos of specimens were done by D. Oleksiak and K. Ilska, Geological Survey, and by M. Małachowska-Kleiber and L. Dwornik in the Museum of the Earth, Polish Academy of Sciences.

---

Fig. 1. Location and lithologic profile of Triassic deposits pierced by the borehole Zebrak IG-1; indicated is the sea extent of the Lower Muschelkalk in Poland
1 sandstones, 2 marlstones and claystones, 3 marls, 4 limestones, 5 wavy limestones, 6 oolitic limestones, 7 coquinas, 8 horizon with juvenile terebratulids
MATERIALS AND METHODS OF INVESTIGATION

After a clayey marlstone was dissolved in water, about 200 specimens of terebratulids were received. Their shell length ranges from 0.25 to 20.0 m. Among the analyzed material there are common juvenile specimens (shell length to 4.0 m), rare young specimens (shell length of 4.0—10.0 mm), and a few adult specimens.

An attribution of the specimens with their shell lengths over 10.0 mm for the mature ones is arbitrary, as some genera of Triassic terebratulids possess a mature loop already in the shells 10.0 mm long (Dagis 1972), whereas the loop development in some Jurassic specimens happens at much smaller lengths of the shells (Baker 1972).

The juvenile specimens have a diversified outer shape. Some of them display a circular or slightly transversally oval brachial valve whereas the others, have it longitudinally oval (Text-fig. 2 and Pl.1, Figs 1—5).

Fig. 2
Variability of shell outlines of juvenile terebratulids from Zebrok: A — specimens with oval brachial valves, B — specimens with circular brachial valves

After being boiled in balsam, the specimens filled with sediments were sectioned perpendicularly to the lateral commissure. The specimens with empty interiors were photographed in a transmitted light in immersion liquids. Among the sectioned specimens, 11 could be reconstructed: 6 represented the juvenile specimens whereas 2 were young and 3 were mature ones.

Observations of the shell interiors of the empty specimens and the reconstruction of those sectioned enable to recognize the very early development stages of the brachidium.
DEVELOPMENTAL STAGES OF BRACHIDIUM

STAGE I

Juvenile specimens with their shell lengths from 0.25 to 1.0 mm, with distinct triangular shapes and a sulcus on the anterior of the brachial valve, prove in a transparent light a presence of two longitudinal ribbon-like lamellae that hang freely at a hinge margin inside the valve. These elements are not connected with each other (Text-fig. 3A and Pl. 2, Figs 9—12). They are considered for the initial growth stage of two descending branches of the loop, still before they got jointed.

The comparable early developmental stages of the loop were noted in:

- Upper Cretaceous juvenile specimens of Chatwinothyris subcardinalis Sahni and Magas chitiniformis Schlotheim from the Isle of Rügen (Steinich, 1965, p. 43 and 190, Text-figs 29—30 and 287—292) with their shell length to 2 mm;
- Middle Jurassic terebratellids from the south-western England (Baker 1972, p. 456; Text-figs 2A, 3A and Pl. 83, Figs 13—16), viz. in Zeilleria leckenbyi (Davidson), the minimum shell length of which was about 1.0 mm;
- Upper Carboniferous terebratulids from the North America, viz. in Cryptacanthia prolifera Cooper, the minimum shell length of which was equal 1.0 m (Cooper 1957, p. 8; Pl. 2A, Fig. 1).

In spite of an excellent documentation, such early stages of a loop development have not been named by Steinich (1965) either for terebratulids or for terebratellids. The terms of early stages of the loop development applied by Baker (1972, p. 459) for Middle Jurassic terebratellids, cannot be used for the specimens from Žebrak as the latter do not possess in these stages any element at the floor of the brachial valve. Therefore, the term “precentronelliform”, applied by Cooper for the terebratulid genus Cryptacanthia seems to be most adequate for the smallest and probably the youngest specimens from Žebrak, with their loop described as the stage I. Dagis (1968, 1972, 1974) when dealing with the ontogeny of Triassic terebratulids, has not analyzed the stages preceding the “centronelliform” stage.

STAGE II

The majority of juvenile specimens with their length from 1.0 to 4.0 mm possess triangular-shaped shells with a sulcus at the anterior of the brachial valve. The empty as well as sectioned shells contain loops at the “centronelliform” stage (Text-figs 3B and 4; Pl. 3, Figs 1—7). A loop, composed of two jointed descending branches, has a small echinoderm-like swelling in the centre of the frontal part. It was noted in empty specimens, the length of which was up to 2 mm. Slightly larger sectioned specimens (over 2.0 mm) bear a well developed vertical plate (Text-figs 3B and 4). A loop length of smaller as well as of larger specimens is close to or greater than a half length of the brachial valve. The sectioned specimens present also other elements of the internal
morphology: high inner socket ridges and early developed septalium in the brachial valve, as well as a distinct pedicle collar and hinge teeth without dental plates in the pedicle valve (Text-fig. 4).

The centronelliform stages of the loop development are noted for many genera of fossil terebratulids (Cloud 1942; Cooper 1957; Dagens 1968, 1972, 1974; Usnarska

Fig. 3. Development stages of brachidium of juvenile *Angustothyris angustaeformis* (Boeckh) from Zebrik; A — drawings from empty specimens with the loop at the "precentronelliform" stage, B — reconstructions from sectioned specimens with the loop at the "centronelliform" stage, C — reconstruction from a sectioned specimen with the loop at the stage close to the "quasipremagadiniform" stage, D — reconstruction from a sectioned specimen with the loop at the stage close to the "quasipremagadiniform" stage.
Among the Triassic forms, the material from Żebrak can be compared, there are the following genera: *Angustothyris* Dagis, *Coenothyris* Douvillé, *Fletcherithyris* Campbell, and *Plectoconcha* Cooper.

Basing on internal shell characters of the sectioned specimens from Żebrak, the greatest similarities were found to occur with young specimens of *Angustothyris angustaeformis* (Boeckh) from the Anisian deposits of the north-western Caucasus (Dagis 1972, p. 34, Text-figs. 11—14). Among the above mentioned genera, *Coenothyris* displays also a great conformity of the loop appearance in the centronelliform stage with the one of the specimens from Żebrak. In the genus *Coenothyris*, however, this stage was noted for the specimens considerably larger, 4.9 mm in shell length (Usnarska-Talerzak 1981). Besides, the presence of dental plates in this genus has not yet been clarified. The two other genera display the centronelliform stages at slightly smaller dimensions.

---

Fig. 4. Serial transverse sections of juvenile specimen *A. angustaeformis* (Boeckh) with the loop at the "centronelliform" stage; shell is 2.2 mm long and 2.0 mm wide.
of the shell. In *Fletcherithyris*, the specimens with their shell lengths of 2.5 mm have dental plates (Dagis 1972, p. 32, Fig. 9a), whilst *Plectoconcha* has no septalium but is well ribboned (Dagis 1972, p. 28, Figs 5—6).

A more advanced stage of the loop development was noted in one of the empty specimens, with its length below 2.0 mm (Pl. 4, Fig. 4). This stage is comparable with those described below and typical of the specimens over 4.0 mm long. The specimen is triangular, with a transversally oval-shaped brachial valve.

**STAGE III and following**

The specimens with shell length close to 4.0 mm or slightly larger, possess accessory elements on the vertical plate: swellings visible in loops of empty specimens (Pl. 4, Figs 1—3) and appendices in the sectioned specimens (Text-fig. 3C). The frontal part of the loop in specimens with their shells over 5.0 mm long is also distinctly divided into the left and right side (Text-fig. 3D and Pl. 4, Figs 4—5). The other
elements of the internal morphology, i.e. high inner socket ridges, septum and teeth devoid of dental plates, remain without any change.

The internal characters of the investigated shells are similar to those of *Angustothyris angustaeformis* (Boeckh), described by Dagis (1972, p. 45) as the stages following the "centronelliform" stage. For the latter,

![Diagram of serial transverse sections of young specimen of A. angustaeformis](image)

**Fig. 6.** Serial transverse sections of young specimen *A. angustaeformis* (Boeckh) with the loop at the stage close to the "quasimagadiniiform"; shell is 6.8 mm long and 4.8 mm wide.

Dagis introduced the terms that suggest similarities to typical developmental stages of the loop in the dailinids and terebratellids. Thus, the loops of the empty specimens (Pl. 4, Figs 1—3) and of a sectioned one (Text-figs 3C and 5) are considered as close to the "quasimagadiniiform" stage at which the accessory hood-like elements start growing. They are comparable with loops labelled as 4b by Dagis (1974, p. 45, Fig. 163). The loops with a marked initial division into right and left sides (Text-figs 3D, 6 and Pl. 4, Figs 4—5) are considered as close to
the "quasimagadiniform" stage, comparable with loops 4g in the Dagis's scheme.

Fig. 7: Serial transverse sections of mature specimen with dental plates; shell is 13.7 mm long and 12.5 mm wide and presumably belongs to Zeilleria edingeri (Assmann)
The mature forms of *Angustothyris angustaeformis* (Boeckh) have a short loop, without a distinct division of its branches into descending and ascending ones, developed according to the scheme considered by Dagis (1974) as the "angustothyrid" type of the loop.

Fig. 8. Serial transverse sections of mature specimen without dental plates; shell is 13.0 mm long and 13.1 mm wide and presumably belongs to *Angustothyris angustaeformis* (Boeckh)
FINAL REMARKS

The primarily juvenile forms of the species *Angustothyris angustaeformis* (Boeckh) occur among the investigated terebratulids. Although the internal shell morphology of three specimens, considered for mature ones, has not been reconstructed fully, these forms (Pl. 1, Figs 6—7), were found to represent even two genera as the dental plates were either present or absent. Two specimens, provided for the dental plates (Text-fig. 7), may belong to the species *Zeilleria edlingeri* (Assmann). The third specimen, without dental plates (Text-fig. 8), belongs presumably to *Angustothyris angustaeformis* (Boeckh), the same as the juveniles do.

An attribution of this specimen to *A. angustaeformis* is partly supported by a similarity of its shell width and thickness indices to these of *Waldheimia angustaeformis* described by Boeckh (1873, p. 173) from the Middle Triassic (Recoarokalk) at Köveskala, Tihany Peninsula in Hungary. These indices show a greater similarity than those of the specimen *Angustothyris angustaeformis* (Boeckh) from the Anisian of the Caucasus, reported by Dagis (1974, Pl. 48, Fig. 1) and of the specimen

![Map showing the occurrence of representatives of the family Angustothyrididae in Europe](image-url)

Fig. 9. Occurrence of representatives of the family *Angustothyrididae* in Europe (after Dagis, 1974; modified)

1 — extent of the marine sediments of Middle Triassic age; 2 — localities with representatives of the family *Angustothyrididae*
Aulacothyris angustaeformis (Boeckh) from the turn of the Anisian and Ladinian of the Tatra Mts (Kotanński 1973, Pl. 2, Fig. 8).

Amidst these three mature forms from Żebrak there is no Coenothyris vulgaris (Schlothuheim), commonly cited for Middle Triassic. This species, which has not yet been revised, probably collects the specimens of various species or even genera of similar shell shapes. Some authors (Koschinsky 1878, Bittner 1890, Kirchner 1934) mention for instance a presence of dental plates as diagnostic features of C. vulgaris, whereas the others note their absence (Muir-Wood 1965). There is also an opinion (Nowakowski 1972, Dagiš 1974) on a varying development of dental plates in C. vulgaris.

A preservation of juvenile specimens of Angustothyris angustaeformis (Boeckh) proves them to have been buried in the same place they had lived. Destructed and crumbled mature specimens that form, together with other faunistic remains, a shelly conglomerate, have been most probably transported from distant areas.

The recognition of juvenile specimens of Angustothyris angustaeformis (Boeckh) extends the geographic distribution of this species in Poland from the Tatra Mts (Kotanński 1973) and Upper Silesia (Usnarska-Tażerzak 1981) to the Podlase region. It also extends the distribution of the whole family Angustothyridae sensu Dagiš 1974, Fig. 167) from the Tethyan realm further to the north (Text-fig. 9).

**REFERENCES**


NOWAKOWSKI E. 1972. *Coenothyris vulgaris* (Schlotheim) in warstw terebratulowych dolnego wapienia muszlowego Strzelc Opolskich. [Unpublished M. Sc. thesis; Faculty of Biology, University of Warsaw.]


E. POPIEL-BARCZYK i H. SENKOWICZOWA

**JUWENILNE TEREBRATULIDY ŚRODKOWEGO TRIASU Z OTWORU WIERTNICZEGO ŻEBRAK NA PODLASIU**

(Streszczenie)

Przedmiotem pracy jest analiza juwenilnych terebratulidów z osadów dolnego wapienia muszlowego napotkanych w wierceniu Żebrak IG-1 na Podlasiu (fig. 1—2). Stan zachowania okazów pozwaloli na zbadanie wnętrza muszli najmniejszych form o długości od 0,25 do 4,00 mm metodą szlifów seryjnych (fig. 3—8) oraz przegląda-

niaw cieczach imersyjnych okazów pustych (pl. 2—4). Poznalo w ten sposób bar-

dzo wczesne stadia rozwoju aparatu ramieniowego, identyfikując wśród nich następujące: 1 stadium „precentronelliform”, 2 stadium „centronelliform”, 3 stadium zbliżone do „quasipremagadiniform”, oraz 4 stadium zbliżone do „quasimagadiniform”. Analiza budowy aparatu ramieniowego w stadiach 2, 3 i 4 pozwoliła stwierdzić, że badane juwenilne terebratulidy należą do gatunku *Angustothyris angustaeformis* (Boeckh). Znalezienie *A. angustaeformis* (Boeckh) na obszarach Podlasia przeci-

suwa dotychczas znana granicę występowania tego gatunku w Polsce oraz rozsze-

rza zasięg rozprzestrzenienia rodziny Angustothyrididae w Europie (fig. 9).
1–5 — Angustothyris angustaeformis (Boeckh), juvenile specimens with circular (1, 2, 5) and oval (3, 4) brachial valves; 5 — interior, visible are crural bases and high inner socket ridges; 1 and 5 — ×10, 2 and 3 — ×40, 4 — ×5; 6a — mature specimen presumably of Zeilleria edlingeri (Assmann), ×2.5; 7b — mature specimen presumably of Angustothyris angustaeformis (Boeckh), ×2.5

a — brachial and b — pedicle valve views
1—12 — *Angustothyris angustaeformis* (Boeckh), 1—5 — smallest juvenile specimens, 6—8 — interiors of brachial valves (SEM); 1 — ×78, 2 and 4 — ×90, 3 — ×120, 5 — ×47, 6 — ×21, 7 — ×60, 8 — ×51; 9—12 — specimens with their loop at the "precentronelliform" stage (transmitted light), 9—11 — ×70, 12 — ×40; 13 — interior of juvenile brachial valve, presumably of *Zeilleria edingeri* (Assmann), ×32 (SEM)
1-7 — Angustothyris angustaeformis (Boeckh), juvenile specimens with their loop at the "centronelliform" stage (transmitted light), 1 and 3 — ×47, 2 — ×40, 4 and 5 — ×50, 6 and 7 — ×60
1—6 — Angustothyris angustaeformis (Boeckh), 1—3 — juvenile specimens with their loop at a stage close to the "quasipremagadiniiform", 1 — \( \times 50 \), 2 and 3 — \( \times 40 \); 4 and 5 — juvenile specimens with their loop at a stage close to the "quasimagadiniiform", 4 — \( \times 55 \), 5 — \( \times 17 \) (transmitted light); 6 — specimen from Fig. 5 (reflected light), \( \times 6 \)