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A transitional stringocephalid from the Holy Cross Mountains, Poland, and its evolutionary and stratigraphic significance

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ABSTRACT:

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Stringocephalini gen. et sp. indet. A shows microscopic capillae on both valves, possibly representing a transitional evolutionary stage between smooth-shelled *Stringocephalus* and capillate *Parastringocephalus*. The latter genus seems therefore to have originated directly from *Stringocephalus*, and not via *Subsinucephalus*, as suggested earlier. The occurrence of Stringocephalini gen. et sp. indet. A indicates an early Givetian age of beds cropping out at Błonia Sierżawskie near Świętomarz.

Key words: Stringocephalidae, Brachiopoda, Givetian, Evolution, Stratigraphy, Holy Cross Mountains.

INTRODUCTION

"*Stringocephalus burtini*" had long been a catch-all name for Givetian thick-shelled brachiopods, and the family is a classic index fossil of Givetian strata worldwide. Refinement of the taxonomy of the family Stringocephalidae by STRUVE (1992) provided diagnosis of the genus *Stringocephalus*, and established new taxa such as *Parastringocephalus*, *Subsinucephalus*, and *Stringodiscus*, constituting the tribe Stringocephalini. STRUVE proposed an evolutionary scenario according to which *Parastringocephalus* derived from *Subsinucephalus* through the appearance of capillae, and the evolution of *Subsinucephalus* from *Stringocephalus* via development of sulci. However, a single specimen from Świętomarz (Holy Cross Mountains, Poland), described below as Stringocephalini gen. et sp. indet. A, suggests that *Parastringocephalus* may have originated directly from the genus *Stringocephalus*. The object of the present paper is therefore to suggest an alternative evolutionary scenario for the Stringocephalini, and to outline a proposed biostratigraphic correlation of beds in which the described specimen was found.

GEOLOGICAL SETTING

The toponym "Błonia Sierżawskie" denotes an enlargement of the valley on the eastern side of the Psarka river, north of Świętomarz village. The same name has been used among geologists to describe only the exposure of the Skały Beds in the immediate

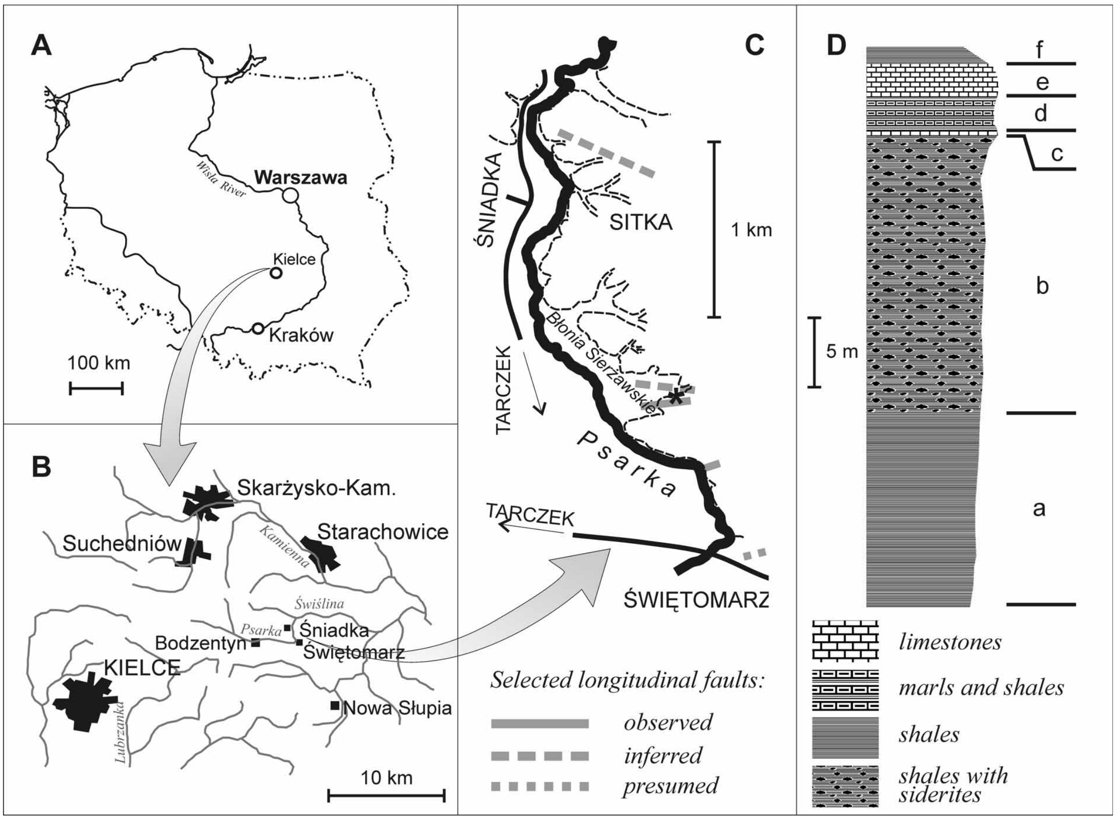


Fig. 1. A-C, Localisation of collecting locality on a schematic map of Poland (A), of the north-western part of the Holy Cross Mts. (B), and of the Świętomarz-Śniadka section (C): the dotted black line indicates the escarpment bordering the Psarka river valley, and the asterisk denotes the described locality. D, Lithological column at the locality (after HALAMSKI, 2004)

proximity of a low cliff forming the south-eastern border of the valley (see Text-fig. 1C), an outcrop already discovered by SOBOLEW (1904). The lithological sequence is cut at the top and in bottom by faults (Text-fig. 1D). The upper limestones ("e") form the above-mentioned low cliff. The specimen was found in rubble under the cliff. Remains of red matrix around the shell allow it to be assigned to the shales ("f").

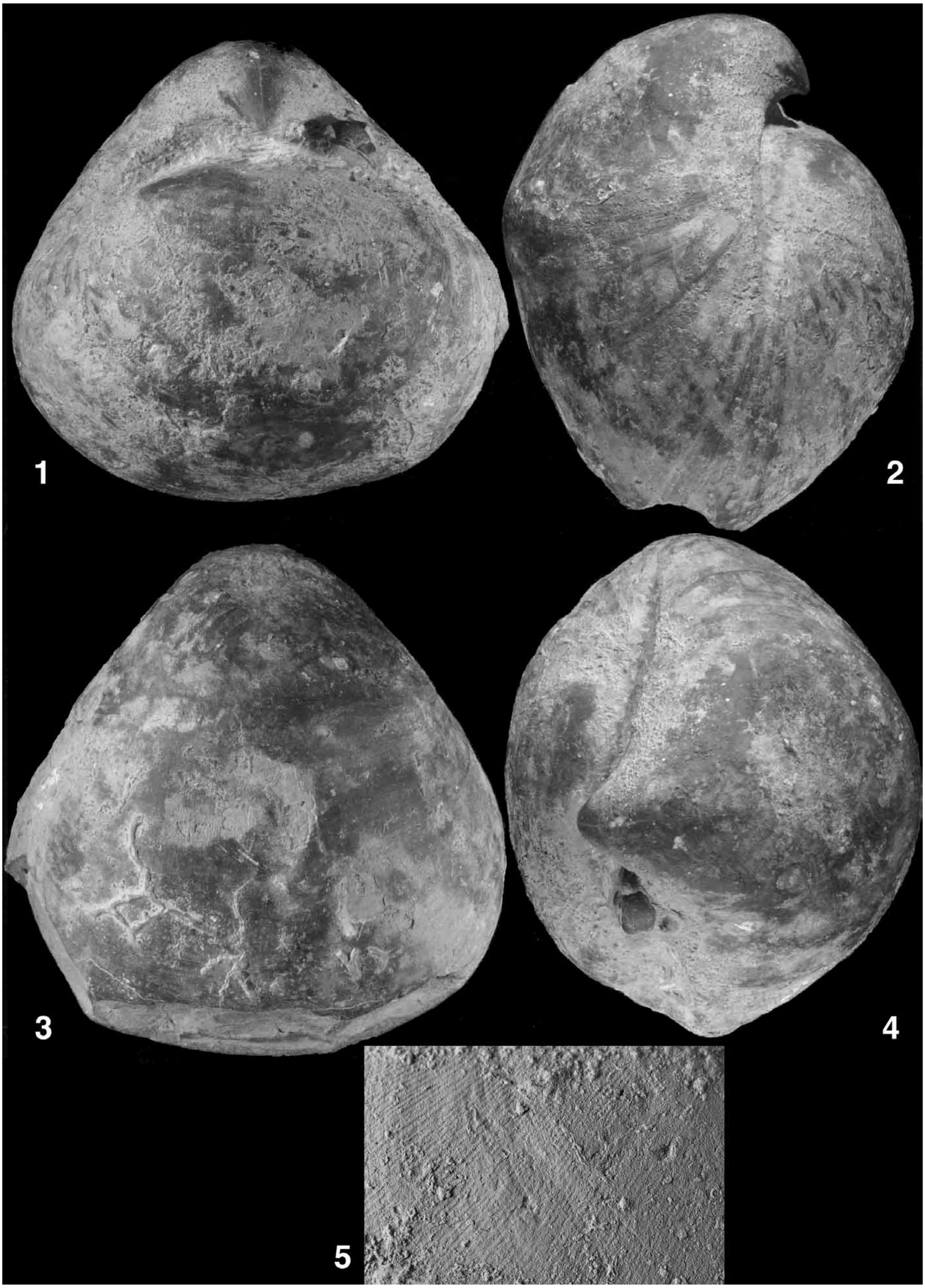
SYSTEMATIC PALAEONTOLOGY

Family Stringocephalidae KING, 1850
Subfamily Stringocephalinae KING, 1850
Tribe Stringocephalini STRUVE, 1992
Stringocephalini gen. et sp. indet. A
(Text-figs 2.1-2.5)

MATERIAL: One articulated shell, anterior region partly missing, otherwise well preserved, from the outcrop at Błonia Sierżawskie (Museum of the Faculty of Geology, Warsaw University, coll. number MWG 009628).

DESCRIPTION: Shell very large (length 98 mm; width 96 mm; thickness 81 mm), approximately as long as wide, markedly ventribiconvex (the ventral valve making 62% of the total thickness). Maximum width slightly anteriorly to midlength of the dorsal valve. Maximum thickness of the ventral valve (50 mm) slightly posteriorly to midlength of the valve, that of the dorsal valve (31 mm) approximately at midlength. Neither sinus nor fold expressed. Ventral valve parabolic in anterior view; umbo thick, beak acute, strongly incurved (*ca.* 150°), not obscuring the hinge line. Ventral interarea apsacline, strongly concave. Dorsal valve slightly flattened in the median part. Dorsal interarea orthocline.

Fig. 2. Stringocephalini gen. et sp. indet. A (hypotype; Museum of the Faculty of Geology, Warsaw Univeristy, coll. number MWG 009628). Outcrop at Błonia Sierżawskie near Świętomarz. Skały Beds, "Sierżawy Member"; lower Givetian. 1-4. Articulated shell in dorsal, ventral, lateral and posterior views; × 0.9; 5. Micro-ornamentation (capillae) in the posterior region of the dorsal valve; × 10


1
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Shell macroscopically smooth, but delicate, distinct radial striae (capillae), spaced 2-3 per mm, are preserved in the posterior regions of both valves. Growth lines distinct in the posterior region, becoming gradually more marked towards the anterior margin, at 2-3 per mm.

Traces of ventral median septum visible; otherwise interior not studied.

REMARKS: It may be noted that, as far as the shape is concerned, the nearest species is *Stringocephalus wedekindi* STRUVE, 1992, from which the described specimen differs in having a less convex dorsal valve and a more incurved ventral umbo (130° in *S. wedekindi*). *S. aleskanus cormon* STRUVE, 1992 is more equibiconvex.

In lateral profile, the specimen shows an abrupt change of convexity: an almost subvertical steepening of the shell is located between two zones of normal, regular convexity. This may correspond to growth arrest or retardation, possibly in response to temporary unfavourable environmental conditions, or other factors.

EPIBIONTS: *Aulopora lataeformis* (det. M.K. ZAPALSKI), bryozoans; a cephalon of *Geesops* sp. (n.?; det. M. BASSE) and a ventral valve of *Squamulariina parva* were found attached to the described specimen.

EVOLUTION OF THE TRIBE STRINGOCEPHALINI

The tribe Stringocephalini STRUVE, 1992 is composed of four genera: *Stringocephalus* DEFRANCE, 1825; *Subsinucephalus* STRUVE, 1992; *Parastringocephalus* STRUVE, 1992; and *Stringodiscus* STRUVE, 1992. The last genus (having possibly originated from *Stringocephalus* through *Stringocephalus ciconia* CRICKMAY, 1968; STRUVE 1992) has not been found in Poland.

The other representatives of the Stringocephalini STRUVE, 1992 may be distinguished from each other by the following characters:

Character / Taxon	External form	Capillae
Stringocephalus	neither sulcus nor fold	absent
Subsinucephalus	sulcus in one or both valves	absent
Parastringocephalus	sulcus in each valve	macroscopic-size
Stringocephalini gen. et. sp. indet. A	neither sulcus nor fold	microscopic-size

The discussed specimen cannot presently be assigned to any specific genus of the tribe, as presently circumscribed.

STRUVE (1992) suggested that *Parastringocephalus* originated from *Subsinucephalus*, which can be summarized on the diagram below (Stringocephalini gen. et sp. indet. A. has been added; Text-fig. 3). However, this requires that microscopic capillae of the shell here described and capillae of *Parastringocephalus* arose independently. It seems more probable that Polish species is an intermediate evolutionary stage between smooth shells of *Stringocephalus* and distinctly capillate shells of *Parastringocephalus*. Independent evolution of sulci in *Subsinucephalus* and *Parastringocephalus* is a more plausible scenario than independent appearance of surface striae differing only in size in both taxa. The sulci in *Parastringocephalus* and *Subsinucephalus* are not necessarily homologous, being present in both valves in the former genus, and either in one or in both in the latter. Sulcation is therefore considered here to be a lesser factor in evolution, as it is in similarly large-shelled Silurian *Pentamerus* (JIN & COPPER 2000). The Polish shell may be a possible ancestor of *Parastringocephalus*, as represented on the diagram below (Text-fig. 4).

Consequently, late Eifelian to late Givetian *Stringocephalus* appear to be the direct ancestors of all other genera of the tribe *Stringocephalini*: *Parastringocephalus* (as suggested above), *Subsinucephalus*, and *Stringodiscus* (after STRUVE, 1992), all three appearing in the middle to late Givetian.

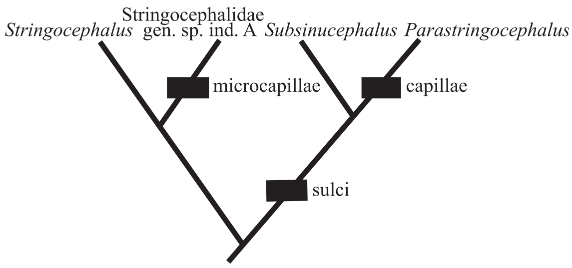

Fig. 3. Phylogeny of *Stringocephalus*, *Subsinucephalus* and *Parastringocephalus* according to STRUVE (1992). See text for further explanation

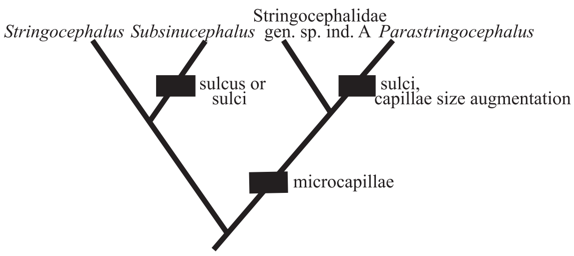

Fig. 4. Suggested phylogeny of *Stringocephalus*, *Subsinucephalus* and *Parastringocephalus*

STRATIGRAPHY

The exposure at Błonia Sierżawskie yields a rich fauna, including corals, brachiopods (28 species; but no find of representative of any stringocephalids up to date), bivalves, gastropods, trilobites, bryozoans and crinoids (SOBOLEW 1909, BEDNARCZYK 1955, HALAMSKI 2004, ZAPALSKI 2005). However, none of them is stratigraphically significant, and diagnostic conodonts are absent (KŁOSSOWSKI 1976, MALEC 1988). The exact stratigraphic position of those strata therefore remained unclear, partly for their tectonic upper and lower contact. KŁOSSOWSKI (1976, 1985) correlated them with limestones of the second threshold of the Sitka ravine; nonetheless, this correlation, based on overall facies resemblance in a region with strong lateral facies variation, remained conjectural. For example, red shales devoid of fauna ("a") have no equivalent in the Sitka profile. WORONCOWA-MARCINOWSKA's (2002) data concern only the northern part of the Świętomarz-Śniadka section.

MALEC (1988) included the discussed strata in the Givetian on the basis of the presence of the ostracod *Wideneria lispa* KESLING & CHILMAN, 1978 (neither illustrated nor described). However, this is a species previously known from a single occurrence (Silica Formation; KESLING & CHILMAN 1978); its vertical range cannot therefore be firmly established. Some ostracods described elsewhere by MALEC (in MALEC & TURNAU 1997) have different vertical ranges in the Eifel region and in the Holy Cross Mts.: this is the case for e.g. *Urftella adamczaki* BECKER, 1965 being an index fossil for the "Looghium" (*hemiansatus* Zone, basal Givetian) in the Eifel (BECKER 1998) and occurring in the Grzegorzowice-Skały section in a higher position (Lower *varcus* Zone). Given the problems of demonstrably different local ranges for ostracod taxa in the Eifel and Holy Cross Mts. areas, they are presently of limited biostratigraphic value for refined correlations.

The possibility that the strata at Błonia Sierżawskie represent lower levels than those exposed at Sitka (the latter section shows only the upper part of the Skały Beds that extend from the upper Eifelian to the lower Givetian) could therefore not be previously excluded. *Stringocephalus* is an index genus for the Givetian in Europe and America (Eifelian representatives occur only in South China; see SUN & BOUCOT 1999, STRUVE 1992). The presence of a form derived from this genus (therefore not older than it; described above) in the exposure at Błonia Sierżawskie is the first definite proof of the Givetian age of those strata. As the top of the Skały Beds is dated by conodonts to the Lower *varcus* Zone, the age of the strata occurring at Błonia Sierżawskie must be early Givetian.

CONCLUSIONS

1. A newly discovered stringocephalid shell with microscopic-scale capillae in both valves may represent an evolutionary transition between early smooth-shelled *Stringocephalus* and capillate *Parastringocephalus*. This is contrary to the view expressed by STRUVE (1992) that *Parastringocephalus* originated from *Stringocephalus* via *Subsinucephalus*.

2. The most probable evolutionary scenario for the radiation of the tribe Stringocephalini STRUVE, 1992 includes a first appearance of *Stringocephalus* in the late Eifelian of China, its almost simultaneous immigration to Europe and America (base of the Givetian), and independent origin of *Subsinucephalus*, *Parastringocephalus*, and *Stringodiscus* somewhat later in the Givetian.

3. The finding of Stringocephalini gen. et sp. indet. A is a biostratigraphic proof of the early Givetian age of beds with a rich fauna cropping out at Błonia Sierżawskie near Świętomarz (Łysogóry Region of the Holy Cross Mountains).

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