Tomagnostus brantevikensis n. sp. (Trilobita) from the middle Cambrian of Scania, Sweden

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Weidner, T. & Nielsen, A.T. 2016. *Tomagnostus brantevikensis* n. sp. (Trilobita) from the middle Cambrian of Scania, Sweden. © 2016 by Bulletin of the Geological Society of Denmark, Vol. 64, pp. 111–116. ISSN 2245-7070 (www.2dgf.dk/publikationer/bulletin). https://doi.org/10.37570/bgsd-2016-64-06

Sparse material of an agnostid trilobite, previously referred to as *Tomagnostus* cf. *corrugatus* (Illing 1916), is recognized as a new species, T. *brantevikensis* n. sp. It occurs in the middle Cambrian (≈ Cambrian provisional Series 3) *Triplagnostus gibbus* and *Acidusus atavus* zones (Almbackenian regional Stage) in Scania, southernmost Sweden, but is very rare. The new species resembles *T. corrugatus* (Illing 1916) and *T. perrugatus* (Grönwall 1902), but the cephalon is characterized by a tapering gla-bella, creating an elongate subtriangular outline, and a deltoid depression. The pygidium has an evenly rounded border, is non-spinose, and has a long axis with a non-elongate node. Both shields have a moderately wide border.

Received 25 August 2016
Accepted in revised form
11 November 2016
Published online
14 December 2016

Keywords: Trilobites, agnostids, *Tomagnostus*, middle Cambrian, Scandinavia.

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Four species of the agnostid trilobite genus *Tomagnostus* Howell 1935 are known from Scandinavia (see Grönwall 1902; Westergård 1946; Weidner & Nielsen 2009, 2014, 2015). They occur in the *Triplagnostus gibbus* and *Acidusus atavus* zones of the middle Cambrian *Paradoxides paradoxissimus* Superzone (Fig. 1), and comprise *Tomagnostus fissus* (Lundgren in Linnarsson 1879), *T. perrugatus* (Grönwall 1902), *T. sibiricus* Pokrovskaya & Egorova in Savitsky *et al*. 1972, and *T. bothrus*? Robison 1994. Overall, representatives of *Tomagnostus* are common only in Scania and Bornholm, but sporadic occurrences are known also from the middle Cambrian of Öland, Närke and the Oslo area (Westergård 1946; Høyberget & Bruton 2008; Weidner & Nielsen 2009), as well as Västergötland (TW unpublished).

The coeval species *T. gracilis* (Illing 1916) and *T. corrugatus* (Illing 1916) have not been recorded from Scandinavia. For detailed descriptions of the *Tomagnostus* species including a summary of their geographical distribution and stratigraphical ranges, see Rushton (1979), Weidner & Nielsen (2014, 2015) and, in particular, Robison (1994) who presented a comprehensive review of species assigned to *Tomagnostus*.

Tomagnostus cf. *corrugatus*, illustrated by Westergård (1946) from the *Triplagnostus gibbus* Zone of Brantevik, Scania (Fig. 2), was assigned to *T. corrugatus* by Pokrovskaya (1958), whereas Rushton (1979) considered the specimens possibly representing *T. deformis* Pokrovskaya 1958. Robison (1994) did not discuss the status of *T.* cf. *corrugatus* but reassigned all specimens identified with *T. deformis* to either *T. corrugatus* or *T. perrugatus* and we concur with this interpretation. However, *T.* cf. *corrugatus* sensu Westergård (1946) represents a new species of *Tomagnostus*, here described as *Tomagnostus brantevikensis* n. sp. Its cephalon resembles that of *T. corrugatus* whereas the pygidium is similar to that of *T. perrugatus*.

Systematic palaeontology

The figured specimens of *T. brantevikensis* n. sp. are deposited in the Swedish Geological Survey (SGU), Uppsala, those of *T. perrugatus* are kept in the Museum of Evolution (PMU), Uppsala University, and the *T. corrugatus* material is in the collection of the Sedgwick Museum (SMA), University of Cambridge, UK.

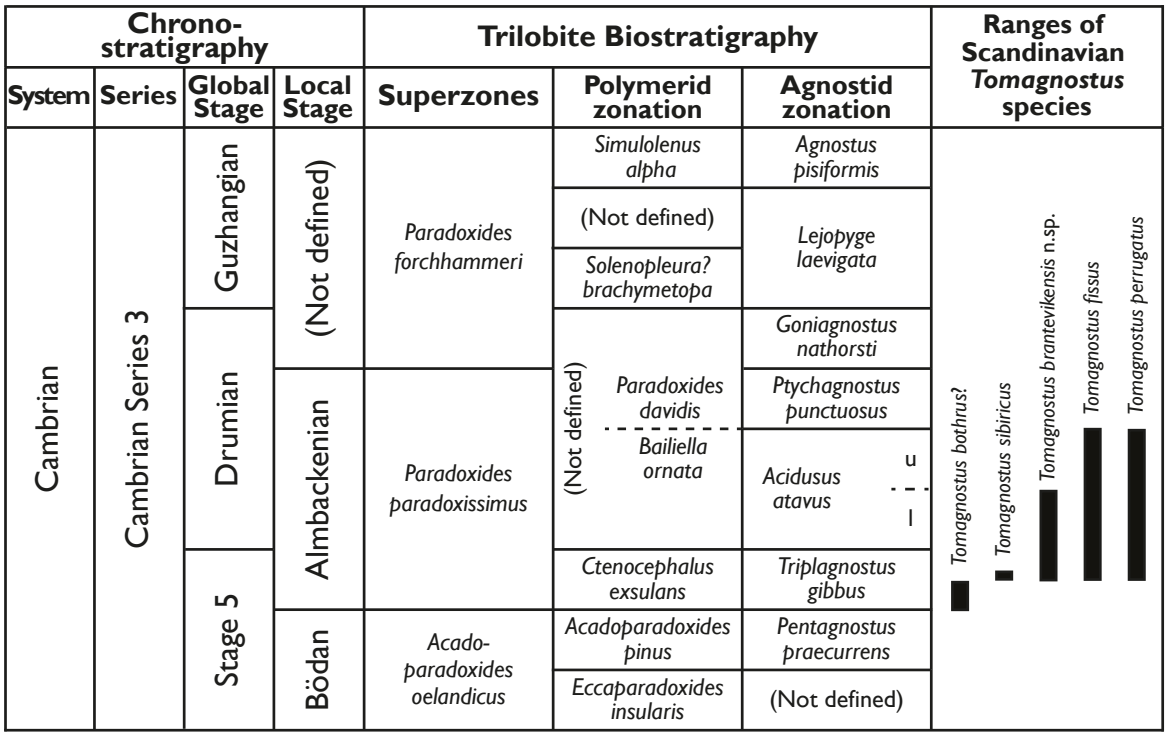


Fig. 1. Biozonation of the middle Cambrian (≈ Cambrian provisional Series 3) in Scandinavia. Ranges of Scandinavian species of *Tomagnostus* are also shown. Revised zonation and ranges according to Weidner & Nielsen (2015); local stages according to Nielsen & Schovsbo (2015).

Family Ptychagnostidae Kobayashi 1939

Genus *Tomagnostus* Howell 1935

Type species (by original definition). *Agnostus fissus* Lundgren in Linnarsson 1879, from the Exsulans Limestone Bed, *T. gibbus* Zone, near Brantevik, Scania, Sweden.

Diagnosis. See Robison (1994) and Shergold & Laurie (1997).

Tomagnostus brantevikensis n. sp.
Fig. 3A, B

1946 *Tomagnostus* cf. *corrugatus* (Illing 1916); Westergård, pp. 60, 61, pl. 8, figs 11, 12.

Derivation of name. The new name alludes to the small village of Brantevik on the east coast of Scania, well known for exposures of Cambrian strata along the shore.

Holotype. Complete specimen, SGU 4859, originally illustrated by Westergård (1946, pl. 8, fig. 12), here reillustrated in Fig. 3A. It derives from the *T. gibbus* Zone, Alum Shale Formation, Gislövshammar, Scania, Sweden. Note that Westergård (1946, pl. 8, fig. 12) erroneously stated the magnification for his illustration as ×4; it is in fact ×3.

Material and occurrence. Westergård (1946) reported this form from boulders of the *Triplagnostus gibbus* and *Acidusus atavus* zones found on the shore between Brantevik and Gislövshammar, eastern Scania. However, of his material only the two illustrated specimens (from the former zone) could be located in the SGU collection. Subsequent fossil collecting from this area has failed to locate additional new material of this apparently very rare form.

Diagnosis. A *Tomagnostus* species with moderately wide cephalic and pygidial borders. Glabella distinctly tapering, creating a subtriangular outline; deltoid depression developed. Pygidium with evenly rounded border, non-spinose; non-elongate node on M2.

Description. The thoracic segments are telescoped under the cephalon in the holotype (Fig. 3A), in which the cephalon is approximately ≥6.0 mm long and the pygidium measures 6.6 mm in length. Total reconstructed length was thus *c*. 15 mm (adding the length of the thorax). The other illustrated complete specimen (Fig. 3B) is 9.5 mm long, of which the cepha-

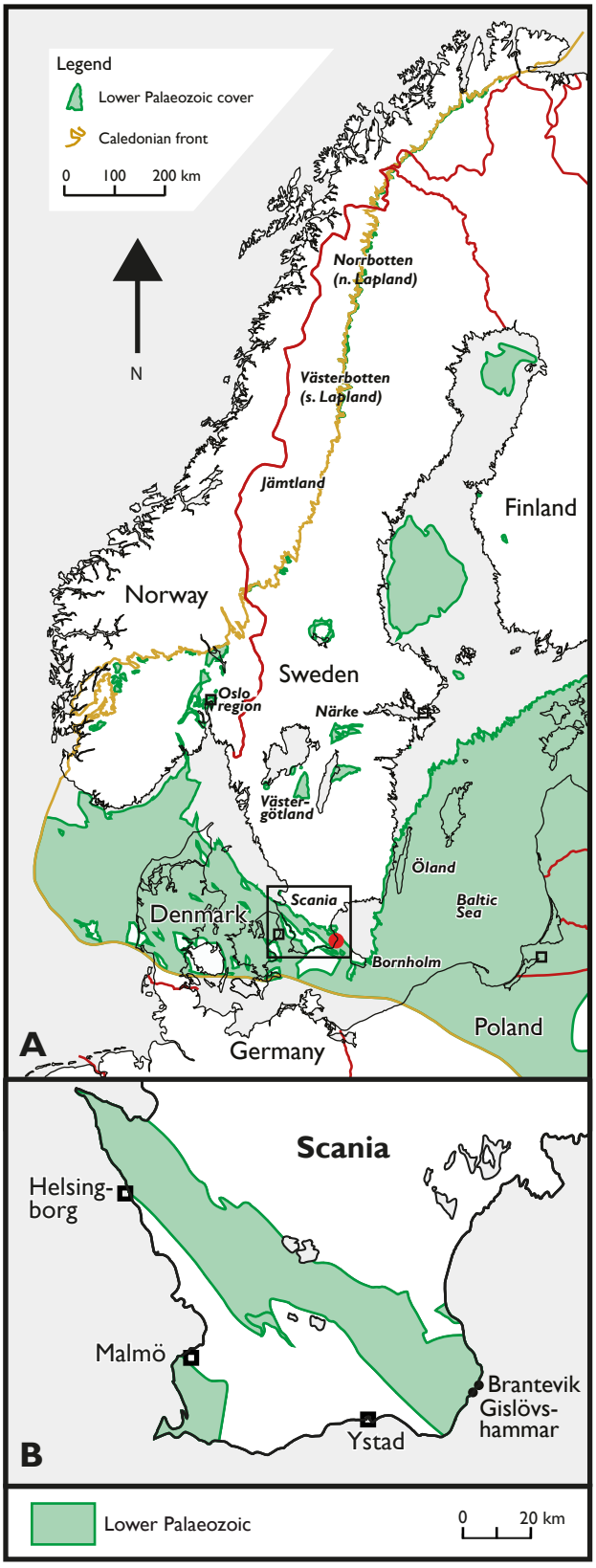


Fig. 2. A: Map of Scandinavia showing the distribution of Cambrian strata. Names of districts referred to in the text are also indicated. (Map modified from Nielsen & Schovsbo 2011). **B**: Map of Scania showing sites referred to in the text.

lon occupies 4.1 mm and the pygidium 4.2 mm. The larger specimen, although less perfectly preserved, is designated above as the holotype because it allows better comparison to large specimens of *T. corrugatus* and *T. perrugatus*.

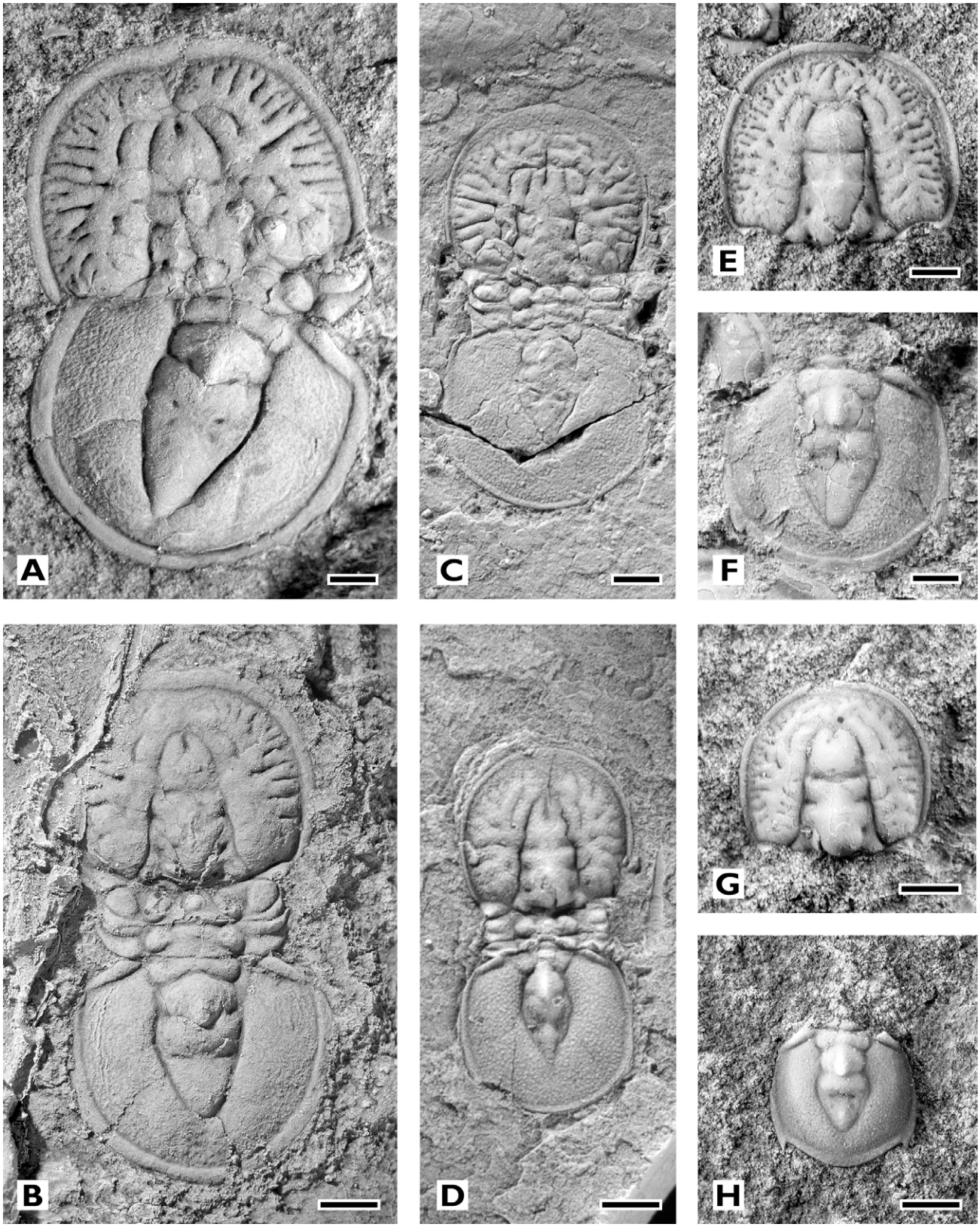
The cephalon is rounded in outline and slightly wider than long, with a moderately wide border and a deltoid depression. The genae show long and deep radiating furrows and a distinct pair of anterior arcuate furrows adjacent to the anteroglabella. A vestigial posterior pair of arcuate furrows is indicated adjacent to the posteroglabella (Fig. 3A). Glabella is rather strongly tapering, giving it a subtriangular outline. Anteroglabella with a distinct frontal sulcus; posteroglabella with short and deep F1 and F2 furrows, M2 bears a narrow, elongate glabellar node (see also Westergård 1946, pl. 8, fig. 11). A shallow median depression separates the cheeks. The basal lobes are slightly elongate. The border, axial and transglabellar furrows are deep and narrow; the latter shallows medially. The thoracic segments are developed as in *T. perrugatus*, *T. corrugatus* and *T. sibiricus*; for description see Weidner & Nielsen (2015).

The pygidum is evenly rounded in outline and slightly wider than long. The border is moderately wide and flat, of even width throughout and without any trace of lateral pygidial swellings or incipient spines. The axis occupies about 70–80% of the pygidial length and accounts for *c.* 35% of the pygidial width. It tapers to a point and the posteroaxis has a transverse depression with a pair of distinct pits just anterior to the midlength with additional indistinct pairs of pits further back (Fig. 3A). The border furrow and the axial and F1 and F2 furrows are narrow. F1 bends forward, F2 is deflected backward by the M2 node which is less elongate than in *T. corrugatus*, *T. perrugatus* or *T. fissus*. Median postaxial furrow very faint.

Remarks. Tomagnostus brantevikensis n. sp. most closely resembles *T. corrugatus* and *T. perrugatus*. In larger cephala of *T. corrugatus* from England (Rushton 1979, fig. 6A [here Fig. 3C], 7E), Greenland (Robison 1994, fig. 29: 5–6) and Siberia (Pokrovskaya 1958, pl. 2, fig. 2) the scrobiculation is more irregular than in *T. brantevikensis* n. sp. Therefore, the axial furrows are less distinct, but nevertheless the subtriangular shape of the glabella is still obvious and is a diagnostic feature for both *T. corrugatus* and *T. brantevikensis* n. sp. (see Rushton 1979, fig. 7E). The border of *T. corrugatus* is evenly rounded, distinctly narrower than in *T. brantevikensis* n. sp. and lacks the deltoid depression. The anterior part of the cheeks is finely granulated in *T. corrugatus*, a feature not developed in *T. brantevikensis* n. sp.

The differences between cephala of *T. perrugatus* and *T. brantevikensis* n. sp. are more pronounced.

Tomagnostus perrugatus typically has a parallel-sided posteroglabella and a rounded or only slightly tapering anteroglabella *vs* a quite strongly tapering glabella in *T. brantevikensis* n. sp.; besides, the border is evenly rounded, lacking a deltoid depression, and is narrower than in *T. brantevikensis* n. sp. (Fig. 3E, G;



Pokrovskaya 1958, pl. 2, figs 5–7, 9; Westergård 1946, pl. 8, figs 1, 3–4, 6–7; Savitsky *et al*. 1972, pl. 5, figs 7, 9; Egorova *et al*. 1982, pl. 5, fig. 5, pl. 54, fig. 9; Weidner & Nielsen 2014, fig. 20A–D; Weidner & Nielsen 2015, fig. 11K–O). Smaller cephala of the three species are, however, quite alike (Figs 3B, D, G) and in order to assign smaller specimens unerringly to one of the species, an associated pygidium is required (Figs 3B, D, H).

Where the cephalon of *T. brantevikensis* n. sp. resembles that of *T. corrugatus*, the pygidium of *T. brantevikensis* n. sp. more closely resembles that of *T. perrugatus*. The latter is distinguished by having a more elongate axial node, extending for the entire length of M2, and posterolateral pygidial spines of variable length (see Westergård 1946, pl. 8, figs 2, 5, 8, 10; Robison 1994, fig. 31:2–3; Weidner & Nielsen 2015, fig. 11P–T). However, some illustrated pygidia have only tiny posterolateral swellings or a mere angulation of the pygidial border instead of spines (Pokrovskaya 1958, pl. 2, figs 5, 8–9; Rushton 1979, fig. 6C, E). The border is not as evenly rounded as in *T. brantevikensis* n. sp., and the lateral parts are generally almost straight until where the posterolateral spines protrude. There is an obtuse angle between the straight lateral parts and the posterior part of the border just inside the spine base (Fig. 3H; Pokrovskaya 1958, pl. 2, figs 5, 8–9; Weidner & Nielsen 2015, fig. 11P–S); the posterior part of the border may be broadly rounded or sharply curved (Pokrovskaya 1958, pl. 2, fig. 5, and Weidner & Nielsen 2015, fig. 11P–T, versus Pokrovskaya 1958, pl. 2, figs 6, 8–9; Rushton 1979, fig. 6C, E and Egorova *et al*. 1982, pl. 54, fig. 12). Furthermore, the border is narrowing anteriorly and often with a posterior collar (Fig. 3F; better seen in Westergård 1946, pl. 8, figs 2, 5; Egorova *et al*. 1982, pl. 54, fig. 12). Pokrovskaya (1958) realized the affinities between *T. deformis* and *T. perrugatus* and stated as key differential characters the narrowing anteroglabella and the "sharply triangular-rounded" posterior part of the pygidial border as well as the lack of posterolateral spines and collar in *T. deformis*. However, Pokrovskaya (1958) had only comparative illustrations of *T. perrugatus* from Westergård (1946) at hand, and since then *T. perrugatus* has been treated and illustrated in numerous publications showing the *deformis* features as intraspecific variations of *perrugatus* (Savitsky *et al*. 1972; Rushton 1979; Egorova *et al*. 1982; Robison 1994; Weidner & Nielsen 2014, 2015). We therefore agree with the transfer of the material described as *deformis* to *T. perrugatus* as suggested by Robison (1994).

The pygidium of *T. corrugatus* is different from that of *T. brantevikensis* n. sp. in several features. The overall shape of the former is more quadrate than rounded and the axis is shorter and narrower and considerably more constricted at M2 than in *T. brantevikensis* n. sp. Furthermore, the border is distinctly narrower. Typical *T. corrugatus* pygidia have either vestigial spines or at least an angulation of the border (Fig. 3C; Pokrovskaya 1958; Rushton 1979; Robison 1994) whereas *T. brantevikensis* n. sp. has a smooth and evenly rounded border. Some specimens of *T. corrugatus* from Greenland (Robison 1994, fig. 29: 5–6) and Siberia (Pokrovskaya 1958, pl. 2, figs 1–3) have a longer axis than is typical for the species and are almost as long as those observed in *T. brantevikensis* n. sp. However, the more constricted axis and narrower border of *T. corrugatus* readily separates the two species.

Conclusions

Four species of *Tomagnostus* have hitherto been reported from Scandinavia, viz. *T. bothrus*?, *T. fissus*, *T. perrugatus* and *T. sibiricus* (see Grönwall 1902, Westergård 1946, Weidner & Nielsen 2009, 2014, 2015). Material originally described as *T.* cf. *corrugatus* by Westergård (1946) is here recognized as a fifth species named *T. brantevikensis* n. sp. This form occurs sparsely in the *T. gibbus* and *A. atavus* zones of Scania, Sweden, according to Westergård (1946).

◀ **Fig. 3**. Comparison of *Tomagnostus brantevikensis* n. sp. with *T. corrugatus* and *T. perrugatus*. Black scale bars 1 mm. Upper row (A, C, E and F) shows larger specimens and lower row (B, D, G and H) shows smaller specimens. **A**–**B**: Complete specimens of *Tomagnostus brantevikensis* n. sp. from the *Triplagnostus gibbus* Zone, Alum Shale Formation, Gislövshammar, Scania, Sweden. Previously figured by Westergård (1946, pl. 8, figs 11, 12). **A**: Holotype, SGU 4859. **B**: Cast of SGU 4858; note that Westergård (1946, pl. 8 fig. 11) illustrated the inverted negative imprint. **C**–**D**: Complete specimens of *Tomagnostus corrugatus* (Illing 1916) from the *Tomagnostus fissus* Zone, Abbey Shales, England. Previously figured by Rushton (1979, fig. 6A, B). **C**: Lectotype, SMA 242. **D**: SMA 55446. **E**–**H**: *Tomagnostus perrugatus* (Grönwall 1902) from the Alum Shale Formation, Brantevik, Scania, Sweden. **E**: Cephalon, PMU 27361, *Triplagnostus gibbus* Zone. Previously figured by Weidner & Nielsen (2015, fig. 11K). **F**: Pygidium, PMU 27370, *Triplagnostus gibbus* Zone. Previously figured by Weidner & Nielsen (2015, fig. 11T). **G**: Smaller cephalon with atypical slightly triangular glabella, PMU 27365, *Triplagnostus gibbus* Zone. Previously figured by Weidner & Nielsen (2015, fig. 11O). **H**: Pygidium, PMU 25874, *Acidusus atavus* Zone. Previously figured by Weidner & Nielsen (2014, fig. 20F).

Acknowledgements

We thank L. Wickström, SGU, Uppsala, for lending us the specimens of *T. brantevikensis* n. sp. previously illustrated by Westergård (1946). J.O.R. Ebbestad, Uppsala, and I. Korovnikov, Novosibirsk, helped us with Russian literature. Recommendations by referees John Laurie, Canberra, Australia, and Elena Naimark, Moscow, Russia, improved the final manuscript.

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