Tomagnostella tullbergi n. sp. (Agnostidae) from the middle Cambrian *Lejopyge laevigata* Zone of Scandinavia

THOMAS WEIDNER, ARNE THORSHØJ NIELSEN & JAN OVE R. EBBESTAD

Geological Society of Denmark
https://2dgf.dk

Received 22 June 2024
Accepted in revised form
27 September 2024
Published online
13 November 2024

Weidner, T., Nielsen, A.T. & Ebbestad, J.O.R. 2024: *Tomagnostella tullbergi* n. sp. (Agnostidae) from the middle Cambrian *Lejopyge laevigata* Zone of Scandinavia. Bulletin of the Geological Society of Denmark, Vol. 73, pp. 193–198. ISSN 2245-7070. https://doi.org/10.37570/bgsd-2024-73-11

A rare new agnostoid species, *Tomagnostella tullbergi* n. sp., is described from the lower part of the middle Cambrian *Lejopyge laevigata* Zone in Scandinavia, corresponding to the lower part of the Guzhangian global Stage. The species is currently known only from the Andrarum Limestone Bed of Skåne, southernmost Sweden, and coeval strata in the Oslo Region, Norway; it has also been recorded from ice-rafted Andrarum Limestone found in Germany. The material assigned to *T. tullbergi* n. sp. has previously been confused with *Tomagnostella exsculpta*. The new species is characterized by a cephalon with a moderately angular glabellar front (distinctly angular in *T. exsculpta*) and a pygidium with a narrow, pointed axis showing a depressed tip; a small secondary node is located within this depression close to the tip of the axis (in *T. exsculpta* the axis is broad and rounded posteriorly and without a posterior depression; a minute terminal node may or may not be present). *Tomagnostella tullbergi* n. sp. is also comparatively large-sized whereas *T. exsculpta* attains smaller maximum sizes.

Keywords: Agnostoids, *Tomagnostella*, Andrarum Limestone, Miaolingian, Scandinavia.

Thomas Weidner [to.we@paradis.dk], Ravnholtvej 23, Rårup, DK-7130 Juelsminde, Denmark. Arne Thorshøj Nielsen [arnet@ign.ku.dk], Department of Geosciences and Natural Resource Management, University of Copenhagen, Øster Voldgade 10, DK-1350 Kbh K, Denmark. Jan Ove R. Ebbestad [jan-ove.ebbestad@em.uu.se], Museum of Evolution, Uppsala University, Norbyvägen 22, SE-75236 Uppsala, Sweden.

http://zoobank.org/urn:lsid:zoobank.org:pub:5A94A097-6AA3-489E-84A7-C0C2C2CB6067

Angelin (1851) described *Agnostus exsculptus* based on four cephala and two specimens interpreted as pygidia, all stated to derive from the Andrarum Limestone at Andrarum, Skåne (southern Sweden). Later, Tullberg (1880, p. 22) identified the two 'pygidia' as cephala of *Goniagnostus nathorsti*, and he also considered that two of the syntype cephala, although generally similar to *A. exsculptus*, represented an ancestral form, supposedly deriving from bituminous limestone (stinkstone) below the Andrarum Limestone. Westergård (1946) agreed with this interpretation, except that one of the discarded syntype cephala was reassigned to *Hypagnostus exsculptus* (*ibid*., pl. 6, fig. 1a, b, NRM Ar 2006, 5.6 mm long). According to Westergård, this specimen is also preserved in Andrarum Limestone. The syntype cephalon previously illustrated by Tullberg (1880, pl. 1, fig. 10) was selected as lectotype for *H. exsculptus* and re-illustrated (Westergård 1946, pl. 5, fig. 35a, b, NRM Ar 2007, 3.0 mm long; it is here shown in Fig. 1A). Westergård (1946) also figured an additional cephalon, assigned to *H. exsculptus,* from a drill-core obtained at Södra Sandby, Skåne (*ibid*., pl. 6, fig. 2, SGU 4008a, 5.6 mm long; see Fig. 1G), and he further listed six unfigured cephala from Andrarum and Kiviks-Esperöd (Skåne), all deriving from the Andrarum Limestone. Westergård (1946) also illustrated three relatively large pygidia, representing two different morphs, but he was uncertain which of these forms belong to *H. exsculptus*.

Robison (1988), Peng & Robison (2000), Peng *et al*. (2009) and Weidner *et al*. (2023) assigned *exsculpta* to *Tomagnostella* (see also Kobayashi 1939 and Öpik 1979) and described material from Greenland, China, Himalaya and Scandinavia. These authors demonstrated that *T. exsculpta* is a variably scrobiculate species with shields up to 3 mm long, characterized by

a cephalon with an angular glabellar front (Fig. 1A) and a pygidium with a broad axis reaching the border furrow or almost so (Fig. 1B). They synonymized *T. nepos* (Westergård, 1946) with *T. exsculpta* as the exterior sculpture, smooth or scrobiculate, is of no taxonomic significance and intermediate specimens occur. For a detailed discussion on the confused interpretation of *T. exsculpta* through time, see Weidner *et al*. (2023).

Prior to these contributions, Öpik (1979, p. 71) pointed out that both the larger cephalon illustrated by Westergård (1946, pl. 6, fig. 1a, b) with its apparently straight glabellar front and the three tentatively assigned pygidia (Westergård 1946, pl. 6, figs 3–5) with a narrow and pointed axis have features not observed in *T. exsculpta*. Öpik suggested that the cephalon and the two pygidia with a depressed tip (Westergård 1946, pl. 6, figs 3–4) may represent a new species of *Tomagnostella*. We agree with this interpretation (see Weidner *et al*. 2023, pp. 61–62), but new photographs of the cephalon (Fig. 1E1) show that the glabellar front is moderately angular and not straight as stated by Westergård. In recent decades, sparse additional material of this form has been recorded from the Oslo Region (Norway), Skåne (Sweden) and an ice-rafted boulder found in Germany (all occurrences are specified below) which allows formal description of a new species, here named *T. tullbergi* n. sp.

Systematic palaeontology

We follow the generic concept of Shergold & Laurie (1997).

Repositories. NRM (Naturhistoriska Riksmuseet, Swedish Museum of Natural History, Stockholm); PMO (Palaeontological collections of the Natural History Museum, University of Oslo, Norway); PMU (Palaeontological collections, Museum of Evolution, Uppsala University, Sweden); SGU (Geological Survey of Sweden).

This published work and the nomenclatural acts it contains have been registered in ZooBank: http://zoobank.org/urn:lsid:zoobank.org:pub:5A94A097-6AA3-489E-84A7-C0C2C2CB6067

Family Spinagnostidae Howell, 1935

Genus *Tomagnostella* Kobayashi, 1939

Type species (OD). Agnostus exsculptus, Angelin, 1851, from the Andrarum Limestone Bed, lower part of the *Lejopyge laevigata* Zone, Andrarum, Skåne, Sweden.

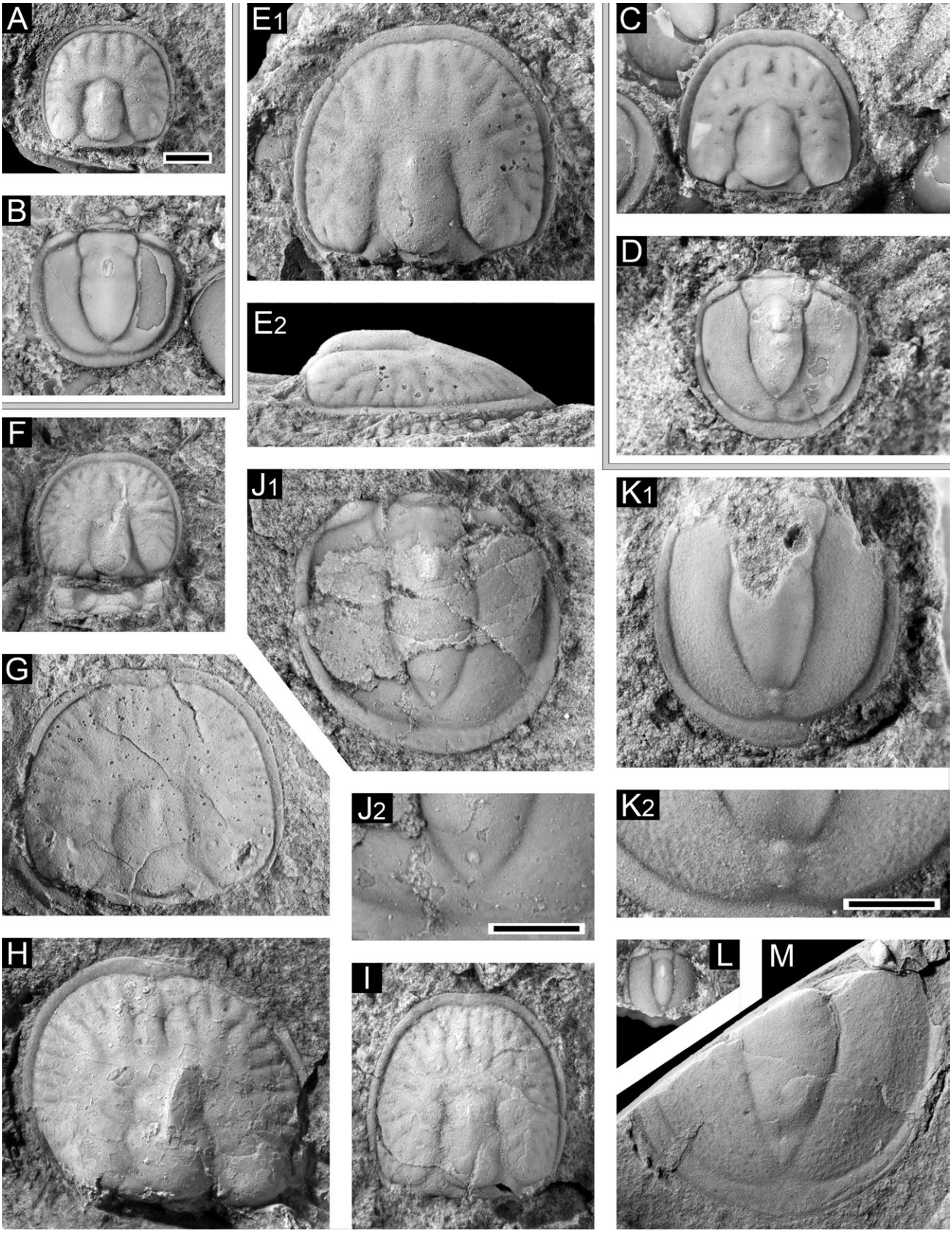
Diagnosis. See Shergold & Laurie (1997).

Tomagnostella tullbergi n. sp.

Fig. 1E1–M

1946 *Hypagnostus exsculptus* (Angelin, 1851) [*partim*]; Westergård, pp. 50–51, pl. 6, figs 1–2; non pl. 5, fig. 35a, b.
1946 *Hypagnostus exsculptus*? (Angelin, 1851) [*partim*]; Westergård, pp. 50–51, pl. 6, figs 3–4; non pl. 6, fig. 5.
1959 *Tomagnostella exsculpta* (Angelin); Howell, p. O186, Fig. 127:2a, b.
1994 *Tomagnostella exsculpta* (Angelin 1851); Rudolph, pp. 138–139, pl. 7, fig. 15.
2008 *Tomagnostella exsculpta* (Angelin 1851); Høyberget & Bruton, pp. 44–45, pl. 7, figs A–D.

▼ **Fig. 1.** *Tomagnostella exsculpta* and *T. sulcifera* are figured to facilitate comparison with *T. tullbergi* n. sp. **A, B:** *Tomagnostella exsculpta* (Angelin, 1851). **A:** Lectotype cephalon (NRM Ar 2007), from Andrarum, Skåne. Previously illustrated by Tullberg (1880), pl. 1, fig. 10, Westergård (1946), pl. 5, fig. 35a, b and Shergold & Laurie (1997, fig. 226:2a). **B:** Pygidium (PMU 37227/2), from Gislövshammar, Skåne. Previously illustrated by Weidner *et al*. (2023), fig. 33U. Note the minute terminal node. **C, D:** *Tomagnostella sulcifera* (Wallerius, 1895). **C:** Cephalon (PMU 34319/1), from Vilske, Västergötland. Previously illustrated by Weidner *et al*. (2023), fig. 33O. **D:** Pygidium (PMU 38335/2), from Vilske, Västergötland. Note the terminal node. Previously illustrated by Weidner *et al*. (2023), fig. 33P. **E–M:** *Tomagnostella tullbergi* n. sp. **E1, E2:** Cephalon in dorsal and right lateral views (NRM Ar 2006), from Andrarum, Skåne. Previously illustrated by Westergård (1946), pl. 6, fig. 1a, b. **F:** Cephalon (PMO 211.993), from Gjøvik, Norway. Previously illustrated by Høyberget & Bruton (2008), pl. 7C. **G**: Cephalon (SGU 4800a), from Södra Sandby, Skåne. Previously illustrated by Westergård (1946), pl. 6, fig. 2. **H**: Cephalon (PMO 211.992), from Gjøvik, Norway. Previously illustrated by Høyberget & Bruton (2008), pl. 7B. **I**: Paratype cephalon (PMO 211.991), from Gjøvik, Norway. Previously illustrated by Høyberget & Bruton (2008), pl. 7A. **J1, J2:** Holotype pygidium in dorsal view and close up showing secondary node within the axial depression (PMO 211.994), from Gjøvik, Norway. Previously illustrated by Høyberget & Bruton (2008), pl. 7D. **K1, K2:** Pygidium in dorsal view and close up showing secondary node within the depression (NRM Ar 9519), from Andrarum, Skåne. Previously illustrated by Westergård (1946), pl. 6, fig. 4. **L:** Small pygidium (PMU 31777), from Brantevik, Skåne. (M) Pygidium (SGU 4801), from Södra Sandby, Skåne. Previously illustrated by Westergård (1946), pl. 6, fig. 3. Black scale bars: 1 mm; scale bar in A is the same for all except J2 and K2.


A
B
E1
E2
C
D
F
J1
K1
G
J2
K2
H
I
L
M

Derivation of name. In recognition of the Swedish botanist, palaeontologist and geologist Sven Axel Tullberg (1852–1886). He discarded two of the cephala from Angelin's syntype material of *Agnostus exsculptus* (see Tullberg 1880, p. 22; Westergård 1946, pp. 50–51) and one of these is here assigned to *Tomagnostella tullbergi* n. sp. (illustrated in Fig. 1E1, E2).

Holotype (designated here). Pygidium, PMO 211.994, from the *Lejopyge laevigata* Zone at Gjøvik, Norway, illustrated in Fig. 1J1, J2. It was previously illustrated by Høyberget & Bruton (2008), pl. 7D.

Paratype (designated here). Cephalon, PMO 211.991, from the *Lejopyge laevigata* Zone at Gjøvik, Norway, illustrated in Fig. 1I. It was previously illustrated by Høyberget & Bruton (2008), pl. 7A.

Material and occurrence. All material of the new species illustrated in the literature so far, six cephala and four pygidia, derives from the lower part of the *Lejopyge laevigata* Zone, i.e. the Andrarum Limestone (henceforth AL) and the equivalent level in southern Norway. All of these specimens have been restudied except for the cephalon recorded as *T. exsculpta* by Rudolph (1994), from an ice-rafted boulder of AL found on the island of Rügen, Germany. Measurements and museum numbers of the specimens are listed in Table 1. Material illustrated as *H. exsculptus* by Westergård (1946) includes one cephalon and one pygidium from the AL at Andrarum, and one cephalon and one pygidium from the same horizon in a boring at Södra Sandby, Skåne. One pygidium was collected by H.-J. Schmütz from a block of AL on the shore at Brantevik, Skåne, and donated to PMU. In addition to the holotype pygidium and the paratype cephalon, another two cephala were reported as *T. exsculpta* from a limestone lens at Gjøvik, Norway, by Høyberget & Bruton (2008).

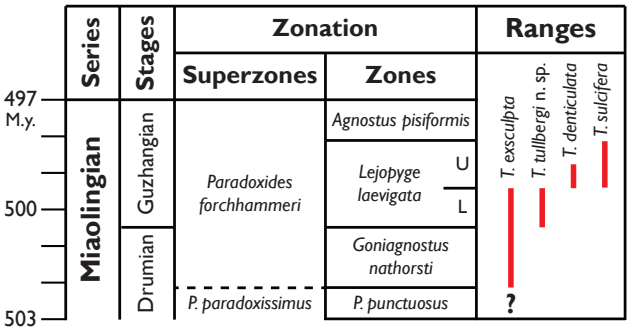


Fig. 2. Stratigraphic distribution of species of *Tomagnostella* in Scandinavia. Data from Westergård (1946), Rudolph (1994), Høyberget & Bruton (2008), Weidner & Nielsen (2014) and present study.

Diagnosis. A comparatively large *Tomagnostella* species with a cephalon having radial scrobiculae and a glabella with faintly indicated and moderately angular F3 forming the glabellar front. Pygidial axis is narrow, pointed, with a depressed tip; a tiny, but distinct secondary node is located within this depression. The axis extends to the border furrow or nearly so.

Description. No complete specimen is at hand. However, all cephala and pygidia derive from the Andrarum Limestone and the equivalent stratigraphic level in Norway and in some cases even from the same sample. They possess features characteristic of *Tomagnostella* but differ from the longer-ranging *T. exsculpta* and the younger *T. sulcifera* as specified below (ranges shown in Fig. 2). We therefore confidently consider the described cephala and pygidia as conspecific.

Tomagnostella tullbergi n. sp. is a comparatively large species. The length of the five studied cephala ranges from 3.2 mm to 6.0 mm, and the three adult pygidia are between 6.2 mm and 6.5 mm long (Table 1). The cephalon is moderately inflated (for a side view, see

Table 1. List of the investigated material of *Tomagnostella tullbergi* n. sp.

Repository no.	Fig. this paper	Part	Length (mm)	Previous illustration	Previous assignment
NRM Ar 2006	E1, E2	cephalon	5.6	Westergård 1946, pl. 6, fig. 1a, b	*Hypagnostus exsculptus*
PMO 211.993	F	cephalon	3.2	Høyberget & Bruton 2008, pl. 7C	*Tomagnostella exsculpta*
SGU 4800a	G	cephalon	5.6	Westergård 1946, pl. 6, fig. 2	*Hypagnostus exsculptus*
PMO 211.992	H	cephalon	6.0	Høyberget & Bruton 2008, pl. 7B	*Tomagnostella exsculpta*
PMO 211.991	I	cephalon	5.1	Høyberget & Bruton 2008, pl. 7A	*Tomagnostella exsculpta*
PMO 211.994	J1, J2	pygidium	6.4	Høyberget & Bruton 2008, pl. 7D	*Tomagnostella exsculpta*
NRM Ar 9519	K1, K2	pygidium	6.2	Westergård 1946, pl. 6, fig. 4	?*Hypagnostus exsculptus*
PMU 31777	L	pygidium	1.7	(New collection)	
SGU 4801	M	pygidium	6.5	Westergård 1946, pl. 6, fig. 3	?*Hypagnostus exsculptus*

Westergård 1946, pl. 6, fig. 1b), has a rounded outline, with approximately equal width/length, and a border only slightly widening anteriorly, delimited by a narrow well-defined border furrow. The glabella is slender and fades out in front of M3; the glabellar front (corresponding to F3) is moderately angular. The F3 furrow is very faintly impressed in all five cephala at hand including the small specimen (Fig. 1F). M1 and M2 appear as one lobe, slightly bowed out, F2 is marked by weak constrictions only; in some specimens F1 is seen as weak indentations (Fig. 1G, I). M3 is narrower than the combined M1–M2 lobe and bears an elongate node, situated almost centrally on the acrolobe. In most specimens the axial furrows are shallow. Basal lobes are simple. The surface sculpture consists of radial scrobiculae.

The pygidium has a border of equal width all the way, except behind the axis where it widens forwards (sag.). The border furrow is narrow. The axis is slender and bounded by moderately deep furrows. M2 bears an elongate node and is narrower (tr.) than both M1 and the posteroaxis. The posteroaxis tapers to a sharp point and reaches the border furrow or nearly so; the tip of the axis is depressed and a small secondary node is located within this depression close to the tip of the axis. The latter features are especially characteristic of the new species and can already be observed in juvenile specimens (Fig. 1L).

Remarks and comparison. In *T. exsculpta* (Fig. 1A), characteristic of the *G. nathorsti* Zone, but also occurring sparsely in the AL (Fig. 2), the axial furrows of the cephalon are distinct and the glabellar front (corresponding to F3) is distinctly angular (moderately angular in *T. tullbergi* n. sp.). The F1 and F2 furrows are typically obsolete, but rarely very faint constrictions are recognizable. The surface is mostly smooth (Høyberget & Bruton 2008, pl. 6O–R, as *T. nepos*; Weidner *et al*. 2023), but scrobiculate cephala are reported from China and Himalaya, and in these specimens the segmentation of the glabella is also better defined (Peng & Robison 2000, fig. 69; Peng *et al*. 2009, fig. 16). All known cephala of *T. tullbergi* n. sp. are scrobiculate. The pygidium of *T. exsculpta* has a wide and inflated axis that has a sharply rounded termination. In material from Scandinavia and Himalaya, a minute terminal node is generally observable (Høyberget & Bruton 2008, pl. 6S–V, as *T. nepos*; Weidner *et al*. 2023, fig. 33; Fig. 1B; Peng *et al*. 2009, fig. 16), but not in material from China (Peng & Robison 2000, pl. 69). The secondary node of *T. tullbergi* n. sp. differs by being located within a transverse depression near the tip of the axis.

Tomagnostella sulcifera (Fig. 1C, D) is common in the upper part of the *L. laevigata* Zone. In the cephalon, the axial furrows are distinct, and the glabellar front is distinctly angular, like in *T. exsculpta*. The segmentation of the glabella is well-defined by constrictions of the F1 and F2 furrows. The surface can be smooth or display scrobiculae. The pygidial axis is short and bears at its extreme end a tiny node, which has been observed in material from Sweden (Weidner *et al*. 2023, fig. 33; Fig. 1D) and China (Peng & Robison 2000, pl. 70). A long postaxial furrow is present.

One of the pygidia figured by Westergård (1946, pl. 6, fig. 5a, b) from the Andrarum Limestone of Skåne (as *H. exsculptus*?) has a strongly incised M2, the axis is narrow and shows a terminal node but lacks the transverse depression characteristic of *T. tullbergi* n. sp., and the axial tip is far from reaching the border. This specimen brings *T. sulcifera* to mind (compare Fig. 1D) but identification remains uncertain.

Conclusions

Four species of *Tomagnostella* are now described from the Miaolingian of Scandinavia (Fig. 2). The common *T. exsculpta* (Angelin, 1851) from the *G. nathorsti* Zone and the lower part of the *L. laevigata* Zone, the rare *T. tullbergi* n. sp. from the lower part of the *L. laevigata* Zone, and the common *T. denticulata* (Westergård, 1946) and *T. sulcifera* (Wallerius, 1895) from the upper part of the *L. laevigata* Zone. These species differ with regard to the outline of the glabellar front, the outline of the pygidial axis (length; pointed or more rounded tip; posterior depression), presence or absence of a postaxial furrow, and presence or absence as well as position of a secondary pygidial node. *Tomagnostella denticulata* (Westergård, 1946) is furthermore distinguished by having short posterolateral spines in the pygidium.

Acknowledgements

We are grateful for help with specimens from various collections and thank Niclas Borinder (SGU), Jonas Hagström (NRM) and Franz-Josef Lindeman (PMO). Hans-Jürgen Schmütz kindly donated a specimen of *T. tullbergi* n. sp. from Brantevik, Skåne. Comments and corrections by referees Per Ahlberg (Sweden) and John Laurie (Australia) improved the original manuscript which is gratefully acknowledged.

References

Angelin, N.P. 1851: Palaeontologia Svecica. P. I. Iconographia Crustaceorum formationis transitionis. Fasc. I, 24 pp. Lund: Berlings.

Howell, B.F. 1935: New Middle Cambrian agnostian trilobites from Vermont. Journal of Paleontology 9, 218–221.

Howell, B.F. 1959: Suborder Agnostina and Eodiscina. In: Moore, R.C. (ed.): Treatise on Invertebrate Paleontology. Part O, Arthropoda 1, O172–O190. New York: Geological Society of America and Lawrence: University of Kansas Press.

Høyberget, M. & Bruton, D.L. 2008: Middle Cambrian trilobites of the suborders Agnostina and Eodiscina from the Oslo Region, Norway. Palaeontographica, Abteilung A 286, 87 pp. https://doi.org/10.1127/pala/286/2008/1

Kobayashi, T. 1939: On the Agnostids (part 1). Journal of the Faculty of Science, Imperial University of Tokyo, Section 2(5), 69–198.

Öpik, A.A. 1979: Middle Cambrian Agnostids: Systematics and Biostratigraphy. Bureau of Mineral Resources, Geology and Geophysics Bulletin 172, 188 pp.

Peng, S.C. & Robison, R.A. 2000: Agnostoid biostratigraphy across the Middle-Upper Cambrian boundary in Hunan, China. Memoirs of the Paleontological Society 53, 104 pp. https://doi.org/10.1666/0022-3360(2000)53[1:ABATMC]2.0.CO;2

Peng, S.C., Hughes, N.C., Heim, N.A., Sell, B.K., Zhu, X.J., Myrow, P.M. & Parcha, S.K. 2009: Cambrian trilobites from the Parahio and Zanskar Valleys, Indian Himalaya. Paleontological Society Memoir 71, 95 pp. https://doi.org/10.1666/08-129.1

Robison, R.A. 1988: Trilobites of the Holm Dal Formation (late Middle Cambrian), central North Greenland. Meddelelser om Grønland, Geoscience 20, 23–103. https://doi.org/10.7146/moggeosci.v20i.139888

Rudolph, F. 1994: Die Trilobiten der mittelkambrischen Geschiebe, 309 pp. Wankendorf: Verlag Frank Rudolph.

Shergold, J.H. & Laurie, J.R. 1997: Introduction to the Suborder Agnostina. In: Kaesler, R.L. (ed.): Treatise on Invertebrate Paleontology. Part O. Arthropoda 1, Trilobita, revised. Volume 1, O331–O383. Boulder: The Geological Society of America and Lawrence: The University of Kansas Press.

Tullberg, S.A. 1880: Om Agnostus-arterna i de kambriska aflagringarne vid Andrarum. Sveriges Geologiska Undersökning C42, 38 pp.

Wallerius, I.D. 1895: Undersökningar öfver zonen med Agnostus laevigatus i Vestergötland, jämte en inledande öfversikt af Vestergötlands samtliga Paradoxideslager, 72 pp. Lund: Gleerupska Universitetsbokhandeln. https://doi.org/10.1080/11035899609444325

Weidner, T. & Nielsen, A.T. 2014: A highly diverse trilobite fauna with Avalonian affinities from the Middle Cambrian Acidusus atavus Zone (Drumian Stage) of Bornholm, Denmark. Journal of Systematic Palaeontology 12, 23–92.

Weidner, T., Nielsen, A.T. & Ebbestad, J.O.R. 2023: Middle Cambrian agnostoids and trilobites from the Lower Allochthon, Swedish Caledonides. Fossils and Strata 68, 121 pp. https://doi.org/10.18261/9788215068022-2023-01

Westergård, A.H. 1946: Agnostidea of the Middle Cambrian of Sweden. Sveriges Geologiska Undersökning C477, 140 pp.