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MEDIAL MAIOLINGIAN (WULIUAN–DELAMARAN) *GLOSSOPLEURA WALCOTTI* BIOZONE TRILOBITES FROM THE HAWKE BAY FORMATION (LABRADOR GROUP), PORT AU PORT PENINSULA (NTS 12B/06, CAPE ST. GEORGE), WESTERN NEWFOUNDLAND

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INTRODUCTION

The Hawke Bay Formation (Schuchert and Dunbar, 1934[1]) – a 150–170 m thick formation of dominantly well-bedded quartz arenites (Knight and Boyce, 2014) – is the youngest unit of the dominantly siliciclastic Lower to Middle Cambrian Labrador Group[2]. It is exposed on the southern shore of the Port au Port Peninsula (Figures 1 and 2), where it was variably mapped as the Kippens Formation (Riley, 1962) and the De Gras Formation (Williams, 1985). It is exposed for 8 km in a narrow, gently north-dipping but faulted belt, between Grand Jardin and Marches Point (Knight and Boyce, 2014).

Medial Maiolingian (Wuliuan–Delamaran) *Glossopleura walcotti* Biozone trilobites are described from the Hawke Bay Formation. In ascending order of appearance, the trilobite taxa comprise: *Glossopleura redbrookensis* Boyce, sp. nov., *Glossopleura walcotti* C. Poulsen, 1927, ptychopariid gen. et sp. undet., and *Eobathyuriscus* sp. A Boyce.

The Hawke Bay Formation on the Port au Port Peninsula was deposited during the Delamaran *Glossopleura walcotti* Biozone (Figure 3), correlating with the nearshore *Glossopleura walcotti* Biozone strata of North West Greenland (C. Poulsen, 1927; V. Poulsen, 1964; Peel, 2020), Nunavut (Poulsen, 1946; Peel, 2020); Northwest Territories, Canada (Handkamer *et al.*, 2022); the Marble Mountains of the Mojave Desert, California (Resser, 1928, 1935), the Carrara Formation in the Great Basin, USA (Palmer and Halley, 1979); the Precordillera Terrane, San Juan, Argentina (Bordonaro and Branchig, 1995; Foglia and Vaccari, 2010); Mendoza, western Argentina (Tortello, 2011, 2022), and the *Glossopleura* Biozone in the Canadian Rocky Mountains (Rasetti, 1951).

In western Newfoundland, the fauna correlates with *Glossopleura walcotti*-bearing beds of the Bridge Cove Member of the Hawke Bay Formation in Chimney Arm, Canada Bay (Knight and Boyce, 1987). Appendix A details the referenced fauna described in the systematic paleontology.

SYSTEMATIC PALEONTOLOGY

All of the specimens illustrated herein were uncoated prior to photography. Larger specimens were photographed using macro-equipped Canon or Panasonic bridge cameras. Smaller specimens were photographed in the Paleontology Lab at The Rooms Natural History Annex, St. John's, using a 10.0 MP OMAX A35100U digital microscope camera (http://omaxmicroscope.com/a35100u-omax-10-0mp-usb-digital-camera-for-microscope-with-0-01mm-calibration-slide-windows-mac-linux.html). Multiple images were taken of each specimen at varying distances; these images subsequently were stitched together using Alan Hadley's freeware vertical image stacking program CombineZP for Windows. Badly preserved material (*i.e.*, *Eobathyuriscus* sp. A from 1998F085) was photographed under low-angle lighting, to highlight furrowing, *etc*. The photographed material is housed at The Rooms Natural History Annex, Provincial Museum Division, The Rooms Corporation of Newfoundland and Labrador, prefixed by 'NFM F-'.

[1] Schuchert and Dunbar (1934) included the sandstones of the unit in the March Point Formation.
[2] The Labrador Group comprises, in ascending order, the Bradore, Forteau and Hawke Bay formations (Schuchert and Dunbar, 1934).

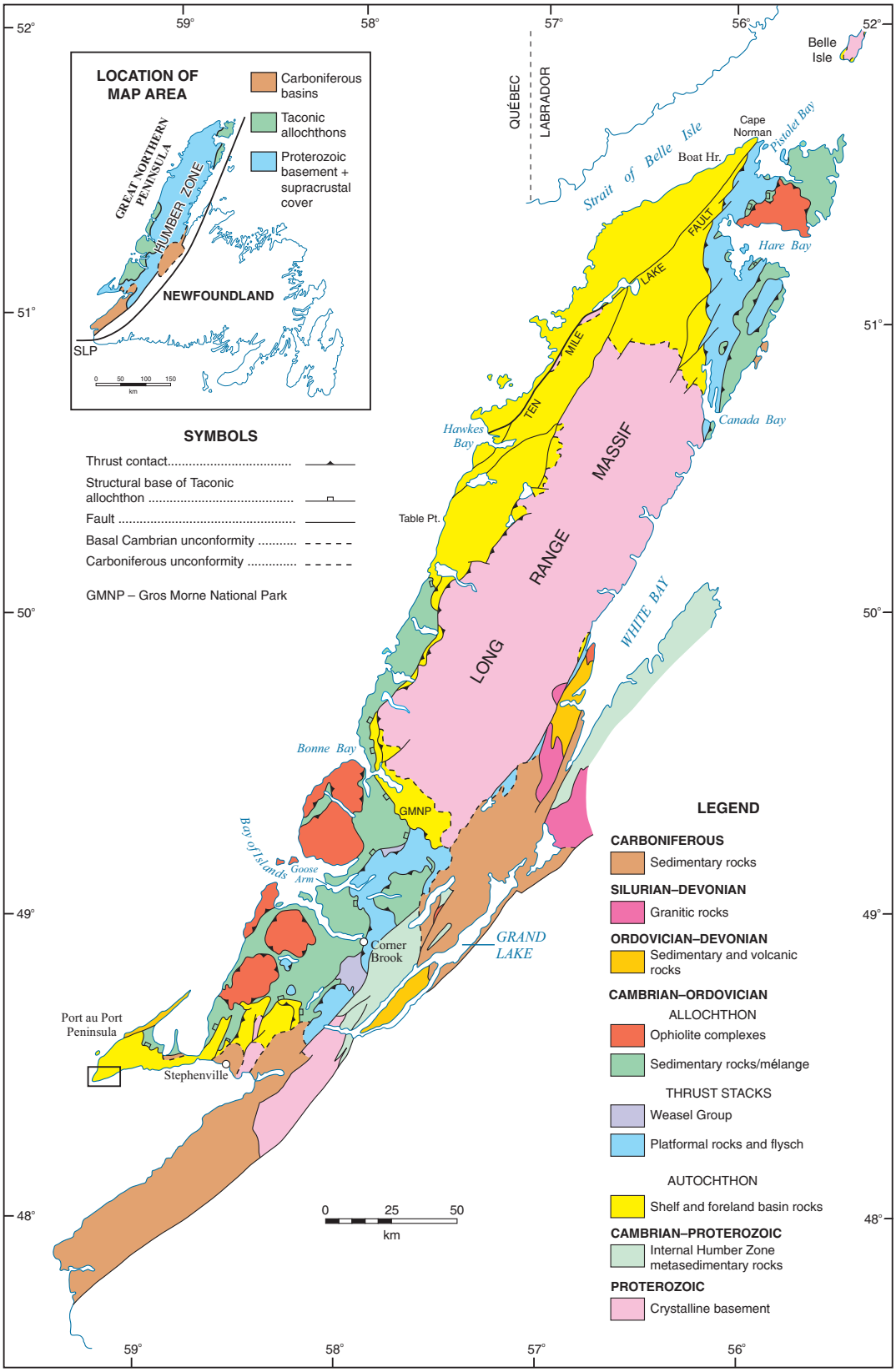


Figure 1. *Regional geological map of western Newfoundland showing the major geologic terranes. Map based on Knight (2007).*

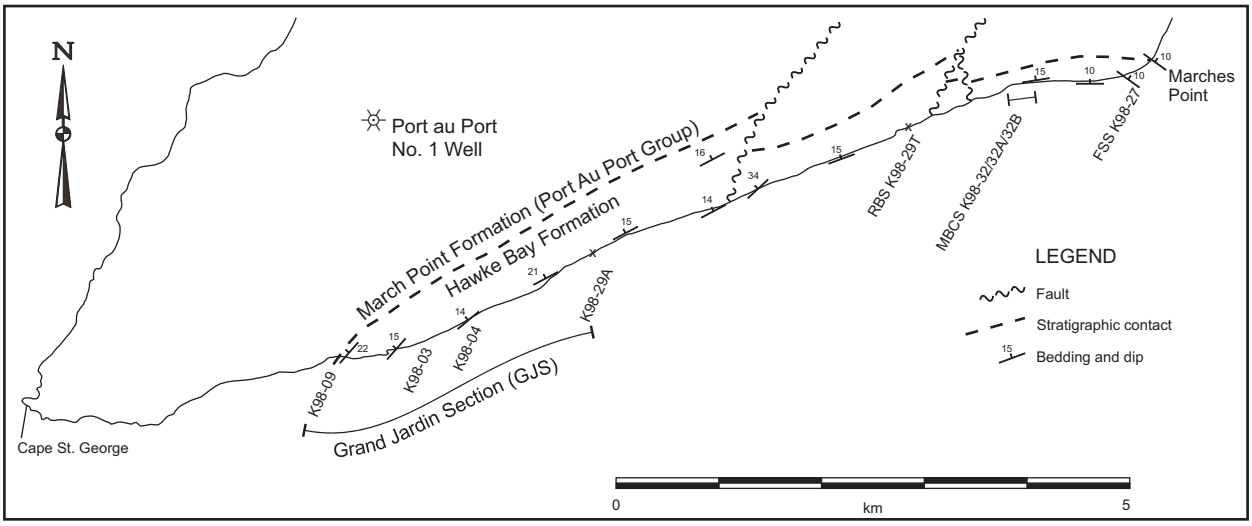


Figure 2. *Location of the stratigraphic sections studied in the Hawke Bay Formation along the southern shoreline of Port au Port Peninsula (based on Knight and Boyce, 2014). GJS=Grand Jardin Section; RBS=Red Brook Section; MBCS=Mike Benoit's Cliff Section; FSS=Fishing Shacks Section, west of Marches Point.*

GLOBAL		LAURENTIA		PREVIOUS BIOZONES	CURRENT BIOZONES	SUBBIOZONES/ ASSEMBLAGES	PORT AU PORT PENINSULA
SERIES	STAGES	SERIES	STAGES				
MIAOLINGIAN	WULIUAN	LINCOLNIAN	TOPAZAN	~503 Ma *Bathyuriscus-Elrathina*	*Ehmaniella*	*Altiocculus* S	March Point Formation
						Ehmaniella S	
						Elrathiella S	Barren Interval
						Proehmaniella S	
			DELAMARAN	*Glossopleura*	*Glossopleura walcotti*	None	Hawke Bay Formation
				Albertella	*Mexicella mexicana*	*Albertella highlandensis* A	Not Exposed
						Unnamed	
						Albertella aspinosa A	
				Plagiura-Poliella	*Poliella denticulata*	*Kochiella augusta* A	
						Poliellaites gloriosa A	
						Syspacephalus longus A	
						Fieldaspis celer A	
						Poliella denticulata A	
LENALDANIAN	STAGE 4			~506.64 Ma	*Amecephalus arrojosenis*		
					Eokochaspis nodosa		

Figure 3. *Correlation of the Port au Port Peninsula Hawke Bay Formation trilobite faunas with standard Cambrian Series and Stages. Global Series and Stages after Zhao* et al. *(2019) and Geyer (2019). Laurentian Series and Stages after Palmer (1998), Sundberg (1994, 2005) and McCollum and Sundberg (2007, page 149, Figure 2). Radiometric age dates after Karlstrom* et al. *(2020, page 426, Figure 2); and Sundberg* et al. *(2020, page 442, Figure 2).*

Note: In this report, an ‘original cast’ is the original fossil specimen positively preserved in the rock. A ‘latex cast’ is a replica made from the original fossil impression (negative or mold) in the rock. Unless otherwise indicated in the captions, the specimens are original casts.

Phylum ARTHROPODA Siebold and Stannius, 1845
Class TRILOBITA Walch, 1771
Order CORYNEXOCHIDA Kobayashi, 1935
Family DOLICHOMETOPIDAE Walcott, 1916a
Genus *Eobathyuriscus* Handkamer and Pratt in Handkamer *et al.*, 2022

Type species. Eobathyuriscus mackenziensis Handkamer and Pratt *in* Handkamer *et al.*, 2022, from the *Albertelloides mischi* and *Glossopleura walcotti* biozones of the Mount Cap Formation, Northwest Territories, Canada.

Diagnosis. See Handkamer and Pratt *in* Handkamer *et al.* (2022, page 13).

Eobathyuriscus sp. A Boyce
Plate 1A–D

Stratigraphic range. Hawke Bay Formation, Fishing Shacks Section (FSS), west of Marches Point – *see* Appendix A:
Section K98-027 of Knight and Boyce (2014)
1998F085

Figured material. One cranidium (NFM F-2664, Plate 1B); one left librigena (NFM F-2663, Plate 1A); and two pygidia (NFM F-2665, Plate 1C; NFM F-2666, Plate 1D); all poorly preserved.

Remarks. Boyce originally assigned this taxon to *Dolichometopus* Angelin, 1854[3], most recently treated by Rushton and Weidner (2002). However, the highly effaced material, including the extremely narrow posterior pygidial border is judged more typical of the recently defined *Eobathyuriscus* Handkamer and Pratt *in* Handkamer *et al.*, 2022.

Description. Cranidium (NFM F-2664; Plate 1B) is weakly convex and strongly effaced; cranidial length–width ratio is 77% (estimated). Glabella is weakly convex with indistinct, slightly waisted, parallel-sided glabella; length–width ratio is 164%. Glabellar–cranidial length ratio (sag.) is 100%; glabellar–cranidial width ratio (tr.) is 47%. Occipital ring is weakly defined; occipital ring length–width ratio is 28%. Occipital ring–cranidial length ratio (sag.) is 17%; occipital ring–cranidial width ratio (tr.) is 47%. Palpebral lobes are not preserved. Posterior fixigenal areas are triangular. Prosopon is not preserved.

Hypostoma unknown.

Librigena (NFM F-2663; Plate 1A) is weakly convex and strongly effaced; librigenal length–width ratio is 260%. Lateral border length–width ratio is 1083%; lateral border–librigenal width

[3] The type species, *Dolichometopus svecicus* Angelin, 1854 occurs in imestones of the *Paradoxides forchhmammeri* Stage of Sweden.

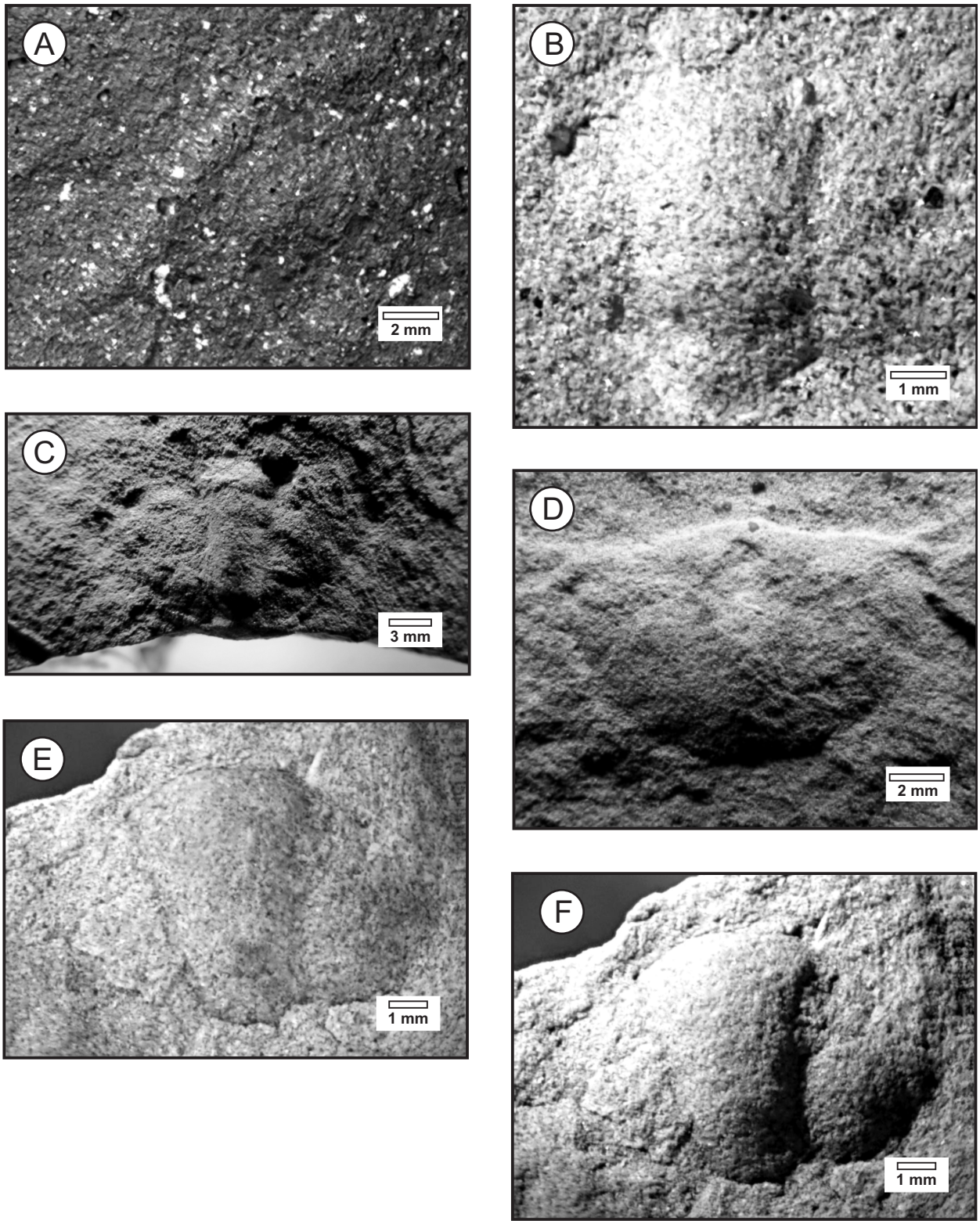


Plate 1. Eobathyuriscus *sp. A. Boyce, 1998F085. A) Left librigena (latex cast, NFM F-2663); B) Cranidium (original cast, NFM F-2664); C) Pygidium (original cast, NFM F-2665); D) Pygidium (original cast, NFM F-2666); E, F)* Glossopleura redbrookensis *Boyce, sp. nov., 1998F065, paratype cranidium (original cast, NFM F-2667), original and alternate lighting, respectively.*

ratio (tr.) is 24%. Lateral border furrow is wide (tr.), shallow; lateral border furrow–librigenal width ratio (tr.) is 8%. Librigenal field length–width ratio is 239%. Lateral border–librigenal field width ratio is 35%. Prosopon is not preserved.

Pygidium (NFM F-2665, Plate 1C) is weakly convex, semi-elliptical to semicircular; length–width ratio is 66%. Pygidial axis is weakly convex, transversely weakly arched, posteriorly gently tapering and gently rounded, expanding anteriorly at an angle of 14–16°; it comprises four indistinct axial rings and a gently rounded terminal ring. Pygidial axis length–width ratio is 195%. Pygidial axis–pygidial length ratio (sag.) is 91%; pygidial axis–pygidial width ratio (tr.) is 31%. Articulating half-ring is narrow (sag.), crescentic; length–width ratio is 5%. Articulating half-ring–pygidial length ratio (sag.) is 2%; articulating half-ring–pygidial width ratio (tr.) is 31%. Articulating half-ring furrow–pygidial length ratio (sag.) is 4%. Post-axial field is narrow (sag.); post-axial field–pygidial length ratio (sag.) is 3%. Three faint pairs of pleural ribs are developed. Posterior border is narrow (sag.); Posterior border–pygidial length ratio (sag.) is 6%. Prosopon is not preserved.

Remarks. This poorly preserved material – stratigraphically the highest in the Hawke Bay Formation on the Port au Port Peninsula – benefitted from being re-photographed in low angle light, with the OMAX A35100U digital microscope camera, but a species definition must still await more numerous, better preserved sclerites.

The pygidium of *Eobathyuriscus* sp. A most closely resembles that of *E. mackenziensis* from the *Glossopleura walcotti* Biozone of the Cap Mountain Formation in the Northwest Territories (compare NFM F-2665, Plate 1C to Handkamer *et al.* (2022; page 19; Figure 13-1).

Genus *Glossopleura* C. Poulsen, 1927

1952 *Sonoraspis* – Stoyanow *in* Cooper *et al.*, page 50.
1955 *Sonoraspis* – Stoyanow and Susuki.
1955 *Sonoraspis* – Stoyanow and Lumsden.
1958 *Sonoraspis* – Stoyanow.

Type species. Dolichometopus boccar Walcott, 1916b from the Stephen Formation of British Columbia, Canada.

Remarks. C. Poulsen (1927, page 268) selected the previously described taxon *Dolichometopus boccar* Walcott, 1916b as the genotype for his newly proposed genus. According to Palmer (1954) and Foster (2022), *Sonoraspis* Stoyanow *in* Cooper *et al.*, 1952 is a junior synonym of *Glossopleura*.

Diagnosis. See Palmer (1954, page 67).

Remarks. Robison and Babcock (2011, page 10), Foster (2011, page 105) and Handkamer and Pratt *in* Handkamer *et al.* (2022) report that more than fifty *Glossopleura* species have been described – from North America, Greenland, and the Precordillera terrane of Argentina – mostly based on disarticulated sclerites (chiefly cranidia and pygidia).

Glossopleura bosworthensis Resser, 1935, *G. mckeei* Resser, 1935, *G. nitida* Resser, 1935 and *G. stephenensis* Resser, 1935 are regarded as junior synonyms of *G. boccar* (Walcott, 1916b), following Sundberg (2005, page 66) and Foster (2011, page 105). Peel (2020) regarded *G. longifrons* C. Poulsen, 1927 as separate from *G. walcotti*.

Glossopleura redbrookensis Boyce, sp. nov.
Plate 1E, F; Plate 2A–F; Plate 3A–E

Etymology. For the nearby community of Red Brook.

S*tratigraphic occurrence.* Hawke Bay Formation, Grand Jardin Section (GJS) of Knight and Boyce (2014):

Section K98-29A of Knight and Boyce (2014) – *see* Appendix A
1998F065

Diagnosis. Glabella anteriorly expanding at 25°. Pygidium with relatively long (sag.) post-axial field, exhibiting a well developed ridge or keel extending from the terminal axial ring to the posterior border.

Holotype. Pygidium (NFM F-2674; Plate 3A, B).

Paratypes. Seven cranidia (NFM F-2667, Plate 1E, F; NFM F-2668, Plate 2A; NFM F-2669, Plate 2B; NFM F-2670, Plate 2C; NFM F-2671, Plate 2D; NFM F-2672, Plate 2E; NFM F-2673, Plate 2F); three pygidia (NFM F-2675, Plate 3C; NFM F-2676, Plate 3D; NFM F-2677, Plate 3E).

Description. Description of cranidium chiefly based on NFM F-2667 (Plate 1E, F). Cranidial length–width ratio is 98%. Anterior border–cranidial length ratio (sag.) is 0%. Anterior border–cranidial width ratio (tr.) is 100% (estimated), because anterior border and cranidial widths (tr.) are judged to be identical. Anterior border furrow not developed; anterior border furrow–cranidial length ratio (sag.) consequently is 0%. Preglabellar field not developed; preglabellar field–cranidial length ratio (sag.) also is 0%. Glabella extends to anterior margin, therefore glabellar–cranidial length ratio (sag.) is 100%. Glabellar–cranidial width ratio (tr.) is 33%. Glabellar length–width ratio is 164%. Glabella gently rounded, straight-sided, anteriorly expanding at 25°. Four pairs of lateral glabellar furrows, poorly defined, restricted to immediate vicinity of weakly defined axial furrows. Palpebral lobes relatively long (sag.), semicircular. Palpebral area–cranidial length ratio (sag.) is 40%. Line joining palpebral lobes' midpoints crosses sagittal line at 36% of cranidial and glabellar lengths from posterior margin, in other words, the palpebral lobes are posteriorly situated. Occipital furrow narrow, shallow. Occipital furrow–cranidial length ratio (sag.) is 0%. Occipital ring semielliptical to subrectangular; occipital ring length–width ratio is 38–40%. Occipital ring–cranidial length ratio (sag.) is 13%. Occipital ring–cranidial width ratio (tr.) is 33%.

Hypostomata, librigenae and thorax unknown.

Pygidium is strongly convex, semicircular; length–width ratio is 62–84%. Pygidial axis length–width ratio is 160–165%. Pygidial axis–pygidial length ratio (sag.) is 59–69%. Pygidial axis–pygidial width ratio (tr.) is 23–35%. Pygidial axis weakly defined, straight-sided, posteriorly

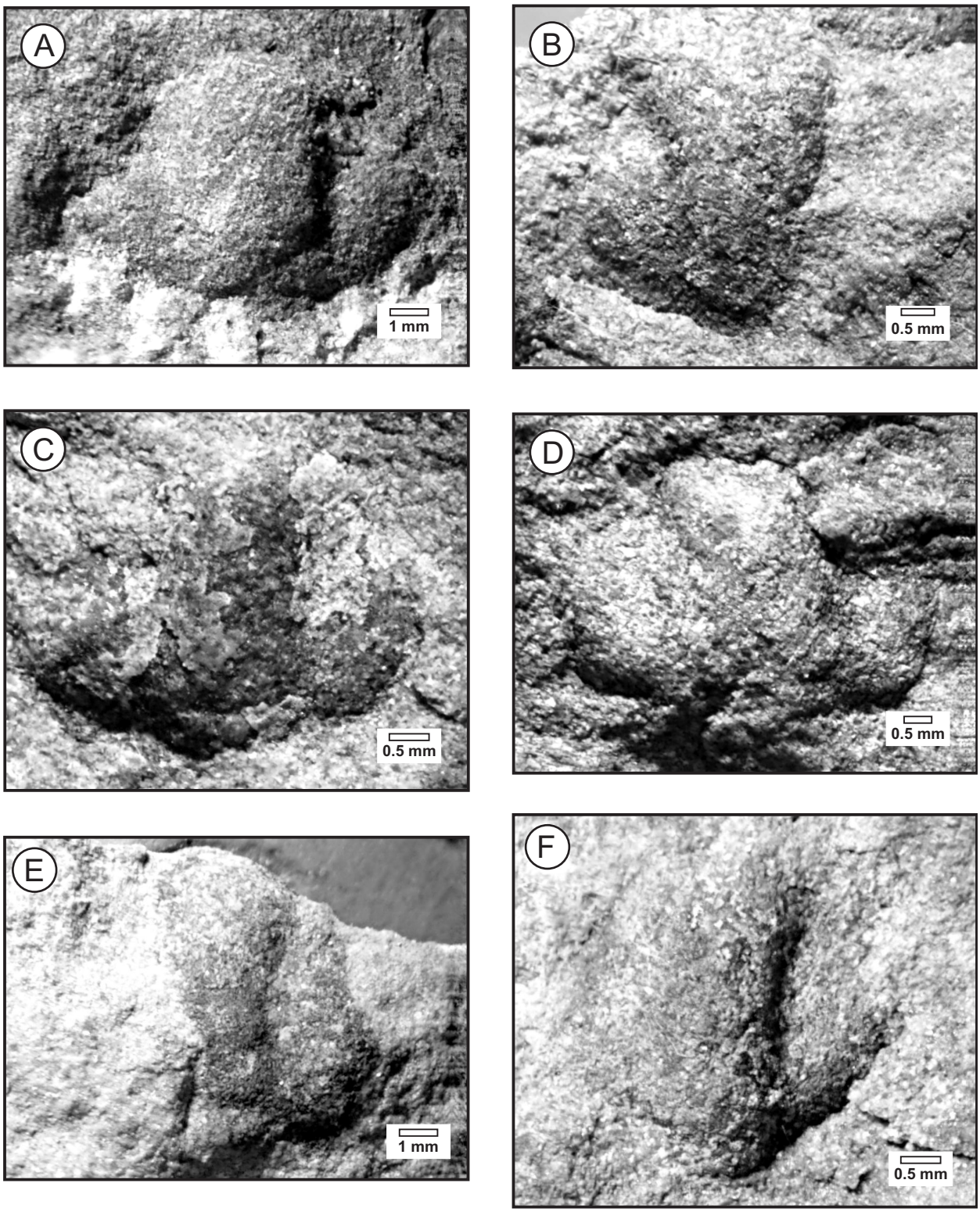
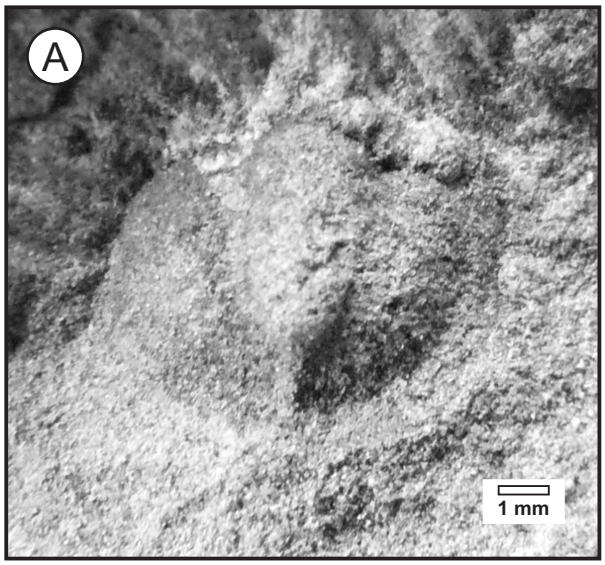
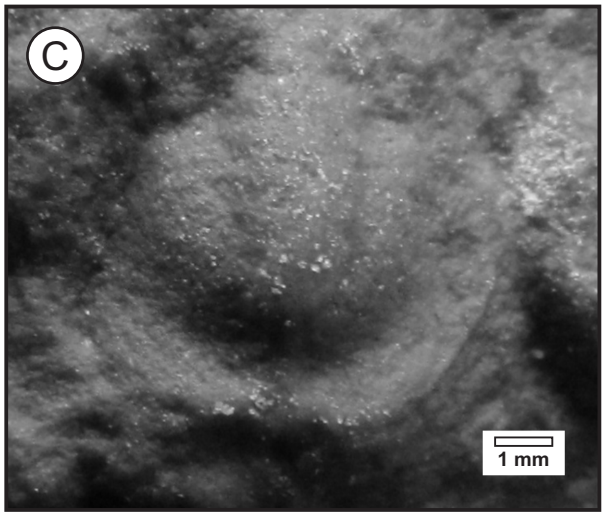
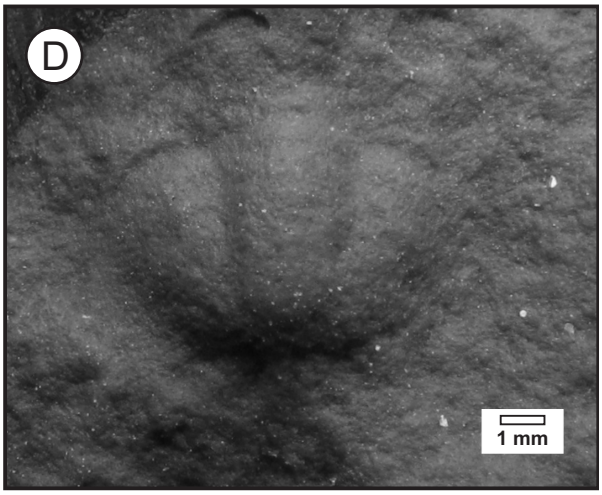


Plate 2. Glossopleura redbrookensis *Boyce, sp. nov., 1998F065. A) Paratype cranidium (original cast, NFM F-2668); B) Paratype cranidium (original cast, NFM F-2669); C) Paratype cranidium (original cast, NFM F-2670); D) Paratype cranidium (original cast, NFM F-2671); E) Paratype cranidium (original cast, NFM F-2672); F) Paratype cranidium (original cast, NFM F-2673).*







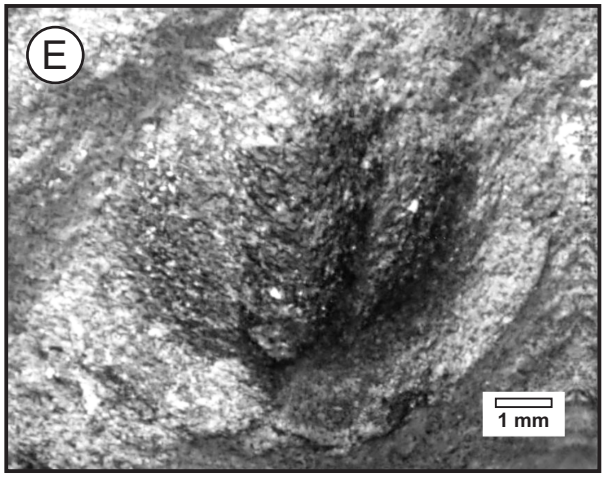


Plate 3. Glossopleura redbrookensis *Boyce, sp. nov, 1998F065. A, B) Holotype pygidium (original cast, NFM F-2674), dorsal and posterior views; C) Paratype pygidium (clay cast, NFM F-2675); D) Paratype pygidium (clay cast, NFM F-2676); E) pygidium (original cast, NFM F-2677).*

tapering; anteriorly expanding at 14–17°. Articulating half-ring subtriangular; articulating half-ring–pygidial length ratio (sag.) is 10%. Articulating half-ring–pygidial width ratio (sag.) is 23–35%. Lengths (sag.) of post-axial field and posterior border are comparable. Post-axial field–pygidial length ratio (sag.) is 15–17%. A well-developed ridge or keel extends from the terminal axial ring to the posterior border. Posterior border furrow is more a change in slope than a sharp demarcation. Posterior border concave, of constant width (exsag.); posterior border–pygidial length ratio (sag.) is 15–19%.

Remarks. Compared to *G. redbrookensis*, the more common *G. walcotti* has a more parallel-sided, less anteriorly expanding glabella and its semi-elliptical pygidium lacks a postaxial field.

Glossopleura walcotti C. Poulsen, 1927
Plate 4A–E; Plate 5A–F; Plate 6A–H; Plate 7A–E

1927 *Glossopleura walcotti* n. sp. – C. Poulsen, pages 268–269; Plate XVI, figures 20–30.
1927 *Glossopleura expansa* n. sp. – C. Poulsen, page 269; Plate XVI, figures 31, 32.
1927 *Glossopleura sulcata* n. sp. – C. Poulsen, page 272; Plate XVI, figure 39.
1927 *Glossopleura longifrons* n. sp. – C. Poulsen, page 272; Plate XVII, figure 10 only.
1946 *Glossopleura walcotti* Poulsen – C. Poulsen, page 318.
1964 *Glossopleura walcotti* Poulsen – V. Poulsen, pages 25–29; Figures 3, 4; Plate 1, figures 2–4.
1979 *Glossopleura walcotti* Poulsen – Palmer and Halley (in part), page 79; Plate 16, figures 6–8, 11–13, 16–19 not figures 14 and 15.
1987 *Glossopleura walcotti* Poulsen – Knight and Boyce, page 361, Figure 4; page 362.
1994 *Glossopleura walcotti* Poulsen – Babcock, page 94; Figure 12, 1–6.
1995 *Glossopleura* aff. *leona* Lochman – Bordonaro and Banchig; Plate 2, figures 13–14.
2009 *Glossopleura walcotti* Poulsen – Benedetto *et al.*, figure 2g.
2010 *Glossopleura walcotti* Poulsen, 1927 – Foglia and Vaccari, pages 434–435, 438, 439; Figures 4.10–23.
2011 *Glossopleura walcotti?* Poulsen, 1927 – Foster, page 106; Figures 4.4 and 4.5.
2020 *Glossopleura walcotti* Poulsen, 1927 – Peel, page 19; Figures 3A–E, G, H.
2022 *Glossopleura walcotti* Poulsen, 1927 – Foster, page 16.

Diagnosis. Glabella with deep S_1 furrows and occipital furrows (Foster, 2011, page 106; Foster 2022, page 18).

Stratigraphic occurrence. Hawke Bay Formation – *see* Appendix A:
Mike Benoit's Cliff Section (Section K98-32/032A/032B1 of Knight and Boyce, 2014)
1998F092
Red Brook Section (Section K98-29T of Knight and Boyce, 2014)
1999F126=1998F058
1999F127=1999F125=1998F090=1998F047
Grand Jardin Section (GJS) of Knight and Boyce (2014)
Section K98-03 of Knight and Boyce (2014)
1998F020
1999F123=1998F050
1999F122=1998F049

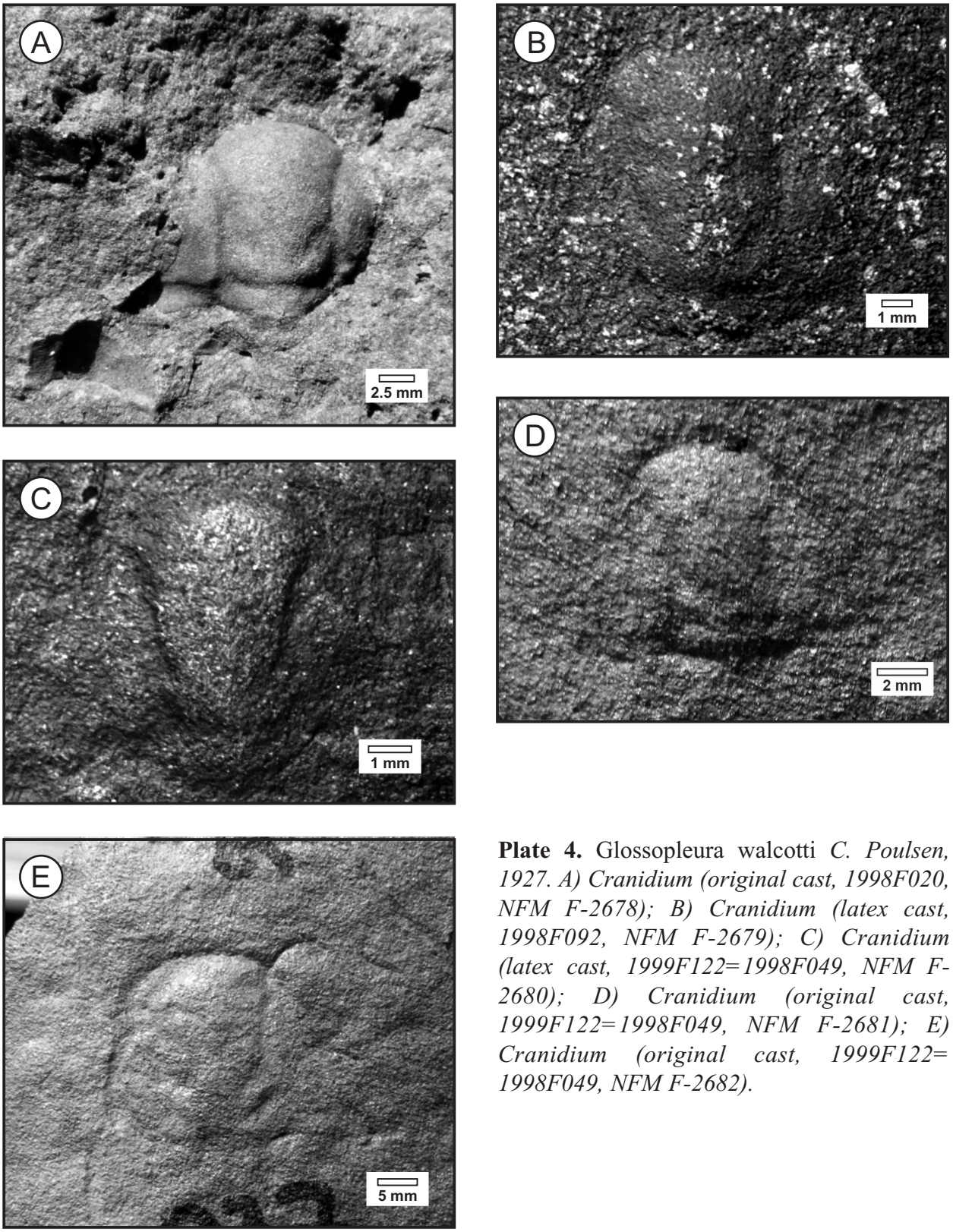


Plate 4. Glossopleura walcotti *C. Poulsen, 1927. A) Cranidium (original cast, 1998F020, NFM F-2678); B) Cranidium (latex cast, 1998F092, NFM F-2679); C) Cranidium (latex cast, 1999F122=1998F049, NFM F-2680); D) Cranidium (original cast, 1999F122=1998F049, NFM F-2681); E) Cranidium (original cast, 1999F122= 1998F049, NFM F-2682).*

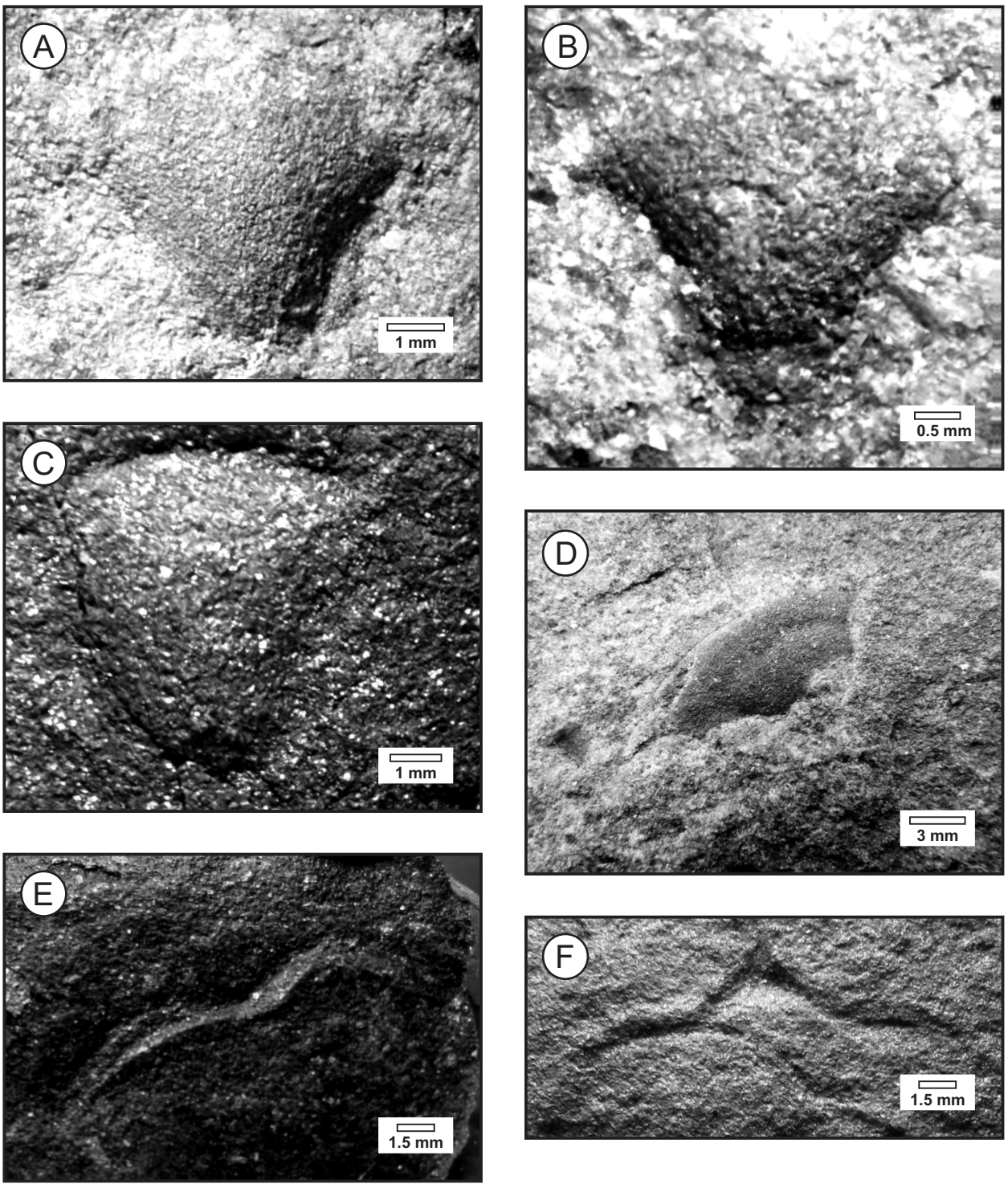


Plate 5. Glossopleura walcotti *C. Poulsen, 1927. A) Hypostome (original cast, 1999F126= 1998F058, NFM F-2690); B) Hypostome (original cast, 1999F126= 1998F058, NFM F-2691); C) Hypostome (latex cast, 1999F122= 1998F049, NFM F-2683); D) Left librigena (original cast, 1999F126= 1998F058, NFM F-2692); E) Incomplete thoracic segment (latex cast, 1999F122= 1998F049, NFM F-2684); F) Thoracic segment (original mold, 1999F122= 1998F049, NFM F-2685).*

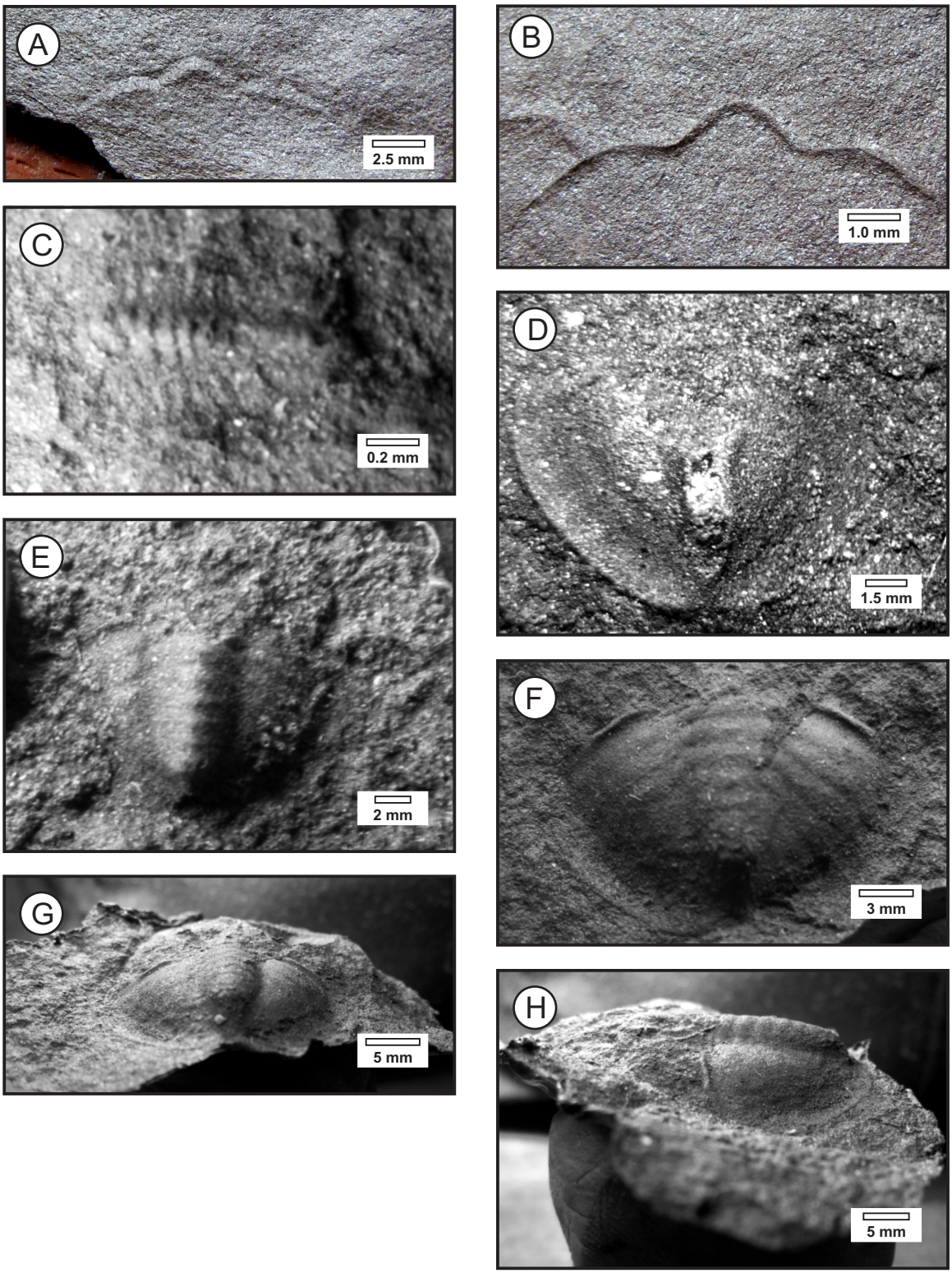


Plate 6. Glossopleura walcotti *C. Poulsen, 1927. A) Thoracic segment (original cast, 1999F122= 1998F049, NFM F-2686); B) Thoracic segment (original mold, 1999F122=1998F049, NFM F-2695), showing probable axial spine; C) Poorly preserved partial thorax and pygidium (latex cast, 1998F020, NFM F-2687); D) Pygidium (latex cast, 1998F020, NFM F-2688); E) Pygidium (latex cast, 1998F020, NFM F-2689); F–H) Pygidium (latex cast, 1999F126=1998F058, NFM F-2693), dorsal, posterior and left lateral views.*

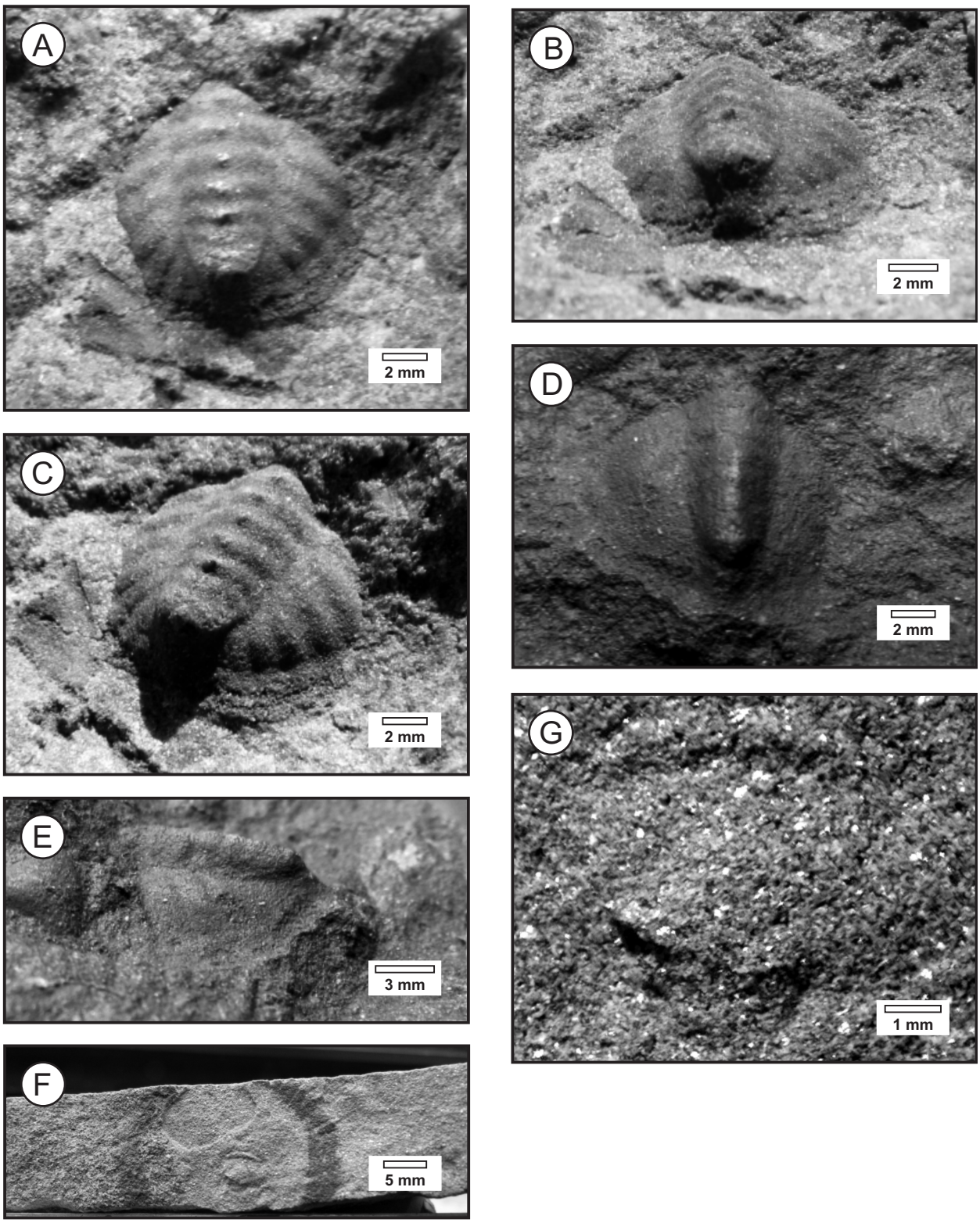


Plate 7. Glossopleura walcotti *C. Poulsen, 1927. A–C) Pygidium (original cast, 1999F126= 1998F058, NFM F-2694), dorsal, posterior and right oblique views; D, E) Pygidium (latex cast, 1998F092, NFM F-2696), dorsal and left lateral views; F, G) Ptychopariid gen. et sp. undet. Hawke Bay Formation, 1998F087. Cranidium (original cast, NFM F-2697), original and close-up views.*

Figured material. Cranidia (1998F020, NFM F-2678, Plate 4A; 1998F092, NFM F-2679, Plate 4B; 1999F122=1998F049, NFM F-2680, Plate 4C; NFM F-2681, Plate 4D; NFM F-2682, Plate 4E), hypostoma (1999F126=1998F058, NFM F-2690, Plate 5A; NFM F-2691, Plate 5B; 1999F122=1998F049, NFM F-2683, Plate 5C); left librigena (1999F126=1998F058, NFM F-2692, Plate 5D); three thoracic segments (1999F122=1998F049, NFM F-2684, Plate 5E; NFM F-2686, Plate 6A; NFM F-2695, Plate 6B); partial thorax and pygidium (1998F020, NFM F-2687, Plate 6C), pygidia (1998F020, NFM F-2688, Plate 6D; NFM F-2689, Plate 6E; 1999F126= 1998F058, NFM F-2693, Plate 6F–H; NFM F-2694, Plate 7A–C; 1998F092, NFM F-2696, Plate 7D, E).

Description. Prosopon unknown, material is non-trestate. Sclerites preserved in massive, fine grained red sandstones (*i.e.*, 1998F020, 1998F092, 1999F126=1998F058) generally exhibit strong convexity and well developed furrowing, whereas dark grey, micaceous sandy siltstone/silty sandstone-preserved material (*i.e.*, 1999F122=1998F049) has been substantially flattened and exhibits weak to moderate convexity and significant effacement of furrows. To summarize, sandstone-preserved specimens retain their true convexity and furrowing; those in sandy siltstone/silty sandstone are flattened and effaced.

Cranidium is subtrapezoidal. Glabella is moderately to strongly convex, transversely weakly vaulted, slightly concave-sided (waisted), anteriorly expanding. Preglabellar field and anterior border are not developed; glabella extends to anterior margin. S_1 is deep; imaginary line through it intersects sagittal line at 30°. Axial and occipital furrows are narrow, shallow, faint. Occipital ring is subrectangular; length–width ratio is 38%. Occipital and posterior border furrows are wide, shallow, distinct. Posterior fixigenae are small, triangular; posterior branches of facial suture diverge at 80°.

Hypostoma (NFM F-2690, Plate 5A; NFM F-2691, Plate 5B; NFM F-2683, Plate 5C) are triangular, featureless.

Librigenal length–width ratio is 283% (NFM F-2692, Plate 5D). Lateral border is weakly convex, wide. Lateral and posterior border furrows are wide, shallow, and faint.

Thorax (NFM F-2687, Plate 6C) comprises at least seven strongly vaulted (tr.) segments of constant length (sag.) and width (tr.). Pleural furrows are narrow, shallow, weakly defined.

Pygidium is semi-elliptical; length–width ratio is 70% in red sandstone-preserved specimens, 58–63% in micaceous sandy siltstone/silty sandstone-preserved specimens. Pygidial axis length–width ratio is 200% in red sandstone-preserved specimens, 249% in micaceous sandy siltstone/silty sandstone-preserved specimens. Pygidial axis–pygidial length ratio (sag.) is 79% in red sandstone-preserved specimens, 87% in micaceous sandy siltstone/silty sandstone-preserved specimens. Pygidial axis–pygidial width ratio (sag.) is 28% in red sandstone-preserved specimens, 20% in micaceous sandy siltstone/silty sandstone-preserved specimens. Axis comprises at least eight variably defined axial rings with associated axial nodes, and abruptly rounded terminal ring; posteriorly gently tapering, anteriorly expanding at an angle of 14° in red sandstone-preserved specimens, 9–10° in micaceous sandy siltstone/silty sandstone-preserved specimens. Articulating half-

ring length–width ratio is 26% in red sandstone- and micaceous sandy siltstone/silty sandstone-preserved specimens. Articulating half-ring is subtriangular; articulating half-ring–pygidial length ratio (sag.) is 10% in red sandstone-preserved specimens, 9% in micaceous sandy siltstone/silty sandstone-preserved specimens. Articulating half-ring–pygidial width ratio (sag.) is 28% in red sandstone-preserved specimens, 20% in micaceous sandy siltstone/silty sandstone-preserved specimens. Up to six pairs of variably developed pleural ribs are present. Post-axial field is absent. Posterior border is narrow, concave, abaxially widening, defined by change in slope.

Remarks. This material was assigned to *G. walcotti*, based on the deep S_1 furrows. There is a substantial variation in effacement in both the cranidia and pygidia. It is possible that the species has been overlumped.

Glossopleura walcotti was first described from North West Greenland (C. Poulsen, 1927); it is also known from the Marble Mountains of the Mojave Desert, California (Resser, 1928, 1935), the *Glossopleura walcotti* Biozones of the Carrara Formation in the Great Basin, USA (Palmer and Halley, 1979), the Emigrant Formation of Split Mountain, Nevada (Sundberg, 2018), the La Laja Formation of the Precordillera Terrane, San Juan, Argentina (Bordonaro and Branchig, 1995; Foglia and Vaccari, 2010), and around the Kane Basin of Nunavut, Canada and Greenland (Poulsen, 1946; Peel, 2020). Foglia and Vaccari (2010, page 435) excluded from *G. walcotti* the pygidia illustrated by Palmer in Palmer and Halley (1979, page 79; Plate 16, figures 14, 15).

Order PTYCHOPARIDA Swinnerton, 1915
Suborder PTYCHOPARIINA Richter, 1933
Superfamily PTYCHOPARIACEA Matthew, 1887
Family PTYCHOPARIIDAE Matthew, 1887

ptychopariid gen. et sp. undet.
Plate 7F, G

Stratigraphic occurrence. Hawke Bay Formation, Grand Jardin Section (GJS) of Knight and Boyce (2014):

Section K98-07B of Knight and Boyce (2014) – *see* Appendix A
1998F087

Figured material. One cranidium (NFM F-2697; Plate 7F, G).

Description. Cranidium is weakly convex. Anterior border is distinct, moderately convex, rim-like, long (sag.), convex-forward. Anterior border–cranidial length ratio (sag.) in front of glabella is 10%, abaxially non-tapering. Anterior border furrow is distinct, deep; anterior border furrow–cranidial length ratio (sag.) in front of glabella is 5%, abaxially non-tapering. Preglabellar field is long (sag.); preglabellar field–cranidial length ratio (sag.) is 18%. Glabella is slightly rounded, moderately convex, transversely moderately vaulted, straight-sided, anteriorly tapering, posteriorly expanding at 30° glabellar length–width ratio is 150%. Glabellar–cranidial length ratio (sag.) is 83%. Lateral glabellar furrows are not developed, except for deep, distinct S_1, the imaginary line through which intersects the sagittal line at 55°. Axial furrows narrow, distinct. Palpebral areas not preserved. Occipital furrow is distinct, deep; occipital furrow–cranidial length ratio (sag.) is 5%.

Occipital ring is crescentic, concave forward; length–width ratio (sag.) is 18%. Occipital ring–cranidial length ratio (sag.) is 10%. Posterior fixigenae are not preserved. Prosopon is unknown.

Remarks. The cranidium is only 5 mm long, and was the only body fossil found in 1998F087. It occurs in grey, micaceous, sandy siltstone/silty sandstone with some flat pebbles; the horizon is rich in trace fossils (*Cruziana*, *Rusophycus*, scratch marks, a swaly specimen, and paired, plug-like specimens on the bases of beds – probably u-shaped burrows.)

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APPENDIX

Appendix A is available as a digital comma-separated file (.csv) through this link.

APPENDIX A: Sample details of trilobite taxa referred to in the report.