

Review Article

Review of the genus *Crangopsis* (Crustacea: Malacostraca: Peracarida) with a description of two new species from the Carboniferous of Scotland

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ABSTRACT: This study reviews *Crangopsis* based on newly collected material from Carlops, Bearsden (and equivalent exposures of the same horizon), Granton and Ardross and a redescription of older collections mostly held in The Hunterian, University of Glasgow, Scotland. Two new species, *Crangopsis carlopsensis* sp. nov. and *Crangopsis baljaffrayensis* sp. nov., are described based on diagnostic character differences such as the shape of the pleura on the pleon. Newly observed structures on *Crangopsis* include a short acute ridge of unknown purpose on the pleonal pleura, a short rostrum, a vertical straight cervical groove on the carapace, as well as several thoracic body segments (thoracomeres) that do not appear to be attached to the carapace. The eight paired thoracopods and two maxillipeds and the separate thoracomeres indicate that *Crangopsis* is an early member of the Mysidacea.



KEY WORDS: crustacean, Carboniferous, Eumalacostracan, mysidacean, Scottish

1. Introduction

Crustaceans representing many of the extant groups of Malacostracans have been recorded from the Carboniferous rocks of Scotland since the mid-1800s and provide a small contribution to the overall palaeodiversity of that period. In the late 1970s, Euan Clarkson (University of Edinburgh) joined forces with Derek Briggs (then of Goldsmiths, University of London) to examine an unusual lagerstätte from the Firth of Forth at Muirhouse, near Edinburgh, Scotland (Briggs & Clarkson 1983; Clarkson 1985; Briggs *et al.* 1991). This lagerstätte contains many crustaceans, fish, soft-bodied animals, and the first examples of the famous conodont animal (Aldridge *et al.* 1993). Clarkson, with other researchers, continued the project throughout the 1980s, producing a comprehensive body of work on the palaeoenvironments, palaeoecology, taxonomy and taphonomy of these rarely preserved crustaceans that have served as a foundation to the continuing study of these fossils in the Carboniferous rocks of Scotland and elsewhere (Schram 1979, 1983; Briggs & Clarkson 1983, 1985, 1989; Cater 1987; Cater *et al.* 1989; Clark *et al.* 2017). The higher taxonomy of these crustaceans has been widely debated, and some species have shifted between different groups depending on the interpretation of diagnostic structures. The taphonomy of the crustaceans and the process of moulting can influence the interpretation of certain structures (for example, whether the carapace is connected to all the thoracomeres could depend on whether the fossil represents a moult or a carcass (Clark 2013).

The earliest Carboniferous malacostracan crustaceans from Scotland are found in the Ballagan Formation of the Tournaisian in the Scottish Borders (Clark & Ross 2024) and

the latest are from the Duckmantian (Bashkirian) deposits of the Midland Valley of Scotland (Schram 1979; Clark 2024). *Crangopsis* has been recorded from rocks that span the range from the Asbian to the Duckmantian (Bashkirian) of the Airdrie Blackband Ironstone (Peach 1908; Ross 2010; McLean 2018) (Fig. 1), although also from the earliest Carboniferous of Northumberland (Peach 1908).

The earliest description of *Crangopsis* was by Salter (1861a) where he described a small shrimp-like crustacean from the Carboniferous of Fife which he named *Uronectes socialis*. Later, he recognised that the name ‘*Uronectes*’ should not be applied to this crustacean as it was different in the number of exposed segments and suggested it represented a macrurous decapod giving it the name *Palaeocrangon* (Salter 1861b). As this genus was previously occupied by an amphipod crustacean, Salter again renamed the crustacean as *Crangopsis* (Salter 1863). Since then, ten species of *Crangopsis* have been recognised by Peach (1908) which were subsequently synonymised into two species by Schram (1979) – *Crangopsis socialis* (Salter) and *Crangopsis eskdaleensis* (Peach). Peach had concluded that *Pygocephalus huxleyi* should not be placed within the genus *Pygocephalus* as originally described by Huxley (1862) and Woodward (1867) but should be included in the genus *Crangopsis* based on the woodcut images, and he named it *Crangopsis huxleyi* (Woodward). Although Huxley had the original specimen to study from the collections of the Reverend William Fraser of Paisley, only the woodcuts were available to Woodward, and Peach (1908) just mentioned this species and used the same illustration as Huxley. The specimen of *Crangopsis huxleyi* was still not available for Schram (1979) to study and is now considered to be lost. As the specimen of *Crangopsis huxleyi* comes from the Limestone Coal Formation

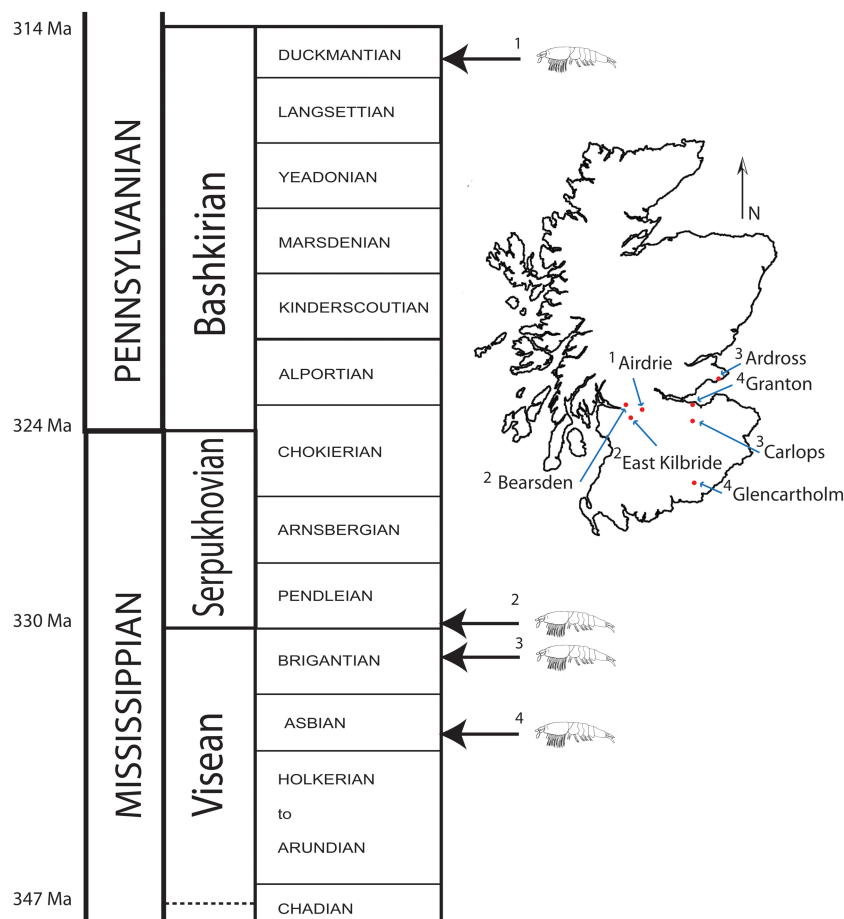


Figure 1. Map of Scotland showing the main localities and geological timescale showing the different occurrences of the genus *Crangopsis* in Scotland: 1 = Airdrie; 2 = Bearsden, East Kilbride and equivalent localities; 3 = Ardross and Carlops; 4 = Glencartholm and Granton. Ages of boundaries based on Cohen et al. (2013).

(based on the description from Huxley 1862 and the stratigraphy documented in Hinxman *et al.* 1920 and Schram 1979), it would appear likely that it came from an equivalent horizon to the strata at Bearsden recorded as 'Manse Burn Formation' by Clark (1989) and probably best renamed as the 'Manse Burn Beds' as part of the Limestone Coal Formation. This level is dated to within the lower Serpukhovian in the western Midland Valley of Scotland (Clark 1989). Without the original specimen of *C. huxleyi* it is impossible to say if it is a species of *Crangopsis* or *Palaemysis* as the expanded second pleonal pleuron is a characteristic of both *Crangopsis* and *Palaemysis* and both these genera are often found together (Clark 1989, 1991). It is possible that *C. huxleyi* is synonymous with the new species *C. baljaffrayensis* sp. nov. described in this study, but without the original specimen it is impossible to be certain.

Peach (1908) split *Crangopsis* into two distinct groups. The first included species that had an enlarged pleuron on the second pleonal somite that overlapped the pleura of the first and third somites. This group included: *C. socialis*; *C. eskdalensis*; *C. huxleyi*; and *C. elegans* (Peach) (which were later grouped into two species by Schram (1979); *C. socialis* and *C. eskdalensis*). The second grouping was for species where the pleuron of the second pleonal somite is pointed and only slightly overlapped backwards on the succeeding pleuron. This second group included: *C. couttsi* Peach; *C. rhodesi* Peach; *C. magna* Peach; *C. robusta* Peach; *C. minuta* Peach; and *C. hastata* Peach. The second group was later synonymised with *Anthracophausia* by Schram (1979).

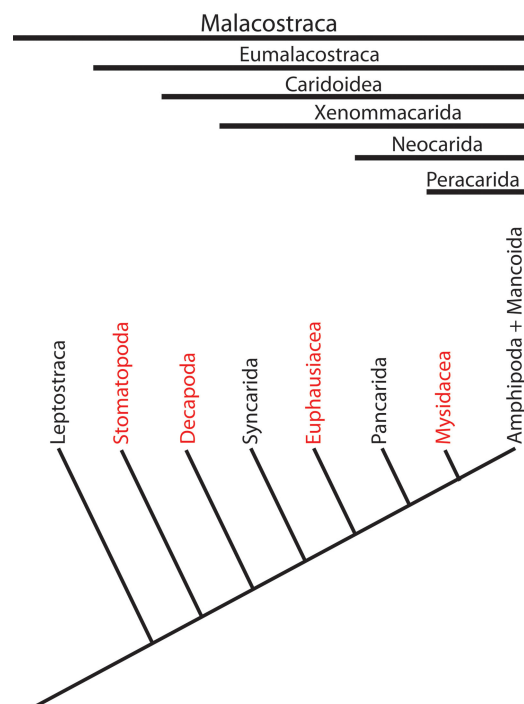


Figure 2. Simplified relationships and taxonomic hierarchy of the living malacostracan crustaceans based on Richter and Scholtz (2001) with the groups in red that *Crangopsis* has previously been assigned to.

Table 1 Scottish localities from which *Crangopsis* has been recorded that were used in this study.

Locality	Age	Species recorded	Author	Notes
Airdrie	Duckmantian (Bashkirian)	<i>Palaemysis dunlopi</i> or <i>Anthracophausia?</i>	Peach (1908) and Schram (1979)	Has been catalogued as <i>Crangopsis</i> in The Hunterian collections and accepted as such in this study.
Bearsden, East Dunbartonshire and equivalent horizons	Pendelian (Serpukhovian)	<i>Crangopsis</i> sp.	Clark (1989)	Excellent preservation except for tail fans. Here described as <i>Crangopsis baljaffrayensis</i> sp. nov.
East Kilbride, South Lanarkshire	Pendleian (Serpukhovian)	<i>Crangopsis couttsi</i>	Peach (1908)	Synonymised with <i>Anthracophausia</i> by Schram (1979).
Ardross, Fife	Brigantian (Viséan)	<i>Crangopsis socialis</i>	Salter (Salter, 1861a) and Peach (1908)	Type locality for <i>Crangopsis</i> .
Amazondean Farm, near Carlops, Scottish Borders	Brigantian (Viséan)	<i>Crangopsis</i> cf. <i>socialis</i>	Mitchell & Mykura (1962) and Schram (1979)	Highly degraded material in BGS collections according to Schram (1979). Here described as <i>Crangopsis carlopsensis</i> sp. nov.
Glencartholm, Dumfries & Galloway	Asbian (Viséan)	<i>Crangopsis eskdalensis</i>	Peach (1882)	The only other species recognised by Schram (1979).
Glencartholm, Dumfries & Galloway	Asbian (Viséan)	<i>Crangopsis magna</i>	Peach (1908)	Synonymised with <i>Anthracophausia</i> by Schram (1979).
Granton	Asbian (Viséan)	<i>Crangopsis socialis</i> and <i>Waterstonella grantonensis</i>	Schram (1979), Briggs & Clarkson (1983)	This study follows the assertion that <i>Waterstonella</i> is <i>Crangopsis</i> as suggested by Clark (1989).

Brooks (1962) suggested that *Crangopsis* and *Anthracophausia* could only be distinguished based on the length of the rostrum and that they should be classified together as ancestral euphausiadians. Schram (1979) went further and placed *Crangopsis* within the Hoplocarida and compared it with *Aratidecthes* on which he recorded the second maxilla as being stenopod (referring to it having the appearance of a walking limb). *Crangopsis* has more recently been assigned to the Kallidecthidae (another crustacean that has been assigned to the Hoplocarida (Stomatopoda)) based on the thoracopods shortening posteriorly (Hyzny *et al.* 2014). This is not the case with well-preserved examples of *Crangopsis* from Granton where the limbs do not appear to reduce in length posteriorly. The number of paired thoracopods is ten, where the anterior two pairs appear slightly shorter than the posterior eight (and possibly modified as maxillipeds). This is more characteristic of the Mysidacea than the Stomatopoda although the pleuron of the second pleonal somite expands to partially cover those of the first and third somites. The expansion of the pleura seems to be a feature of some decapods rather than any other group, but this may represent a feature that evolved separately in the Decapoda but was lost in the extant Mysidacea. Schram & Koenemann (2021) placed *Crangopsis* in the Aeschronectida (an order of the Hoplocarida); however, the diagnostic characters for this order include triflagellate antennules which none of the examples of *Crangopsis* studied here exhibit, having only two. The telson of *Crangopsis* is also bifid rather than sub-rectangular and flat, which is diagnostic of aschronectidans. *Crangopsis* is therefore here considered as a primitive mysidacean as previously suggested by Van Straelen (1931) rather than a decapod as originally indicated by Salter (1861b); euphausiacean (Peach 1908; Brooks 1962); or hoplocarid (Schram 1979; Hyzny *et al.* 2014; Schram & Koenemann 2021) (Fig. 2).

Waterstonella is a genus under consideration here as being a synonym of *Crangopsis*. It has been previously placed as the sole member of its own family (Waterstonellidae) by Schram (1979) and order Waterstonellidea (Schram 1981). The type specimen of this genus is not well preserved but there are many hundreds of well-preserved examples assigned to this species that have been

recovered from the same locality (Briggs & Clarkson 1983). These are often closely associated with specimens identified as *Crangopsis*. The Waterstonellidea was considered by Schram (1981) to be a sister group to the Mysidacea within the Mysoida. The gross morphological similarity, as well as some diagnostic characters in common between these two genera, are here considered adequate to synonymise the two genera.

Only one other specimen of *Waterstonella* has been identified from another locality in Ireland (Orr & Briggs 1999). The illustration of the specimen also appears to be indistinguishable from specimens identified elsewhere as *Crangopsis*. This specimen will need to be re-examined in light of this study.

2. Material used in this study

The material used in this study are crustaceans in the collections of The Hunterian, University of Glasgow, that have been classified as *Crangopsis* and come from several localities around Scotland (Table 1). Some of these locations were examined by Euan Clarkson with Derek Briggs for their study on the Carboniferous crustaceans project in the 1980s. Other material used includes material mentioned previously by Schram (1979), Clark (1989) and Briggs *et al.* (1991).

3. Institutional abbreviations

GLAHM: The Hunterian, University of Glasgow, Glasgow, UK; NMS: National Museums of Scotland, Edinburgh, UK; BGS: British Geological Survey.

4. Taxonomy

Subclass EUMALACOSTRACA Grobben, 1892 *sensu* Martin & Davis, 2001

Order MYSIDACEA Haworth, 1825

Genus *Crangopsis* Salter, 1863

Diagnosis adapted from Schram 1979. Laterally compressed crustacean with a subtrapezoidal carapace with very short rostrum and a vertical cervical groove; antennal peduncles moderately large and long; antennules with paired flagella;

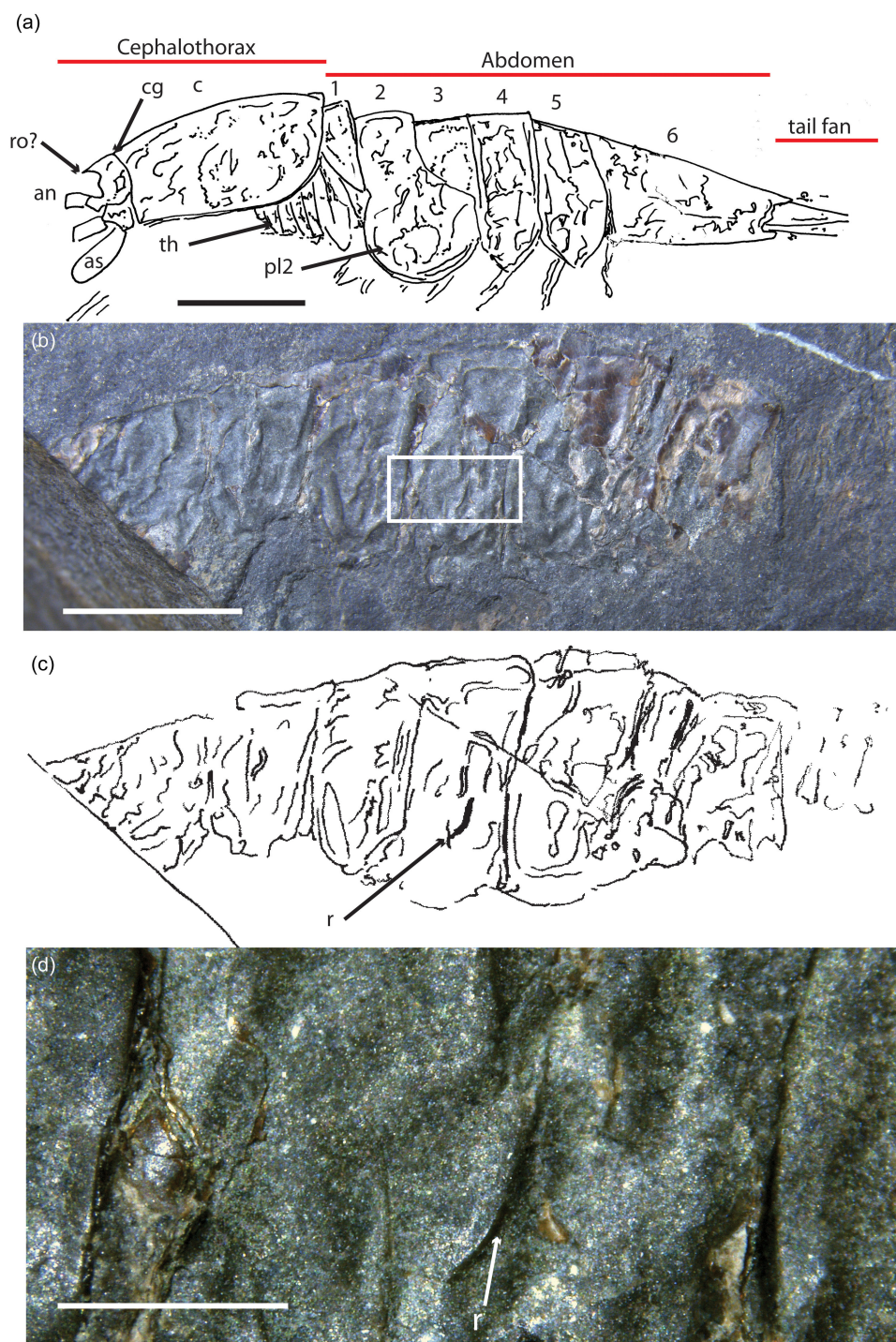


Figure 3. (a) Sketch of the type specimen of *Crangopsis socialis* (BGS GSI 87432) from the Lower Ardross Limestone showing the major subdivisions of the crustacean body. (b, c, d) Specimen GLAHM 163471 from Ardross showing the enlarged second pleonal pleuron and expanded view (d) of the raised ridge on the third pleonal somite. 1–6 – pleonal somites; an – antennules; as – antennal scale; c – carapace; cg – cervical groove; pl2 – second pleonal pleuron; r – ridge on pleonal somite; ro – rostrum; tf – tail fan; th – thoracomeres. Scale bar (a–c) = 5 mm; (d) = 1 mm.

pleon 2.5 times the length of the cephalothorax; pleonal pleura well developed; sixth pleonal somite especially elongate; pleuron of second pleonal somite expands anteriorly as well as posteriorly. Bifid telson associated with elongated uropodal exopods and short uropodal endopods.

Type species. *Uronectes socialis* Salter, 1861a. Ardross, Fife; Brigantian.

Holotype. BGS GSM 87432/GSE 14002 (Schram 1979; fig. 10) (Fig. 3a).

Crangopsis socialis (Salter 1861a)
(Figs 3a–d, 4a–d, 5a–d, 6a–c)

In addition to the extensive synonymy list provided by Schram (1979):

1979 *Waterstonella grantonensis* Schram (pp. 73–75; figs 30, 31)

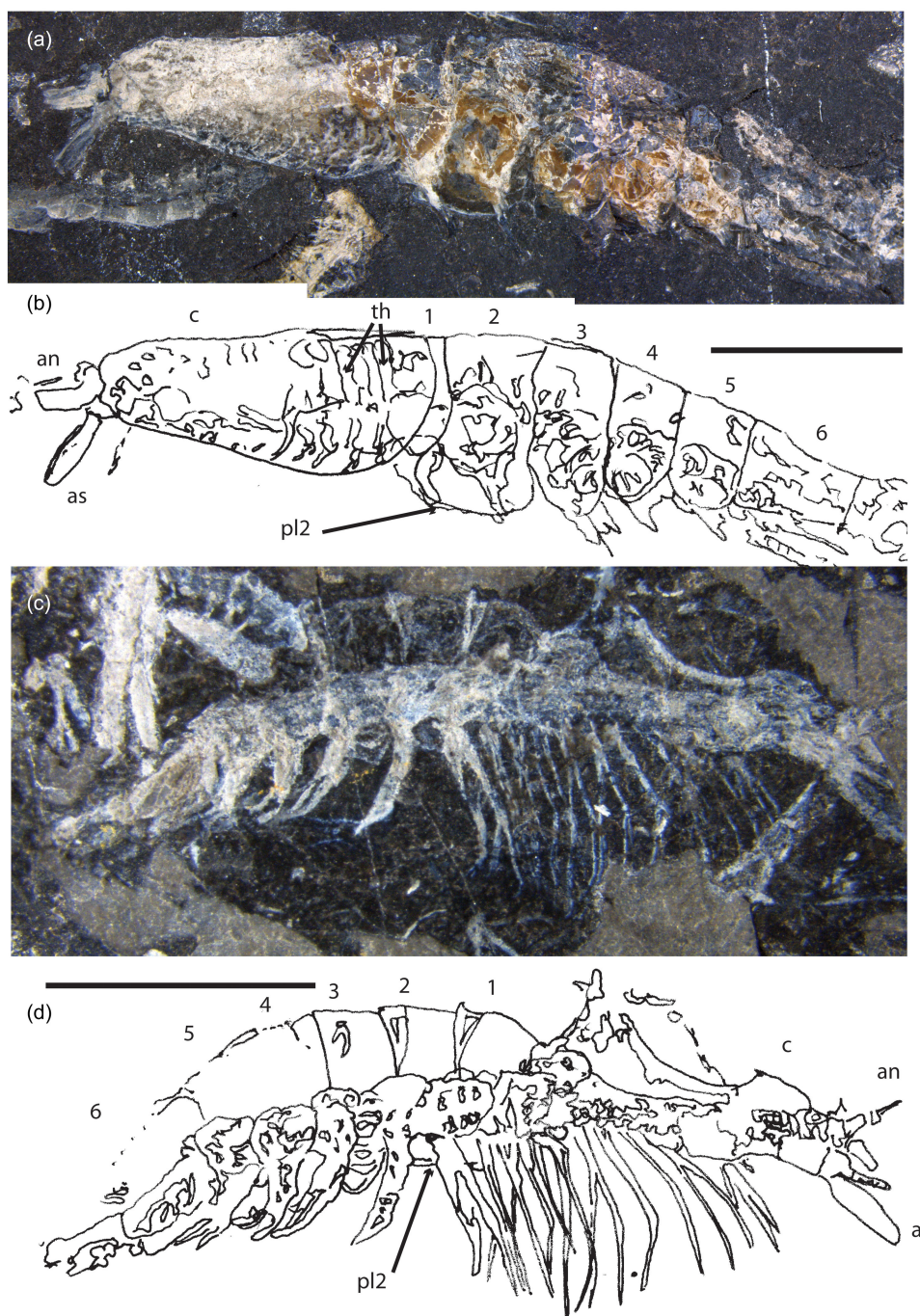


Figure 4. (a, b) *Crangopsis socialis* from Granton showing partial 'ghosting' of the cuticle especially thinned on parts of the carapace and pleura of the pleonal somites where the limbs are showing through (GLAHM 152337). The second pleonal pleuron expands anteriorly and posteriorly to overlap those of the first and third pleonal pleura. (c, d) Moult of *Crangopsis socialis* with thinner cuticle that would have previously been classified as *Waterstonella grantonensis*. The carapace has folded and is misshapen and the pleonal somites and pleura are 'ghosting' but still discernible, including the expanded pleuron of the second pleonal somite. The biramous thoracopods are well preserved. 1–6 – pleonal somites; an – antennules; as – antennal scale; c – carapace; pl2 – second pleonal pleuron. Scale bar = 5 mm.

1983 *Crangopsis* sp. Briggs & Clarkson (p. 165; text-fig. 5f–h; pl. 22, figs 6–8)

1983 *Crangopsis socialis* (Salter). Briggs & Clarkson (p. 165; text-fig. 5i; pl. 22, fig. 9)

1983 *Waterstonella grantonensis* Schram. Briggs & Clarkson (pp. 170–175; text-fig. 4a–f; text-fig. 5a–e; text-fig. 6; pl. 20, fig. 1; pl. 21, figs 2–9; pl. 22, figs 1–5)

Material. Holotype BGS GSM 87432/GSE 14002 designated by Schram (1979; p. 41 (Fig. 3a); GLAHM 163471 from the Lower Ardross Limestone (Brigantian); GLAHM 152337 (Fig. 4a–b), GLAHM 163462 (Fig. 4c–d), GLAHM 163467 (Fig. 5a–b),

BGS GSE 13053 (Fig. 5c–d), NMS GY1989.2.9 (Fig. 5d), GLAHM 163466 (Fig. 6) from the Granton Shrimp Bed (Asbian). A total of 14 specimens from Ardross were examined from the collections of the BGS, NMS and GLAHM. Extensive collections of material from Granton were examined from the collections of the NMS and GLAHM.

Emended diagnosis (after Schram 1979). Second pleonal pleuron broadly rounded. Posterior pleonal somite pleura tapered posteroventrally.

Description. Carapace has a faint vertical cervical groove (Fig. 3a) which is very difficult to discern due to the wrinkled

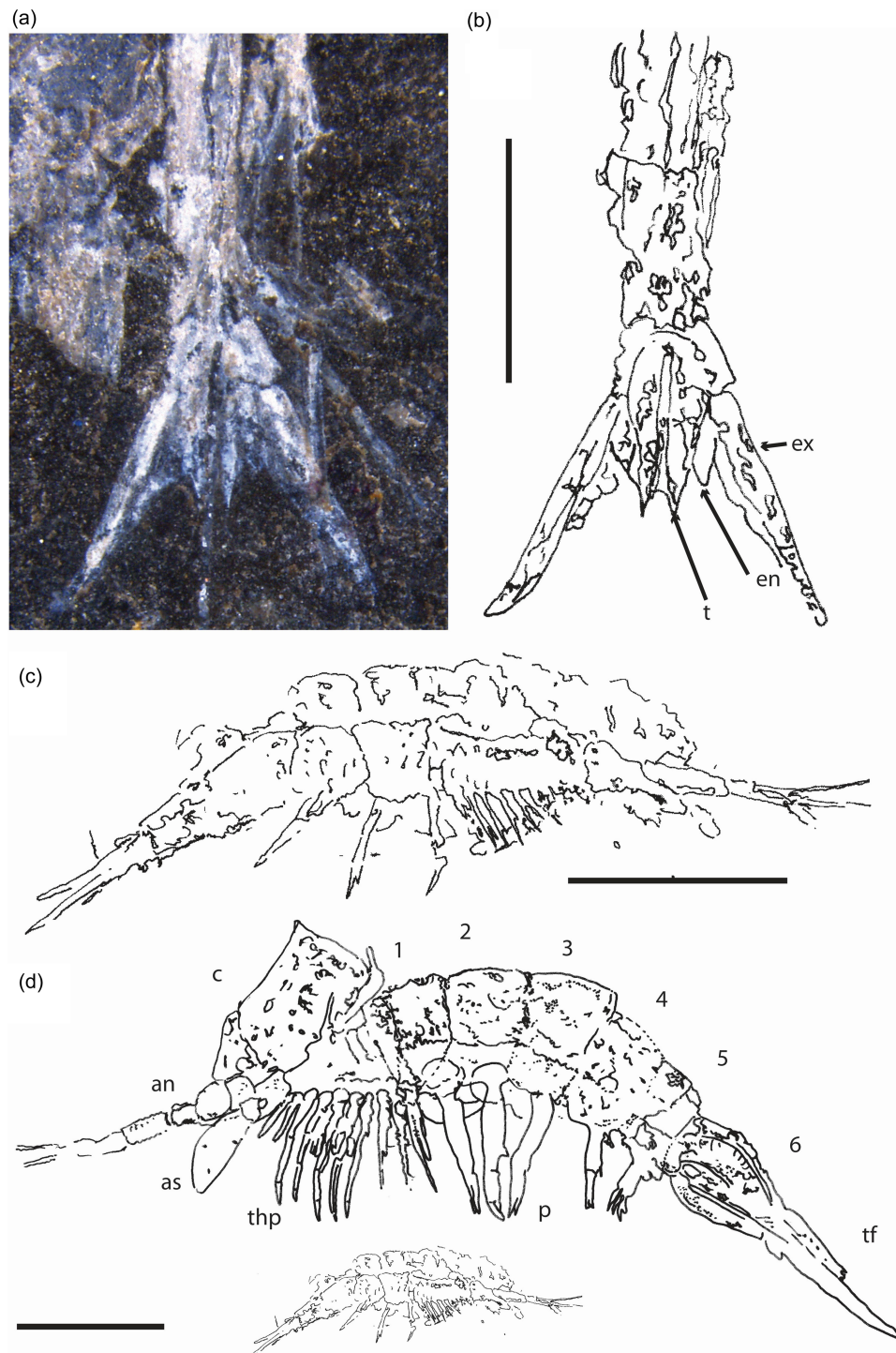


Figure 5. (a, b) Tail fan of *Crangopsis socialis* from Granton showing the bifid nature of the telson with short uropodal endopods and elongate uropodal exopods (GLAHM 163467). (c) Sketch of type specimen of *Waterstonella grantonensis* designated by Schram (1979) (BGS GSI 13053). (d) Sketch of large specimen identified by Briggs et al. 1991 as *Waterstonella grantonensis* with the type specimen below at the same scale. 1–6 – pleonal somites; an – antennules; as – antennal scale; c – carapace; en – uropodal endopod; ex – uropodal exopod; p – pleopods; t – telson; tf – tail fan; thp – thoracopods. Scale bar (a–b) = 2 mm; (c) = 3 mm; (d) = 5 mm.

nature of the cuticle. This extends to the pleon where a short ridge appears on the second, third and fourth pleonal somites (Fig. 3b–d).

Remarks. The reason for including *Waterstonella grantonensis* in the synonymy list is that it is impossible to distinguish between *Crangopsis* and *Waterstonella* in the rocks at Granton on morphological grounds (Figs 3–5). The type specimen of *Waterstonella* (Fig. 5c–d) has a poorly preserved cuticle, as have many of the specimens that have previously been identified as *Waterstonella*. The thinning of the cuticle and the vast number

of fragmentary parts to the crustaceans suggests that many of the specimens preserved at Granton represent moults. Both those identified as *Crangopsis* and *Waterstonella* have the same number of thoracopods, identical pleopods, elongated sixth pleonal somite, a bifid telson with short uropodal endopods and blade-like uropodal exopods. The main character that has been used to differentiate the two forms appears to be the thickness of the cuticle. The thinning of the cuticle is likely to be the result of the resorption of the cuticle during moulting (Corteel & Nauwynck 2010). The wrinkled nature of the cuticle may

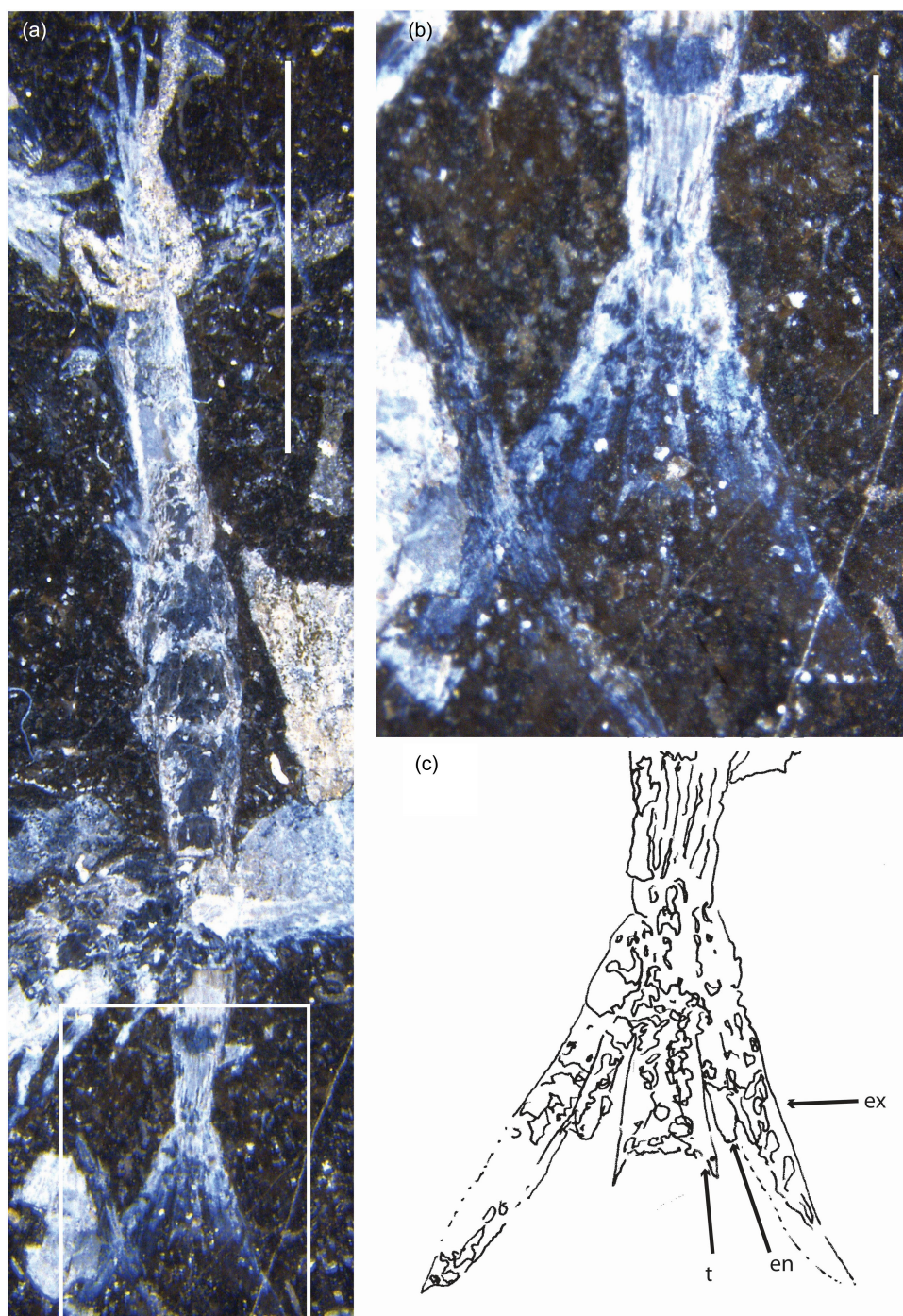


Figure 6. (a, b, c) Dorso-ventrally preserved specimen of *Crangopsis socialis* from Granton showing bifid telson, shorter uropodal endopods and elongated blade-like uropodal exopods (GLAHM 163466). (b, c) white box on (a) enlarged. en – uropodal endopod; ex – uropodal exopod; t – telson. Scale bar (a) = 5 mm; (b–c) = 2 mm.

represent the moulted carcass of crustacean prior to the new cuticle hardening (Drage & Daley 2016 and Drage *et al.* 2019 describe similar structures in trilobites which are perhaps not the best animal for comparison due to the robustness of the calcified cuticle post ecdysis) or the demineralised remains of the shed cuticle. The separation of the carapace from the pleon in the examples of specimens with thin cuticle would suggest that the thinner cuticle fossils represent moults and the thicker cuticle fossils represent carcasses. The preservation, or not, of the pleura, even on specimens confidently identified as *Crangopsis*, is variable and probably related to postmortem or post-moulting taphonomy. The shape of the carapace and the tail fan also varies greatly amongst the thinner cuticle

specimens. Where the loosely attached cuticle (such as the carapace) is thinner, it is more likely to fold and change shape, or more easily become damaged especially in crustaceans where the cuticle on the living crustacean was already quite thin prior to resorption of minerals during ecdysis (Corteel & Nauwynck 2010). As the major body features mentioned previously are indistinguishable between those specimens identified as one species or the other, the two species *Crangopsis socialis* and *Waterstonella grantonensis* are here considered to be synonymous.

Crangopsis eskdalensis (Peach 1882)

(Fig. 7a–c)

Full synonymy list provided by Schram (1979).

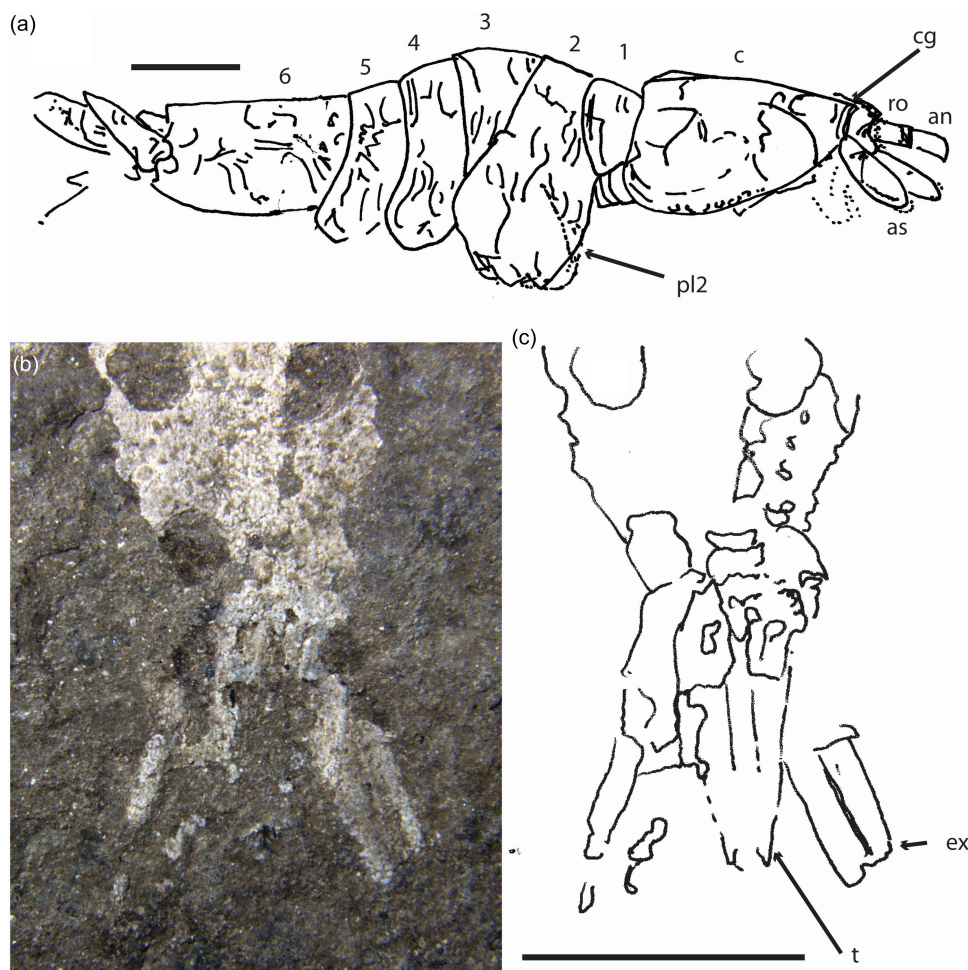


Figure 7. (a) Sketch of the lectotype specimen of *Crangopsis eskdalensis* from Glencartholm showing the shape of the second pleonal pleuron (BGS GSE 5007). (b, c) tail fan from the same locality showing the bifid telson and elongate blade-like uropodal exopods (GLAHM 101117). 1–6 – pleonal somites; an – antennules; as – antennal scale; c – carapace; cg – cervical groove; ex – uropodal exopod; pl2 – second pleonal pleuron; ro – rostrum; t – telson. Scale bars = 5 mm.

Material. Lectotype BGS GSE 5007 (Fig. 7a) designated by Schram (1979, p. 42); GLAHM 101117 (Fig. 7b–c) from the Glencartholm Volcanic Beds (Asbian). Over 20 specimens were examined from the collections of the BGS, NMS and GLAHM.

Emended diagnosis (after Schram 1979). Second pleonal pleuron broadly rounded. Posterior pleonal somite pleura rounded posteroventrally.

Description. Carapace has a faint vertical cervical groove which is very difficult to discern due to the wrinkled nature of the cuticle similar to *C. socialis*. This species tends to be preserved less wrinkled but is more friable perhaps as a result of different taphonomic pathways, life environments, or environments of deposition. There is also a short ridge on the second, third and fourth pleonal somites. The second pleonal pleuron appears to be more inflated than *C. socialis*, but this may also be an artefact of the preservation of these crustaceans.

Remarks. Schram (1979) indicated that the main differences between *C. eskdalensis* and *C. socialis* were that *C. socialis* was bigger than *C. eskdalensis*, that the carapace of *C. socialis* extends further back, the first pleonal somite is longer in *C. socialis*, the posterior pleura attenuate posteriorly in *C. socialis*, and the pleuron of the second pleonal somite is flatter ventrally in *C. eskdalensis*. While the pleuron of the second pleonal somite is less rounded than that of *C. socialis*, it was found that the lectotype still appears to have rounded pleura rather than rectangular. The main difference appears to be that

the pleura of the posterior somites are drawn posteriorly rather than anteriorly as they seem to be in *C. socialis*.

Crangopsis carlopsensis sp. nov.

(Figs 8a–d, 9a–b)

Etymology. Named after the village close to where the type material was found.

Material. Holotype GLAHM 163469 (Fig. 8a–b); Syntypes GLAHM 163468 (Fig. 8c–d); GLAHM 163470 (Fig. 9) from Carlops Bridge near Amazondean Farm on the south bank of the River North Esk (NT16785646) (Brigantian). A total of eight specimens were examined for this study in the collections of GLAHM.

Diagnosis. Second pleonal pleuron broadly rounded. Posterior pleonal somite pleura with flatter termination posteroventrally.

Description. Carapace has a faint vertical cervical groove which is very difficult to discern due to the wrinkled nature of the cuticle. The rostrum is very short if present. The thoracic somites (thoracomeres) are long in lateral aspect suggesting that several of the posterior somites may be free from the carapace (Fig. 8c, d). The wrinkled cuticle also extends to the pleon where a short ridge appears on the second pleonal somite (Fig. 8a, b). Preservation at this locality is quite poor and Schram (1979) mentioned that the crustaceans in the collections of the Geological Survey were ‘disintegrating badly with time’ due to the pyrite content of the shales. The expansion of the second pleonal pleuron is preserved well however, as are the

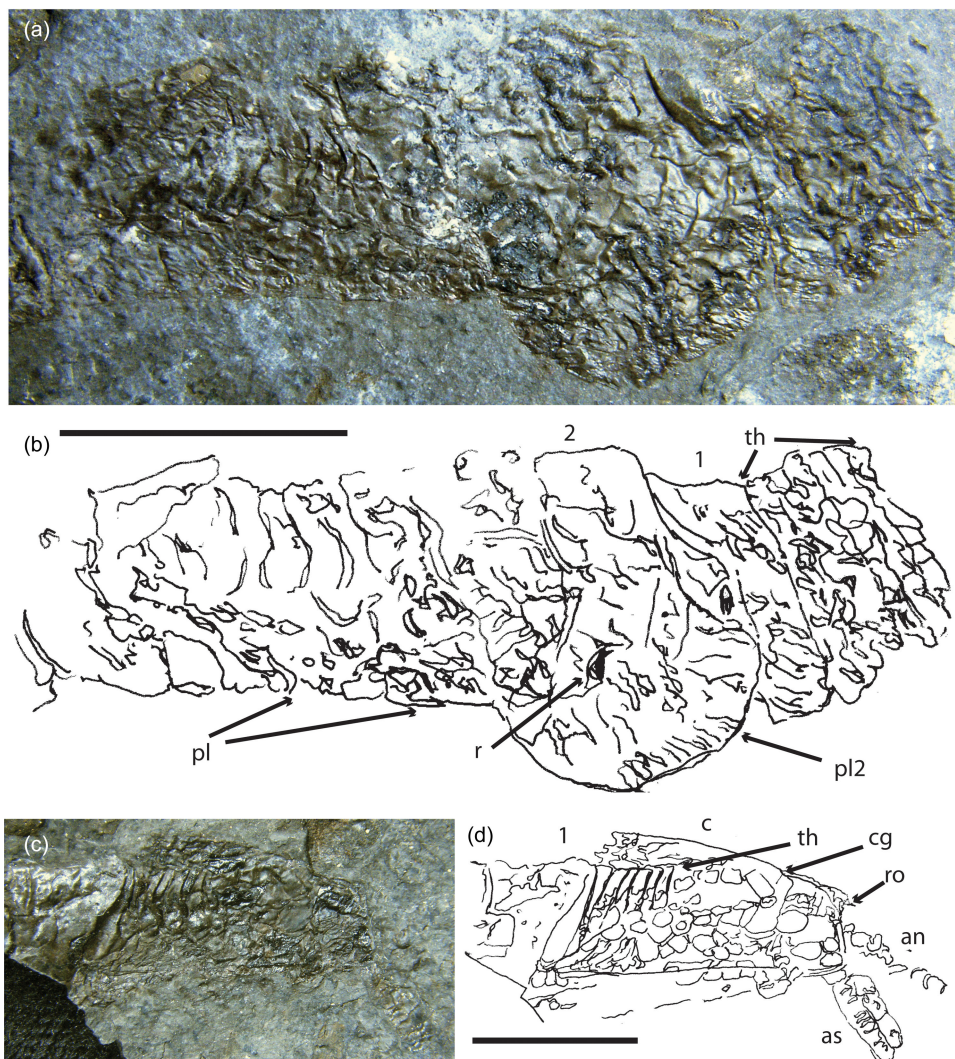


Figure 8. (a, b) Holotype specimen of *Crangopsis carlopsensis* sp. nov., from the Brigantian shales near Carlops, showing the expanded pleuron of the second pleonal somite and the thoracomeres. A ridge is seen on the second pleonal somite but is not easily discernible due to the wrinkled preservation of the cuticle (GLAHM 163469). (c, d) Shows the anterior portion of the crustacean with thoracomeres extending dorsally, a short rostrum, as well as the antennal scales and antennules (GLAHM 163468). 1–2 – pleonal somites; an – antennules; as – antennal scale; c – carapace; cg – cervical groove; pl – pleonal pleura; pl2 – second pleonal pleuron; r – ridge on pleonal somite; ro – rostrum; th – thoracomeres. Scale bar = 5 mm.

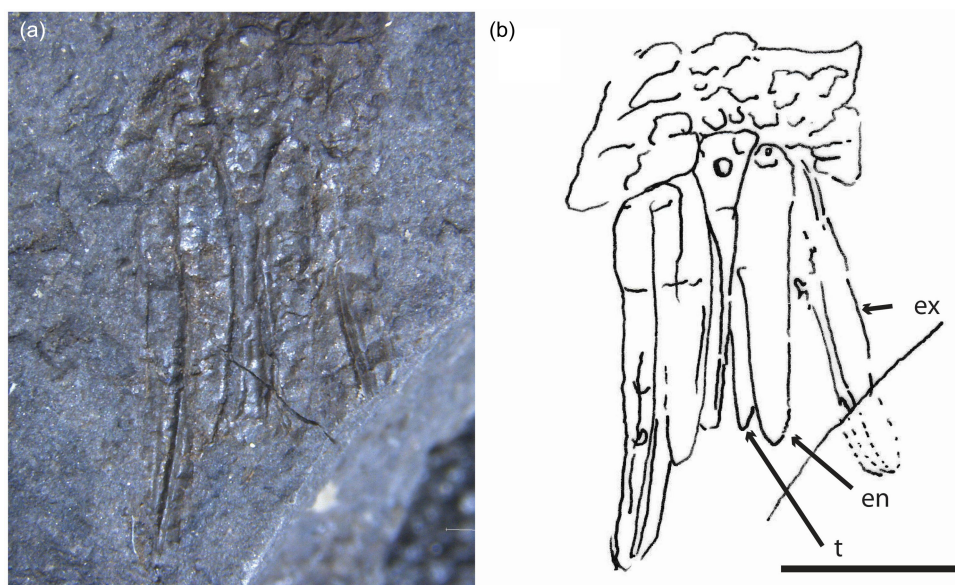


Figure 9. (a, b) Tail fan of *Crangopsis carlopsensis* in ventral aspect showing the elongate blade-like uropodal exopods, shorter uropodal endopods, and the bifid telson (GLAHM 163470). en – uropodal endopod; ex – uropodal exopod; t – telson. Scale bar = 2 mm.

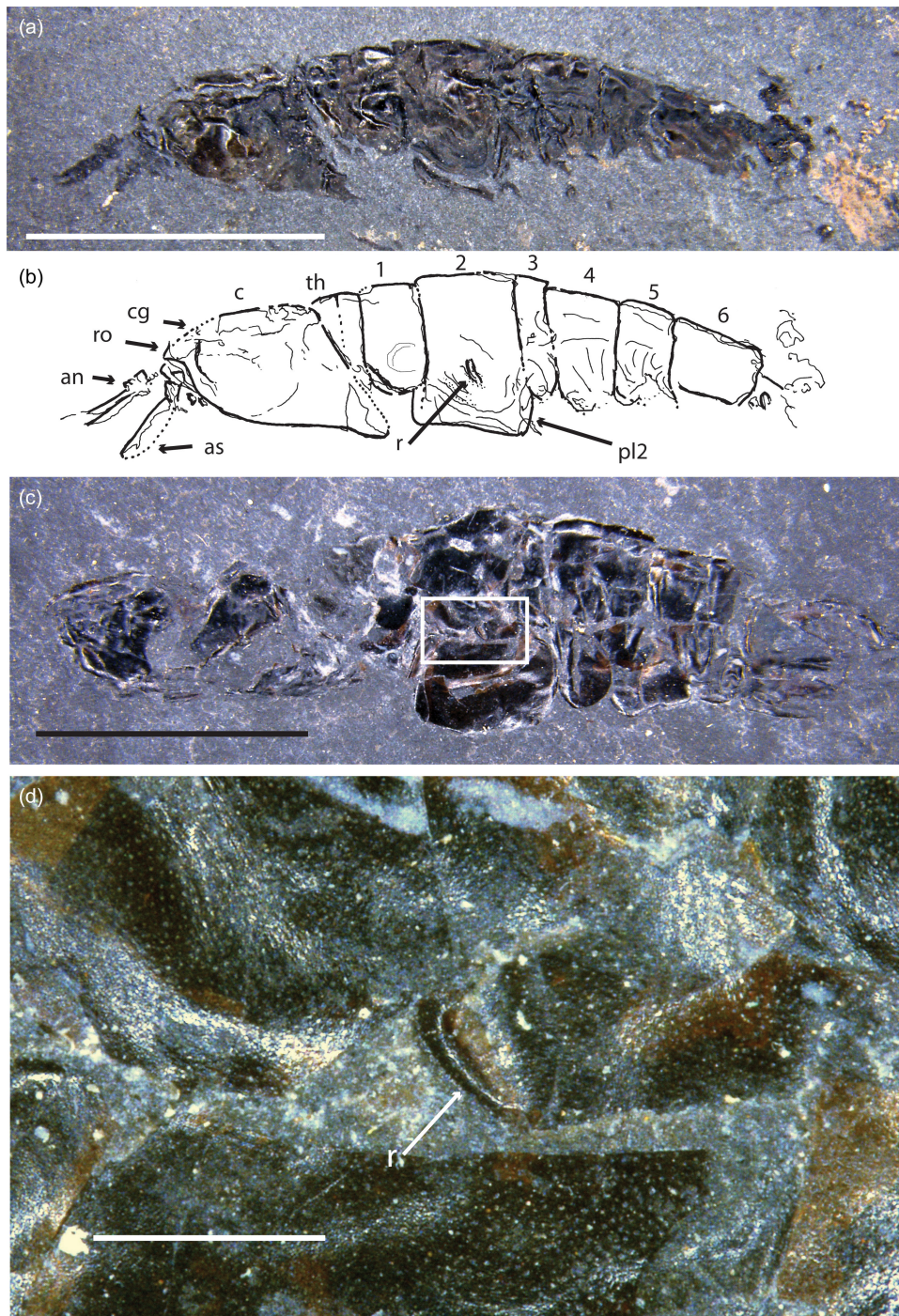


Figure 10. (a, b) Holotype specimen of *Crangopsis baljaffrayensis* sp. nov., from the Pendleian (Serpukhovian) shales near Bearsden, East Dunbartonshire showing the characteristic squared pleuron of the second pleonal somite and associated short ridge (GLAHM A2409.1). (c, d) Another example with an enlargement of the ridge structure on the second pleonal somite (GLAHM A2748). 1–6 – pleonal somites; an – antennules; as – antennal scale; c – carapace; cg – cervical groove; pl2 – second pleonal pleuron; r – ridge on pleonal somite; ro – rostrum; th – thoracomeres. Scale bar (a, b, c) = 5 mm; (d) = 0.5 mm.

terminations of the other pleonal pleura which form a straight line along the pleon. The tail fans are well preserved (Fig. 9) to exhibit a characteristic bifid telson like that seen in *Palaemysis* (Clark 1991). The blade-like uropodal exopods are about a third longer than the telson and curve outwards posterolaterally and have a medial groove. The uropodal endopods are about the same length as the telson and are elongated oval shaped.

Crangopsis baljaffrayensis sp. nov.

(Figs 10a–d, 11a–c)

Etymology. Named after the Baljaffray Estate, the area in East Dunbartonshire within which the famous Bearsden fauna was discovered in 1982.

Material. Holotype GLAHM A2409.1 (Fig. 10a–b); Syntypes GLAHM A2409.6 (Fig. 11); GLAHM A2748 (Fig. 10b–c) from the type locality at Baljaffray, Bearsden, from an excavation at the Manse Burn conducted by Stan P. Wood under the auspices of the Hunterian Museum (Wood 1982) in 1982–1983 (NS53047328).

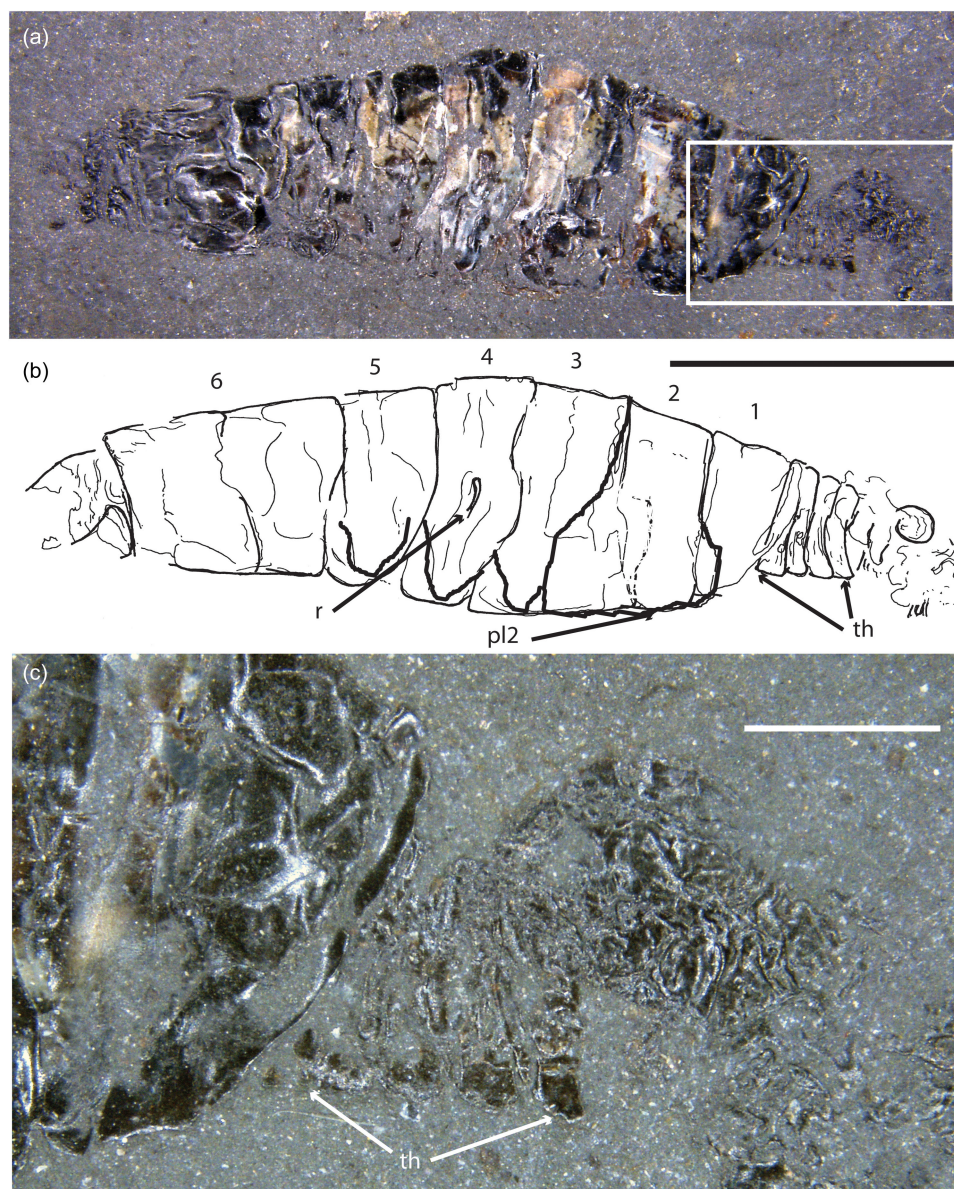


Figure 11. (a, b, c) *Crangopsis baljaffrayensis* from Bearsden (GLAHM A2409.6) showing ridge structure on the 4th pleonal somite, expanded pleuron of the second pleonal somite, and carapace missing to reveal the thoracomeres ((c) = enlargement of white box seen in (a)). 1–6 – pleonal somites; pl2 – second pleonal pleuron; r – ridge on pleonal somite; th – thoracomeres. Scale bar (a, b) = 5 mm; (c) = 1 mm.

The equivalent horizon from shales above the Top Hosie Limestone (Pendleian, Serpukhovian) beyond the boundaries of Greater Glasgow (Table 2) also provided specimens of *Crangopsis* (Clark 1989). Over 15 specimens of this species were studied from the collections of GLAHM.

Diagnosis. Second pleonal pleuron laterally expanded with a ventrally flattened shape rather than rounded. Posterior pleonal somite pleura with tapered termination anteroventrally.

Description. The trapezoidal to triangular carapace has a faint vertical cervical groove and a very short rostrum. The antennules and the stretched oval-shaped antennal scales are occasionally preserved, as in the holotype (Fig. 10a–b). Thoracomeres can be seen where the carapace has been removed or angled away from the rest of the body as a result of ecdysis. The thoracomeres are long in lateral aspect suggesting that some (four or five) may be free from the carapace (Fig. 11a–c). The expansion of the second pleonal

pleuron ends posteroventral in a flat edge. A short ridge appears on the second pleonal somite (Fig. 10a–d). The pleura of the other pleonal somites form a rounded but slightly tapered termination along the pleon. The tail fans are poorly preserved.

Crangopsis sp.

?1908 *Palaemysis dunlopi* Peach (pp. 66–67, pl. 8, figs 12–14) (Fig. 12a, b)

Material. Tail fans from Airdrie, Lanarkshire from just above the Queenslie Marine Band (Duckmantian, Coal Measures Formation, Bashkirian). GLAHM 101102 contains multiple crustacean fragments and tail fans (Fig. 12a, b).

Description. The material has been catalogued within the collections of The Hunterian as representing the remains of *Crangopsis*. The bifid telson and long blade-like uropodal exopods are both characteristic of this genus. As the specimens lack the diagnostic pleonal and carapace structures, it is not possible to assign a species to these specimens

Table 2 List of localities (Carboniferous: Pendleian) from which *Crangopsis baljaffrayensis* sp. nov. has been found in the west of Scotland (Patton & Coutts 1885; Clark 1989). The Peel Burn locality discovered by Patrick Gavin was mentioned in Clark (2013).

Locality	Grid reference	Associated crustacean fauna (with identifications based on Clark 1989, 2024; Clark <i>et al.</i> 2020; Schweitzer <i>et al.</i> 2020)
Baljaffray, Bearsden	NS53047328	<i>Tealliocaris weegie</i> ; <i>Palaemysis dunlopi</i> ; <i>Palaecaris</i> sp.; <i>Tyrannophontes pattoni</i> ; <i>Brittanichus rankini</i> ; <i>Crangopsis baljaffrayensis</i> sp. nov.
East Kilbride (boreholes from the British Geological Survey at Parkhall Street; West Mains; Greenhills and material from the Lymekilns and Kirktonholm Quarries that is now no longer exposed)	Old quarries at Lymekilns (NS630549) and Kirktonholm (NS625543)	<i>Tealliocaris weegie</i> ; <i>Palaemysis dunlopi</i> ; <i>Tyrannophontes pattoni</i> ; <i>Crangopsis baljaffrayensis</i> sp. nov.
Red Cleugh Burn	NS65557849	<i>Tealliocaris weegie</i> ; <i>Palaemysis dunlopi</i> ; <i>Palaecaris</i> sp.; <i>Tyrannophontes pattoni</i> ; <i>Brittanichus rankini</i> ; <i>Crangopsis baljaffrayensis</i> sp. nov.
Burniebrae Burn	NS66047818	<i>Tealliocaris weegie</i> ; <i>Palaemysis dunlopi</i> ; <i>Brittanichus rankini</i> ; <i>Crangopsis baljaffrayensis</i> sp. nov.
Corrie Burn	NS68707876	<i>Crangopsis baljaffrayensis</i> sp. nov. <i>Palaemysis dunlopi</i> ; <i>Crangopsis baljaffrayensis</i> sp. nov.
Woodburn	NS6804 7722	<i>Palaemysis dunlopi</i> ; <i>Crangopsis baljaffrayensis</i> sp. nov.
Hindog Glen	NS27905115	<i>Palaemysis dunlopi</i> ; <i>Crangopsis baljaffrayensis</i> sp. nov.
Powgree Burn	NS33635219	<i>Palaemysis dunlopi</i> ; <i>Crangopsis baljaffrayensis</i> sp. nov.
Swinlees Glen	NS29415342	<i>Palaemysis dunlopi</i> ; <i>Crangopsis baljaffrayensis</i> sp. nov.
Peel Glen	NS51997258	<i>Tealliocaris weegie</i> ; <i>Palaemysis dunlopi</i> ; <i>Brittanichus rankini</i> ; <i>Crangopsis baljaffrayensis</i> sp. nov.

at this stage. It is likely that these represent another new species due to the age difference (~15 million years between the base of the Pendleian (Serpukhovian) and the Duckmantian (Bashkirian), Fig. 1) with the next youngest species *Crangopsis baljaffrayensis*.

Remarks. Schram (1979) recorded *Pygocephalus dubius* and ? *Anthracophausia dunsiana* from the Airdrie locality, but did not recognise *Crangopsis*. The specimen illustrated here does not belong to either of these genera due to the bifid telson (triangular in *Anthracophausia*, more square in *Pygocephalus*) and elongate uropodal exopods which are characteristics more aligned with *Crangopsis*. Until better specimens come to light, it is considered these specimens (GLAHM 101102) should be identified as *Crangopsis* sp. as there are no diagnostic characters that would distinguish them from any other known species of *Crangopsis*.

The type specimen of *Palaemysis dunlopi* first described by Peach (1908) came from this locality and his illustrations are identical in size and form to the specimen illustrated here (Fig. 12a, b). The uropodal exopods are about twice the length of the bifid telson which is similar to *Crangopsis*, whereas the uropodal exopods in *Palaemysis* are about 1.5 times the length of the telson and have a small terminal diaeresis (Clark 1991).

Further examination of other material from Airdrie may confirm this material as being *Crangopsis* which will necessitate a reassessment of *Palaemysis dunlopi* as described by Clark (1991). It is likely that *Palaemysis* from the Bearsden horizon would be best compared to *Palaemysis couttsi* Peach (1908), which was synonymised with *Anthracophausia dunsiana* by Schram (1979) and *Palaemysis dunlopi* by Clark (1991). *Palaemysis couttsi* was described from East Kilbride which is considered to be an equivalent horizon to the shales at Bearsden. Similar material of *Palaemysis* is also known from Granton (Briggs *et al.* 1991).

General remarks. The tail fans of the different species of *Crangopsis* all have a bifid structure to the posterior edge of the telson. This is in contrast to the triangular telson as seen in *Anthracophausia* from Glencartholm, East Kilbride (Fig. 12c, d) and elsewhere (Schram 1979). The length of the uropodal exopods is much shorter relative to the telson in *Anthracophausia* although they are blade-like (see Fig. 12). The uropodal endopods are about the same length as the telson in *Anthracophausia* but are slightly shorter in *Crangopsis*. It should therefore be easy to distinguish these two genera from the tail fans alone if they are well enough preserved. *Palaemysis* (*sensu* Clark 1991) has a very similar bifid telson

Table 3 Characteristics that differentiate the species of *Crangopsis*.

Species of <i>Crangopsis</i>	Shape of the second abdominal pleuron	Shape of the pleurae of somites 3–5
<i>Crangopsis socialis</i>	Rounded ventrally	Tapering posteroventrally
<i>Crangopsis eskdalensis</i>	Rounded ventrally	Rounded posteroventrally
<i>Crangopsis carlopsensis</i>	Rounded ventrally	Flat ventrally
<i>Crangopsis baljaffrayensis</i>	Flat ventrally	Tapering posteroventrally

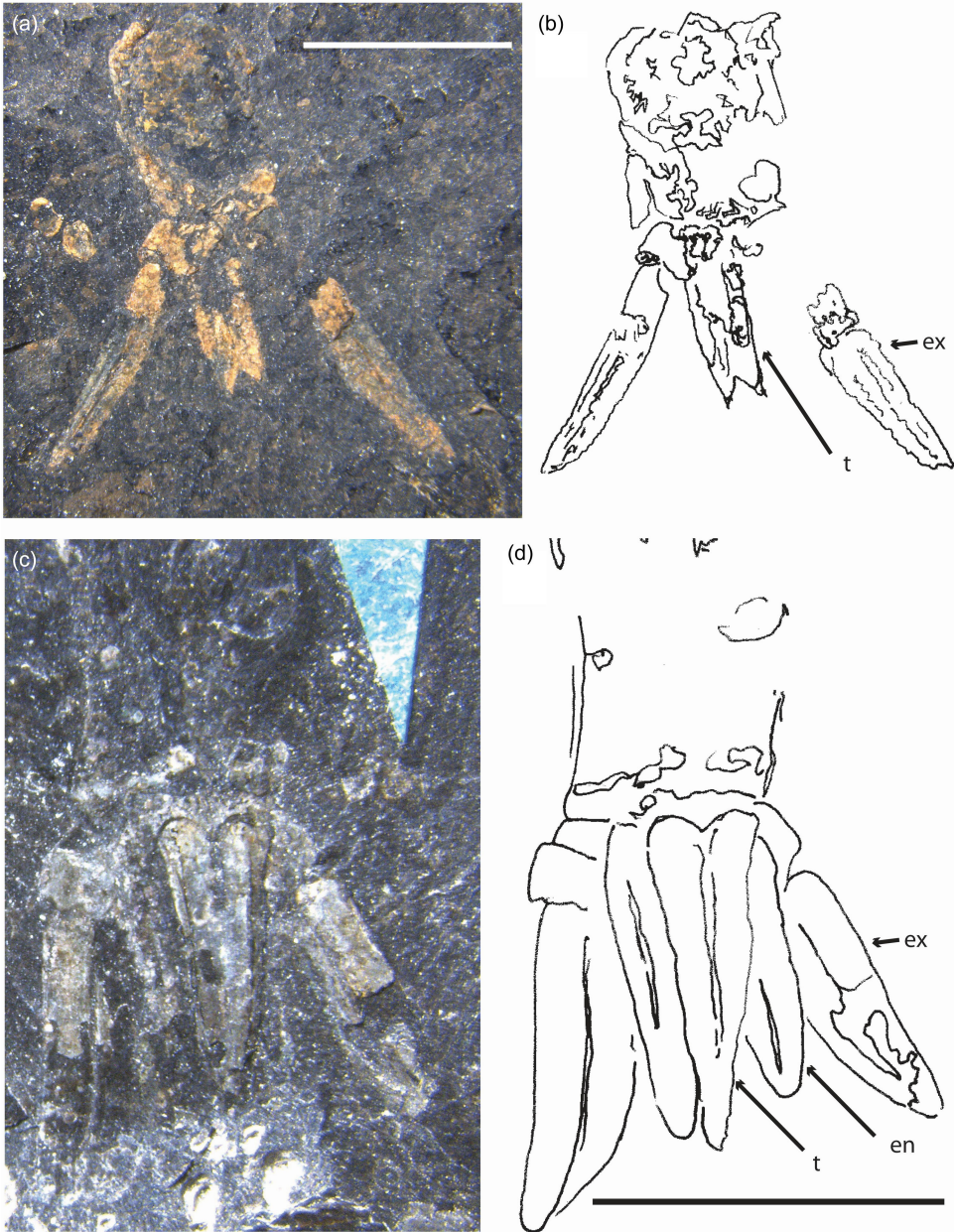


Figure 12. (a, b) Tail fan of a specimen of *Crangopsis* sp. from the Duckmantian (Bashkirian) ironstone of Airdrie showing the characteristic *Crangopsis* bifid telson and elongated blade-like uropodal exopod (GLAHM 101102). (c, d) for comparison, a tail fan specimen previously identified as *Crangopsis* from East Kilbride with a triangular telson and shorter uropodal exopods characteristic of *Anthracocephalus*. en – uropodal endopod; ex – uropodal exopod; t – telson. Scale bar = 5 mm.

to *Crangopsis*, but the uropodal endopods are the same length or slightly longer than the telson, and the uropodal exopods are more triangular than blade-like (Clark 1989, 1991). The second pleonal pleuron expanding to partially cover those of the first and third is also seen in *Palaemysis* but is absent in *Anthracocephalus*.

Of the eight thoracopods seen in *Palaemysis* the posterior seven appear to shorten posteriorly and the most anterior appear to be shorter than the others. This contrasts with the limbs of *Crangopsis*, which are best preserved in specimens from the Granton Shrimp Bed, where ten thoracopods can be counted. The posterior eight thoracopods are biramous and are

of about the same length (see Fig. 3c–d) although the anterior two are shorter and appear uniramous (Fig. 5d). All the species of *Crangopsis* are very similar on basic body plan. The only consistent differences between them are the shape of the pleura (rounded anteriorly, rounded posteriorly or flat ventrally (Table 3). The main similarities that differentiate *Crangopsis* from other Carboniferous crustaceans include the expanded pleuron on the second pleonal somite and the elongated sixth pleonal somite.

The length of the rostrum is the other main characteristic that differentiates these three genera. In *Anthracocephalus* the rostrum is substantial and deep (Schram 1979), whereas in both *Crangopsis* and *Palaemysis* the rostrum is very short relative to the size of the carapace (approximately one-thirtieth of the length of the carapace).

Crangopsis seems to be euryhaline as it occurs in the more marine sediments of Carlops and Granton, potentially less saline lagoonal facies of Ardrross, Glencartholm and Bearsden and potentially freshwater environments represented by the deposits at Airdrie. It is a gregarious animal, often being found in large numbers, or at least relatively common where found, and may moult in numbers too (as seen at the Granton locality).

Although *Crangopsis* appears to be restricted to the United Kingdom, there is a record of a large *Crangopsis* from Czechia of about 30 mm in length (Hyzny *et al.* 2014). The largest from Scotland is about 25 mm in length from Glencartholm, and the majority are about 15 mm. The thoracopods of the Czechia specimens appear to shorten posteriorly in a similar manner to *Palaemysis* and *Kallidechthes* (Schram 1979; Clark 1991). The antennae of *Crangopsis* are short and rarely observed, whereas the antennules are much more substantial with relatively long peduncles. The opposite is true of the specimens from Czechia (Hyzny *et al.* 2014) and they are unlikely to be *Crangopsis*. This material should be re-examined in the light of these differences.

Crangopsis has also been recorded from northern England (Peach 1908; Schram 1979). *Crangopsis huxleyi* was synonymised with *Crangopsis socialis* by Schram (1979). *Crangopsis rhodesi*, *Crangopsis magna*, *Crangopsis couttsi*, *Crangopsis hastata*, as well as all species of *Palaemysis*, were synonymised with *Anthracocephalus dunsiana* by Schram (1979). More recently, *Palaemysis* has been removed from the above synonymy (Clark 1991). However, the type specimen from Airdrie that was used by Clark (1991) based on the original description by Peach (1908) may be a species of *Crangopsis*, as shown by the tail fan in Fig. 12 identified here as *Crangopsis* sp. from the same locality. Sorting the taxonomy of *Palaemysis* is beyond the scope of this current study.

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