A new chasmataspid (Chelicera: Chasmataspida) from the Lower Devonian of the Midland Valley of Scotland

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ABSTRACT: A new chasmataspid (Chelicera, Chasmataspida) is described as Forfarella michelli gen. et sp. nov. from the Lower Devonian of Scotland. This species is problematic in that it was catalogued under the name Forfarella michelli Waterston (no date), but was never formally described. Furthermore, its type locality is uncertain. Chasmataspids are a poorly known taxon within Chelicera which appear to be closely related to eurypterids. F. michelli is only the fourth chasmataspis species to be described. Though poorly preserved, it shows affinities with other Devonian chasmataspids and supports the hypothesis that this group may have been more geographically widespread in the Devonian than has previously been recognised.

KEY WORDS: Arbroath, Forfarella

Chasmataspids are a rare group of fossil chelicerates currently known from one Ordovician species (Caster & Brooks 1956) and two Devonian species (Störmer 1972). These authors originally interpreted them as xiphosurans, though more recently they were excluded from Xiphosura by Anderson & Selden (1997) and recognised as a separate taxon within Chelicera by Dunlop & Selden (1997). Given their rarity, any new record of chasmataspids is significant. In the collections of the British Museum (Natural History) (BMNH) there is a small (17 mm) specimen from the Lower Devonian of the Arbroath region of Scotland. This fossil (BMNH In 60023) is currently in the eurypterid collection labelled as Forfarella michelli Waterston. It resembles a juvenile eurypterid, although based on its opisthosomal segmentation we interpret it as a poorly preserved chasmataspis.

However, there is a problem with Forfarella. The BMNH label gives no date for the Waterston publication, and the name Forfarella could not be traced in the BMNH Type and Figured Catalogue for Chelicera (Morris 1980) or the Zoological Record. We subsequently learnt that in 1962 Charles Waterston borrowed this fossil as an unregistered specimen from the BMNH, along with four other unregistered fossils of juvenile eurypterids (Charles Waterston, pers. comm.). All five specimens are preserved in the same lithology and probably come from the same locality. The associated labels state that the fossils were purchased from the Mitchell collection in 1893, though it is unclear why they were not registered at that time, as other Mitchell material (mostly eurypterids) is included in the BMNH registers for that year (e.g. I. 2912–2945). Waterston recognised one of these unregistered specimens as a chasmataspis (Charles Waterston, pers. comm.) and intended to describe it under the name Forfarella michelli. As such, this name was pencilled into the BMNH register for 1962 under the specimen number In 60023. However, Forfarella was only ever a manuscript name and Waterston never published his description, returning both Forfarella and the juvenile eurypterids to the BMNH after three years (Charles Waterston, pers. comm.). BMNH in 60023 is also associated with a blank Royal Scottish Museum label (presumably supplied by Waterston, who was based there in the 1960s) which on the reverse side gives this proposed name and data about the collector and locality. A new BMNH label repeats this information, although the fossil has remained curated under an unpublished name.

We were also made aware of a problematic specimen in the National Museum, Scotland (NMS, formally the Royal Scottish Museum) suggested as another possible Forfarella (Robert Davidson, pers. comm.). This specimen has poor locality details, does not actually belong to the NMS (Liz Hide, pers. comm.) and it is unclear whose collection it belongs to. Examination of this specimen by one of the present authors (LIA) revealed that it is a poorly preserved arthropod fragment, possibly part of a limb, and is not a chasmataspis. The only Forfarella specimen is therefore the one in the BMNH collection (Charles Waterston, pers. comm.). In this paper we present the first description of BMNH In 60023. To prevent future confusion, we retain the manuscript name Forfarella michelli, under which the specimen is curated. As such, both the genus and species are formally proposed for the first time in this paper.

1. Materials and methods

BMNH In 60023 was examined immersed in 70% alcohol, which revealed the remains of the original cuticle as darker patches. This specimen was photographed under plane polarised light (Fig. 1), and was drawn under alcohol using a camera lucida (Fig. 2). The holotype of the Ordovician form Chasmataspis laurenctic (United States National Museum (USNM) 125099) and new Siberian chasmataspids in the Lithuanian Institute of Geology, Vilnius, were examined for comparative purposes, along with the literature and photographs of newly collected Diploaspis material courtesy of Markus Poschmann (Koblenz).

1.1. Geological setting

The BMNH label and register states that In 60023 was collected from the Lower Old Red Sandstone (LORS), near Arbroath, Angus, Scotland, and that it was purchased from the Mitchell collection in 1893. Mitchell was a keen amateur collector along with his contemporaries, the Rev. Henry Brewster of Farnell and Mr James Powrie of Reswallie, near Forfar (Woodward 1864). All these collectors were often vague as to the exact localities of their fossil material. Furthermore, many of the sites operating when these collectors were active...
are now disused and overgrown, indicated by the presence of mature trees within the quarries. This makes tracking down the exact locality and horizon of *Forfarella* almost impossible. However, some potential sites can be eliminated on the basis of different lithology or preservation style.

Other BMNH fossils from the Mitchell collection are accompanied by slightly more accurate locality details and include material from five Lower Devonian localities, all of which we recognise as being situated within the Dundee Formation of the Arbuthnott Group: (1) Tealing; (2) Canterbury, Kinkardinshire [sic] (now Canterbury Den, Aberdeenshire); (3) Farnell; (4) Whanland, W of Farnell; (5) Cuisewinie Quarry, NE of Forfar (=Mirestone and ‘Carsegownie’ of Armstrong & Patterson (1970)). The host lithology and preservation of *Forfarella* is different to BMNH representatives from all five of these localities. The closest match for the lithology was the laminated fish-beds from Tealing. Interestingly, a fish-bed laminitate at the nearby Whitehouse Den site was investigated by one of us (LIA) and Robert Davidson (Peterculter) in early 1995, and includes a laminitate horizon capable of preserving unmineralised arthropod cuticles. Only a few of the Lower Devonian localities in this area have a fish-bed laminitate sensu stricto, which could also preserve *Forfarella*, and this therefore significantly narrows down the search.

The majority of Mitchell’s collection is in the Montrose Museum and Art Gallery. This material is almost entirely from the Tillywandle fish-bed, which was the subject of a recent re-examination and study by Trewin & Davidson (1996) and from which arthropods have been recorded. A study of the Tillywandle eurypterids is being prepared by one of us (STB). However, Tillywandle has a very distinctive laminitate lithology which differs from that of the *Forfarella* specimen. Perhaps the best clue for the original locality of *Forfarella* comes from its label, stating a site close to Arbroath. As far as we are aware the closest known site with lithology capable of preserving unmineralised arthropods is Kelly Den, a stream section S of the village of Arblont on the outskirts of Arbroath. The discovery of eurypterid remains from this site by the Rev. H. Brewster was reported by Woodward (1864). However, we cannot confidently give a type locality or stratigraphy for *Forfarella* other than the Lower Devonian Dundee Formation of the Arbuthnott Group of the Angus region, Midland Valley of Scotland. It is preserved in a grey siltstone, which is more characteristic of the fish-bed lacustrine facies of the area, rather than the coarser fluvial facies.

2. Morphological interpretation

Chasmataspid resemble both eurypterids and xiphosurans and were usually referred to the latter group (see section 3.1). However, they appear to be a separate taxon within Chelicerata and can be distinguished from other chelicerates by a distinctive differentiation of the opisthosoma into a preabdomen of three segments, referred to as a buckler by Caster & Brooks (1956), and a postabdomen of nine segments (Caster & Brooks 1956; Dunlop & Selden 1997) (Fig. 3). There is also a reduced first segment, opisthosomal segment 1, which is not distinguishable in this specimen, but which can be seen in the better-preserved Chasmataspis material (unpublished observations) and in new, exceptionally preserved chasmataspid from the Lower Devonian of the Severnya Zemlya archipelago, Siberia (Dunlop 1997). The preabdomen therefore consists of segments 2–4, the postabdomen of segments 5–13 (Figs 2–3) to give a total of 13 segments. Dunlop & Selden (1997) followed the older descriptions and claimed that chasmataspid had 12 opisthosomal segments, while Anderson & Selden
that they possess both a metastoma and a genital appendage (Dunlop 1997), both characters traditionally autapomorphic for eurypterids. Their presence in a chasmataspid strongly supports Eldredge's (1974) model, in which Chasmataspida and Eurypterida are sister groups; though the position of the scorpions, which some authors regard as sister group of eurypterids (see Dunlop & Selden 1997) for a review, may complicate this model. There may even be a case for referring the chasmataspids to Eurypterida, although their different opisthosomal tagmosis and the presence of genal spines and perhaps also opthalmic ridges (Dunlop 1997) distinguishes chasmataspids from eurypterids, and we prefer to treat them as separate taxa at this stage. Forfarella is too poorly preserved to add anything further to the wider debate on chasmataspid affinities.

3.2. Distribution
The known chasmataspids include a single Ordovician species (Caster & Brooks 1956). We are also aware of some Late Cambrian fossils provisionally described as merostomes by Wahlman & Caster (1978). These show a rounded prosoma and a long postabdomen, a morphology consistent with them being a series of superimposed resting traces of an animal similar to Chasmataspis. Additionally, there are two species of Lower Devonian chasmataspis (Stormer 1972), with the possibility that some material described as eurypterids by Novojilov (1959) from the Lower Devonian of Siberia may also belong to this group (Stormer 1972). This, along with recent discoveries from Severnya Zemlya and this redescription of Forfarella (both also Lower Devonian), suggests that chasmataspids may be a more widespread group, at least in the Devonian, than has previously been recognised.

A specimen discovered in 1987 by Philippe Janvier, from the Middle Devonian (Givetian/Frasnian) Dò Son Formation of the Dò Son peninsula in northern Vietnam, was provisionally assigned to Chasmataspida (Waterston, in Janvier et al. 1989). However, this identification was based solely on photographs, from which it was not possible to discern the faint preabdominal segmentation which is apparent in this specimen. Study of this material by one of us (SBJ) revealed that it is an eurypterid which could be referred to Carcinosomatidae (Selden 1993), probably Rhinocarcinosoma sp. (Braddy 1994).

4. Systematic descriptions
CHELICERATA Heymons, 1901
CHASMATASPIDA Caster & Brooks, 1956

Remarks. Caster & Brooks (1956) originally described Chasmataspis as an order within Class Xiphosurida; the accepted name for all xiphosurans is now Xiphosura (see Anderson & Selden (1997) for discussion). Stormer (1972) altered Chasmataspida to Chasmataspidae, though we find Stormer's version cumbersome and see no reason not to use the original form. The recognition of chasmataspids as a taxon distinct from other chelicerates (Dunlop & Selden 1997) could mean that Chasmataspida becomes a class name as well as an order. However, to avoid creating unnecessary nomenclature we prefer not to assign a rank to Chasmataspida at this stage, pending a wider revision of chelicerate higher systematics.

Family Diplaspisidae Stormer, 1972

Emended diagnosis. Small chasmataspids with semicircular or subrectangular carapace, a distinctly tapering postabdomen and a short telson; postabdomen in Chasmataspidae elongate and not strongly tapering, telson also elongate. Emended from Stormer (1972).
Type genus. *Diploaspis* Stormer, 1972

**Remarks.** Despite its rather poor preservation, *Forfarella* resembles both published and unpublished descriptions of other Devonian chasmataspids (Stormer 1972; Dunlop 1997). The Ordovician *Chasmataspis* is much larger, with a semicircular carapace, distinct genital spines and an elongate postabdomen. The overall size and body proportions of *Forfarella* are closest to *Diploaspis casteri* from Alken an der Mosel. The postabdomen of *Forfarella* is considerably longer, but unpublished observations of the Severnaya Zemlya forms indicate that the postabdomen of these forms can be preserved with some degree of 'telescoping', presumably a taphonomic effect. As such we are cautious about using a long postabdomen as a diagnostic character between *Forfarella* and other Devonian chasmataspids. On these grounds, *Forfarella* is referred to Diploaspidae which we re-diagnose here. Stormer's other species, *Heteraspis noviolivi*, was placed in a monotypic family, Heteraspidae Stormer, 1972, on account of 'family level' differnces. Based on his photographs, we do not believe that the differences between *Diploaspis* and *Heteraspis* are as great as Stormer (1972) suggested. As such, we suspect Heteraspidae is a synonym of Diploaspidae (the first of the two family names proposed in his paper), though examination of the original material is required to confirm this.

*Forfarella* gen. nov.

**Diagnosis.** Small chasmataspid with distinctly subrectangular carapace, about one and a half times as broad as it is long, and a posteriorly tapering, trapezoidal postabdomen.

**Type species.** (Only included species) *Forfarella michelli* gen. et sp. nov.

**Remarks.** We have used the shape and proportions of the body to distinguish *Forfarella* from *Diploaspis* where, based on Stormer's photographs, the carapace is nearly twice as broad as long (9 mm x 5 mm), but is more rounded anteriorly. The preabdomen of *Diploaspis* is trapezoidal in Stormer's reconstruction, though appears more rounded in his photographs. However, we are aware that these characters are not ideal and may be subject to preservational or ontogenetic variation.

*Forfarella michelli* gen. et sp. nov.

**Diagnosis.** As for genus.

**Holotype.** BMNH In 60023, from the Lower Devonian Dundee Formation of the Arbuthnott Group near Arbroath, Angus region, Scotland. Original locality and precise stratigraphic position unknown, but possibly Kelly Den.

**Additional material.** None.

**Description.** BMNH In 60023 comprises a single, rather poorly preserved specimen with no counterpart. Two cracks run through the prosoma and anterior preabdomen. Dark patches on specimen probably represent traces of original cuticle. Total length approximately 17 mm. Carapace wide and rectangular, broader than long, length 5.2 mm, maximum width 7.6 mm. Details of carapace not preserved, but possible lateral eye tubercle evident in left anterior corner of carapace under plane polarised light (Fig. 1). Fragments of two appendages, probably prosomal appendage VI present on both left and right sides. Preserved length of left appendage 5.6 mm, width 0.7 mm. Preserved length of right appendage 2.7 mm, width 0.6 mm. Other appendages absent. Preabdomen subtrapezoidal, tapering posteriorly, length 4.6 mm, with anterior width 6.9 mm and posterior width 3.6 mm. Tergite 1 not distinguishable, but faint traces of tergites 2, 3 and 4 present on preabdomen, lengths 1.3 mm, 1.0 mm and 2.1 mm respectively. Postabdomen tapering, length 7.2 mm, with proximal width 3.5 mm. Postabdomen tapers posteriorly with nine segments distinguishable, lengths of all segments approximately 0.8 mm. Postabdomen bends distally to the right. Left side of distal postabdominal segments absent. Telson absent, but inferred by comparison with other chasmataspid material.

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