

A FOSSIL WHIP-SCORPION (ARACHNIDA: THELYPHONIDA) FROM THE UPPER CARBONIFEROUS OF THE CARNIC ALPS (FRIULI, NE ITALY)

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Abstract. A new and well-preserved fossil whip scorpion (Arachnida: Uropygi: Thelyphonida) is described from the Late Carboniferous of the Carnic Alps, Friuli, Italy. It is referred to *Parageralinura marsiglioi* n. sp. The new specimen is the first Carboniferous arachnid to be described from mainland Italy and is possibly the youngest Palaeozoic thelyphonid.

INTRODUCTION

Whip scorpions (Uropygi: Thelyphonida) are a distinctive group of arachnids which superficially resemble scorpions, but differ in having robust, subchelate pedipalps, a slender first pair of legs used as tactile appendages, and a long, thin flagellum (whip) forming the tail at the end of the opisthosoma which gives the group one of its common names. They are also sometimes referred to as vinegaroons, because another of their specialities is the ability to defend themselves by spraying a noxious compound, which includes acetic acid, from glands near the base of the tail. This behaviour is often associated with aggressive posturing, in which the opisthosoma is raised almost at right angles to the prosoma, further enhancing their scorpion-like appearance. For a summary of thelyphonid biology see Haupt (2000). The catalogue of Harvey (2003) recorded 103 living species in sixteen genera, all within a single family. Prendini (2011) updated this to 110 species. Extant whip scorpions can be found throughout the tropics in Africa, Asia (Fig. 1) and the Americas. Most are found in humid rainforest-type habitats, although some members of the American genus *Mastigoproctus* Pocock, 1894 inhabit more arid environments. Fossil whip scorpions are extremely

rare and only seven species are currently recognized in the literature. A putative Cenozoic example from California described by Pierce (1945) proved to be an unidentifiable organic fragment (Dunlop & Tetlie 2008). The Cretaceous Crato formation of north-eastern Brazil (~115 Ma) has yielded *Mesoproctus rowlandi* Dunlop, 1998, identifiable to the extant family Thelyphonidae. Incomplete material assigned to the same genus implies that these were very large whip scorpions, perhaps related to *Mastigoproctus* (see also Dunlop & Martill 2002). The six remaining species all come from the Late Carboniferous Coal Measures and span a time interval of ~306-319 Ma. They were last revised by Tetlie & Dunlop (2008) who recognized four Carboniferous genera, and proposed that all of them should be treated as plesion taxa with respect to the living family. The principal reason for this was that the pedipalps in the Palaeozoic whip scorpions are not fully subchelate and lack a projection (apophysis) which opposes the terminal podomere to form a claw. Subchelate pedipalps thus become a putative apomorphy of the Cretaceous-Recent Thelyphonidae.

Coal Measures whip scorpions include an unnamed carapace belonging to a modern-looking animal found in the Late Carboniferous (Kasimovian) of the Lugansk Province in the Donets Basin of Ukraine (Selden et al. 2014). Named species comprise *Proschizomus petrunkevitchi* Dunlop & Horrocks, 1996 from the British Middle Coal Measures



Fig. 1 - Recent thelyphonid, *Thelyphonus doriae* Thorell, 1888, Bukit Panjang, Singapore (1°21'23.38"N 103°48'46.48"E); photo P. A. Selden.

which lacks median eyes and has pedipalps orientated vertically rather than horizontally. It was thus speculated as being on the lineage which leads to another, closely related, arachnid order Schizomida. *Parageralinura neerlandicus* Laurentiaux-Viera & Laurentiaux, 1961, from the Netherlands, and *Parageralinura naufraga* (Brauckmann & Koch, 1983), from Germany, were placed in a genus together based on features such as noticeably robust leg femora. *Geralinura carbonaria* Scudder, 1884, from Mazon Creek in the USA, and *Geralinura britannica* Pocock, 1911, from the British Middle Coal Measures, were redefined by Tetlie & Dunlop (2008) as belonging to a genus characterized by a fairly elongate pygidium (the last three ring-like opisthosomal segments). Finally, *Prothelyphonus bohemicus* (Kušta, 1884) is noticeably larger (body length up to ~30 mm, excluding tail) and more gracile than the other penecontemporaneous fossil whip scorpions. *Prothelyphonus bohemicus* is currently known from a series of mostly rather spectacular fossils (Kušta 1884, 1888; Frič 1904; Petrunkevitch 1953; Dunlop & Penney 2012) from Rakovník and Chomle in the Bohemian Coal Mea-

sures of the Czech Republic. Here, we report *Parageralinura marsiglioi* n. sp. from the Upper Carboniferous of the Carnic Alps, Italy.

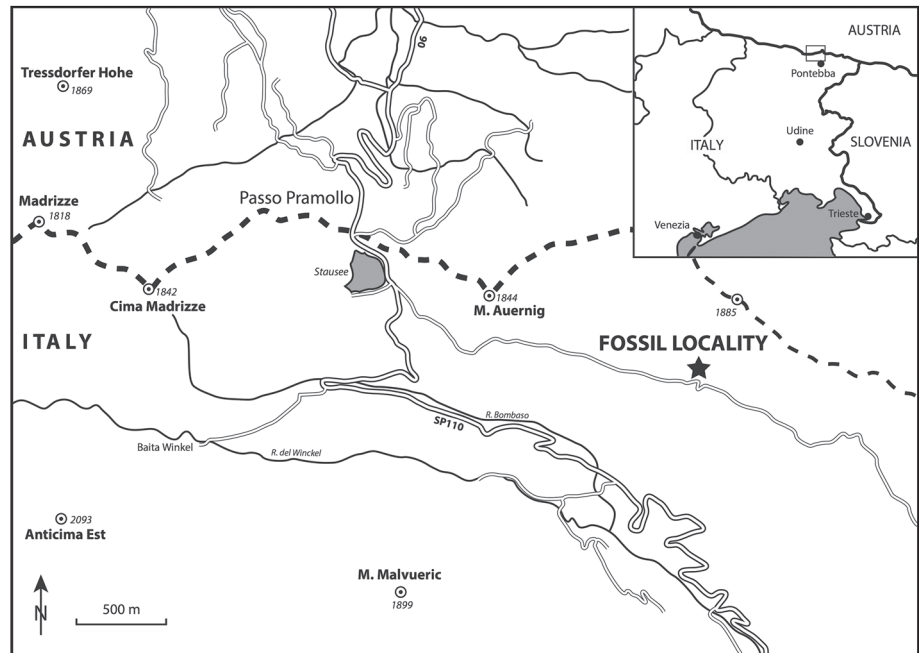
GEOLOGICAL SETTING

The single specimen (part only) comes from the southern side of Mt Auernig, east of Passo Pramollo-Naßfeld, and north of the village of Pontebba (Udine), near the Italian-Austrian border (Fig. 2). This is not far from the locality which yielded *Adelophthalmus* in the underlying Meledis Formation (Lamsdell et al. 2013). The thelyphonid locality, informally known as “Frana Vecchia” (Old Landslide), is on the mountain road leading to Casera For and Casera Cerchio from Passo Pramollo, approximately one kilometre from Casera Auernig. Here, at 46°33'09.6"N 013°18'03.0"E, the road crosses the base of a landslide fan. The specimen was found in debris on a small terrace at the base of the landslide scar, where a few metres of Upper Carboniferous pelites and arenites are exposed. The fossil is on a small slab of dark, thin sandstone. The rocks that crop out just above the terrace are attributed to the Pizzul Formation (Venturini 1990, 2006) and it is most likely that the slab came from this unit. The Pizzul Formation (Kasimovian-Gzhelian A-E) is the second unit from the base of the Pramollo Group (Upper Moscovian-Gzhelian E, Upper Carboniferous) (Selli 1963; Venturini 1990). The whole group is characterized by alternation of transgressive-regressive cycles related to glacio-eustatic control and tectonic activity (Vai & Venturini 1997). The result is a thick sequence of conglomerates and sandstones with high quartz content, preserved in a fluvio-deltaic environment and interbedded with marine shallow-water pelites and carbonates.

MATERIAL AND METHODS

The fossil consists of a relatively complete thelyphonid preserved in dorsal view. The chelicerae and first legs are not preserved; pedipalps and legs II–IV are preserved mainly as proximal podomeres; right leg III preserves the distal podomeres, which include a short basitarsus. Median and/or lateral eyes cannot be seen; folds on the carapace suggest muscle attachment sites. The opisthosoma is preserved in dorsal view, with a tergite count of 12, including a short anterior one, and three narrow ones posteriorly, forming the pygidium. A patch of cuticle at the left posterolateral corner, which shows faint tergite segmentation continuing across it (Fig. 3B, v?), is interpreted as part of the ventral surface.

Fig. 2 - Position of the fossil locality (star) at Frana Vecchia, just north of the ridge track leading east from the road SP110 from Pontebba to Passo Pramollo, which is situated on the Italy-Austria border; spot heights in metres. Inset: location map of the Passo Pramollo area near Pontebba in the north of Friuli.



The specimen is held in the Museo Archeologico e Naturalistico (via G. Pascoli 25, 33017 Tarcento, Udine, Italy), inventory number MPT 39217. It was studied under a Leica Wild MZ8 stereomicroscope, drawn using a camera lucida attachment, and photographed using a Canon EOS 5D MkIII camera attached to the microscope, both dry and under ethanol in cross-polarized light. To enhance depth of field, several photographs were taken of each part of the specimen and then stacked using Adobe Photoshop CS6; finally, a mosaic of these photographs was created to produce a final, high-resolution picture of the whole specimen for study. Final drawings were made based on the camera lucida drawings and the photographs using iDraw (www.ideeo.com). Abbreviations: 1-12 opisthosomal tergite numbers, II-IV leg numbers, bt basitarsus, car carapace, fe femur, L length, pa patella, pd pedipalp, tt telotarsus, ti tibia, v ventral, W width.

SYSTEMATIC PALEONTOLOGY

Order *Thelyphonida* Latreille, 1804

Genus *Parageralinura* Tetlie & Dunlop, 2008

Remarks. Of the four known Coal Measures genera, we can rule out affinities with *Proschizomus* since the pedipalps in the new fossil clearly articulate in a more horizontal plane, as in living species, rather than up and down in a vertical plane. We can also exclude *Geralinura*, which was rediagnosed by Tetlie & Dunlop (2008) on the presence of an elongate pygidium at the posterior end of the opisthosoma in which the terminal (12th) segment is particularly long. The pygidium in the new fossil is squatter (Fig. 3). *Prothelyphonus* is represented by a single species of large (~3 cm long) and quite gracile fossils in which the pedipalps are particularly

massive; specifically they are noticeably longer than the carapace. The pedipalps in the new fossil appear to be shorter than the carapace (Fig. 3).

This leaves *Parageralinura*, a genus proposed by Tetlie & Dunlop (2008) to accommodate two species (see below) from Germany and the Netherlands. Characters proposed in the original diagnosis of this genus are a bluntly rounded pygidium and somewhat inflated femora of legs II-IV compared to other Coal Measures species. Both these features can be seen in the new fossil (Fig. 3). Tetlie & Dunlop (2008) also mentioned a somewhat broad opisthosoma in their diagnosis, which fits less well to the new fossil. However, this character may be less reliable as it was partly based on the original holotype of the German species *Parageralinura naufraga* in Brauckmann & Koch's (1993) description. A probably conspecific specimen discovered later from the same (type) locality of Hagen-Vorhalle (Brauckmann et al 2003: pl. 10, fig. 2) shows more typical body proportions for a whip scorpion and implies that the holotype may be compressed and slightly distorted. On balance we feel that the pedipalp proportions, terminal end of the opisthosoma and the inflated leg femora are most consistent with *Parageralinura*.

Parageralinura marsiglioi n. sp.

Fig. 3

Material: Holotype (part only) and only known specimen,

MPT 39217 in the Museo Archeologico e Naturalistico, via G. Pascoli 25, 33017 Tarcento, Udine, Italy.

Horizon and locality: Kasimovian–Gzhelian (Upper Carboniferous); from “Frana Vecchia”, southern side of Mt Auernig, Passo Pramollo, Pontebba, Udine, Italy.

Etymology: The species is named after the finder of the specimen, Giordano Marsiglio, director of the Museo Archeologico e Naturalistico, Tarcento, Udine, Italy.

Diagnosis: *Parageralinura marsiglioi* differs from the two other species in the genus by its larger size (~25 mm, cf. ~11 and ~16 mm), more slender opisthosoma (L/W ratio 2.60, cf. 1.72 and 1.90), and shorter, broader telson articles.

Description. Cuticle pustulate, especially on carapace. Total body L (excluding telson) 24.70 mm. Carapace elongate; L 8.88, W 6.81 (L/W ratio 1.30); posterior margin straight, posterolateral margins straight and diverging forwards, anterolateral margins then curve slightly forwards from about mid-length, becoming straight to anterior tip of carapace; posterior half with median groove, posterior procurved semicircular groove abuts posterior margin, other grooves radiate from median to lateral margins (Fig. 3). Pedipalps subraptorial, with tumid podomeres; fe L 3.78 mm, pa L 3.08 mm. Legs II–IV with notably inflated femora; podomere lengths: leg II fe 5.83 mm (W 2.06 mm, L/W ratio 2.83); pa 3.42 mm; ti 4.44 mm; leg III fe 6.78 mm (W 2.27 mm, L/W ratio 2.99), pa 3.50 mm, ti 4.24 mm, bt 1.32 mm, tt 2.19 mm (with 3 tarsomeres); leg IV fe 9.40 mm (W 2.59 mm, L/W ratio 3.62), pa 4.00 mm, ti 5.48 mm. Opisthosoma elongate suboval, L 16.31 mm, W 6.27 mm (L/W ratio 2.60), with 12 tergites, last three form a squat pygidium (L 3.23 mm, anterior W 4.16 mm, posterior W 2.08 mm). Telson flagelliform, L \geq 11.37 mm; W 1.12 mm; at least 11 rather broad articles (ratio W tergite 12/W telson 1.86), each about as wide as long (Fig. 3C).

DISCUSSION

The two known species of *Parageralinura* are not easy to distinguish from one another and lack explicit diagnostic apomorphies. Instead, differences are largely in body proportions: *P. naufraga* is larger (~16 mm long), and the pygidium is slightly smaller compared to the rest of the opisthosoma; whereas *P. neerlandica* is smaller (~11 mm), with possibly a slightly more inflated opisthosoma and a proportionally larger pygidium. They are geographically and stratigraphically close to one another and we cannot completely rule out the possibility that

they are different stages of the same morphospecies. The new fossil differs from the German and Netherlands material in being larger than both (almost 25 mm) and in having a more slender opisthosoma. Comparative opisthosoma L/W ratios are as follows: *P. marsiglioi* n. sp. 2.60, *P. neerlandica* 1.72, *P. naufraga* 1.90. Furthermore, the telson articles of the new species are rather shorter and broader than in other thelyphonids, and certainly than in the other *Parageralinura* species (see, e.g. Brauckmann et al. 2003, fig. 22; Laurentiaux-Viera & Laurentiaux 1961, fig. 2). For these reasons, we consider the fossil a new species of *Parageralinura*.

The new thelyphonid is the first Coal Measures arachnid to be described from the Italian mainland; the only other Italian find is a representative of the extinct arachnid order Trigonotarbitida from the San Giorgio Basin (Westphalian D) of Sardinia described by Selden & Pillola (2009). As noted above, fossil whip scorpions are extremely uncommon and any new record is of note.

Parageralinura marsiglioi is stratigraphically younger than the other species in the genus. *P. naufraga* is the oldest known thelyphonid, from the Vorhalle-Schichten of Hagen-Vorhalle, Germany, which belong to the R2c goniatite subzone, Namurian B (middle Bashkirian). *Parageralinura neerlandica* from Limburg, Netherlands, is of Langsettian, Westphalian A age (uppermost Bashkirian). Whilst a precise age cannot be determined for the new species, it dates to Kasimovian–Gzhelian, and is therefore younger than either of its congeners. Indeed, it may be the youngest Palaeozoic thelyphonid, since the Lower Kasimovian age of the carapace described by Selden et al. (2014) from Ukraine, the hitherto youngest Palaeozoic thelyphonid, is at the older end of the possible stratigraphic range of the new *P. marsiglioi*.

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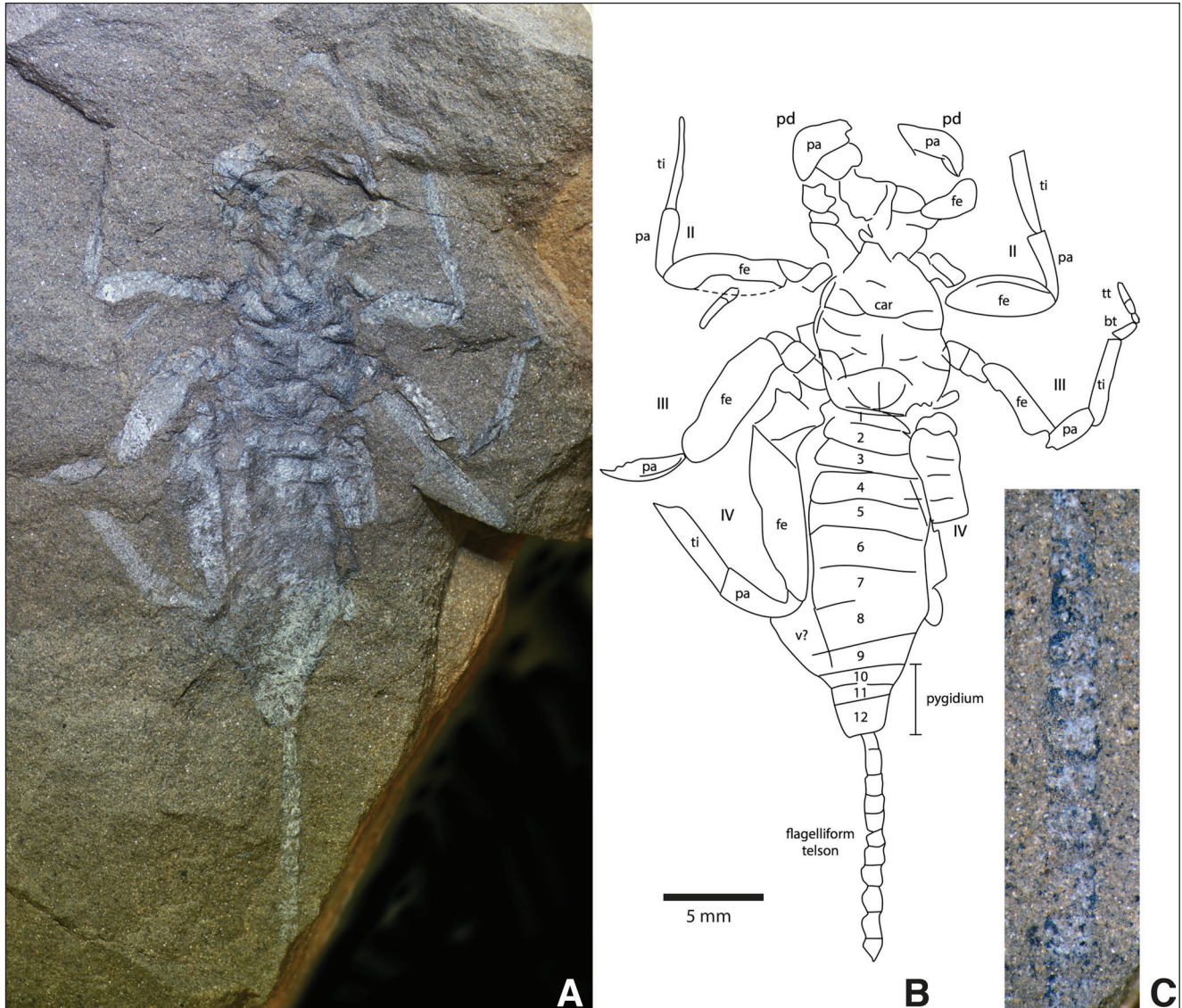


Fig. 3 - *Parageralinura marsiglioi* n. sp. from the Upper Carboniferous (Kasimovian–Gzhelian) Pizzul Formation, Friuli, specimen MPT 39217. A) Photograph of holotype and only known specimen, under alcohol and cross-polarized light. B) Interpretative drawing of the specimen in A. C) Detail of flagelliform telson.

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