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Article abstract

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An Upper Carboniferous trigonotarbid, *Aphantomartus pustulatus* (Scudder, 1884), from the Maritimes Basin (Euramerican Coal Province), New Brunswick, Canada

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A specimen of an aphantomartid trigonotarbid arachnid, *Aphantomartus pustulatus* (Scudder, 1884), found in the Upper Carboniferous (Westphalian C, Minto Formation) coalfields of New Brunswick, Canada, is only the second North American locality for this species. Trigonotarbids are uncommon fossils in Carboniferous deposits, most described specimens being found in Europe. Recent revision of the family Aphantomartidae identified only one genus with two species, which range from the Lower Carboniferous (Viséan) to the Lower Permian (Asselian). The specimen is the only aphantomartid trigonotarbid described from the Maritimes Basin of the Euramerican Coal Province.

Le spécimen d'arachnide aphantomartide trigonotarbide *Aphantomartus pustulatus* (Scudder, 1884) découvert dans des terrains houillers du Carbonifère supérieur (Formation du Westphalien C de Minto) du Nouveau-Brunswick, Canada, constitue la deuxième localisation de cet espèce en Amérique du Nord. Les trigonotarbides constituent des fossiles rares dans les gîtes du Carbonifère, la majorité des spécimens décrits ayant été trouvés en Europe. Une révision récente de la famille des *Aphantomartidae* a défini l'existence d'un seul genre comportant deux espèces, dont la présence s'étend du Carbonifère inférieur (Viséen) au Permien inférieur (Assélien). Le spécimen cité représente le seul trigonotarbide aphantomartide décrit provenant du bassin des Maritimes de la province euraméricaine.

Traduit par la rédaction

INTRODUCTION

Trigonotarbids are extinct spider-like animals. Although they are known from the Silurian (Pridoli) to the Lower Permian (Asselian) they are best known as occurring in the Upper Carboniferous Coal Measures of Europe, and less commonly in North America (Dunlop 1996; Rössler 1998). Even Carboniferous specimens are rare. "Discovery of an extinct arachnid is always noteworthy" remarked Selden and Romano (1983, p. 106) in their description of the only Upper Carboniferous trigonotarbid arachnid from Spain. The discovery of an extinct trigonotarbid from the Upper Carboniferous of New Brunswick, in eastern Canada, is also a unique occurrence and merits description. A single specimen of an aphantomartid trigonotarbid, identified as *Aphantomartus pustulatus* (Scudder, 1884), is described from the Minto Formation (Westphalian C) in the coalfields of central New Brunswick. It is the only known occurrence of a trigonotarbid from New Brunswick (Copeland 1957). A recent compilation by Calder (1998) listed one anthracomartid trigonotarbid, *Coryphomartus triangularis* Petrunkevitch, 1913, from the Upper Carboniferous of Joggins, Nova Scotia and Copeland (1957) identified *Anthracomartus* sp. (possibly *Coryphomartus triangularis*) from the Canso? Group (Namurian) of Nova Scotia. The present specimen is, therefore, the only known aphantomartid trigonotarbid

described from the Maritimes Coal Basin of the "Euramerican Coal Province" (Calder and Gibling 1994), a region that includes extensive areas of present-day Europe and North America underlain, principally, by Late Carboniferous coal-bearing formations (Fig. 1). Given that Upper Carboniferous fossils from New Brunswick and Nova Scotia have been studied since the middle of the nineteenth century (Dawson 1868) it is surprising that few trigonotarbids have been described. In New Brunswick, the only Upper Carboniferous arthropod assemblage described in any detail is from the 'Fern Ledges' site in Saint John, first described in 1865 (Hartt 1865). The 'Fern Ledges' assemblage does contain supposed arachnids (Matthew 1889, 1895a, 1895b, 1897). However, the 'Fern Ledges' specimens are poorly preserved and doubt has been cast on the validity of all identifications.

STRATIGRAPHY AND AGE

The fossil described here was recovered from a plant-bearing grey mudstone, most likely from the roof shales overlying the Minto coal seam, in the upper member of the Minto Formation. The specimen was collected on the floor of a strip mine (Hacquebard and Barss 1970) near Minto, New Brunswick (approx. 46°05' N; 66°04' W). Unfortunately the exact collecting locality is unknown. It was found in the 1970s

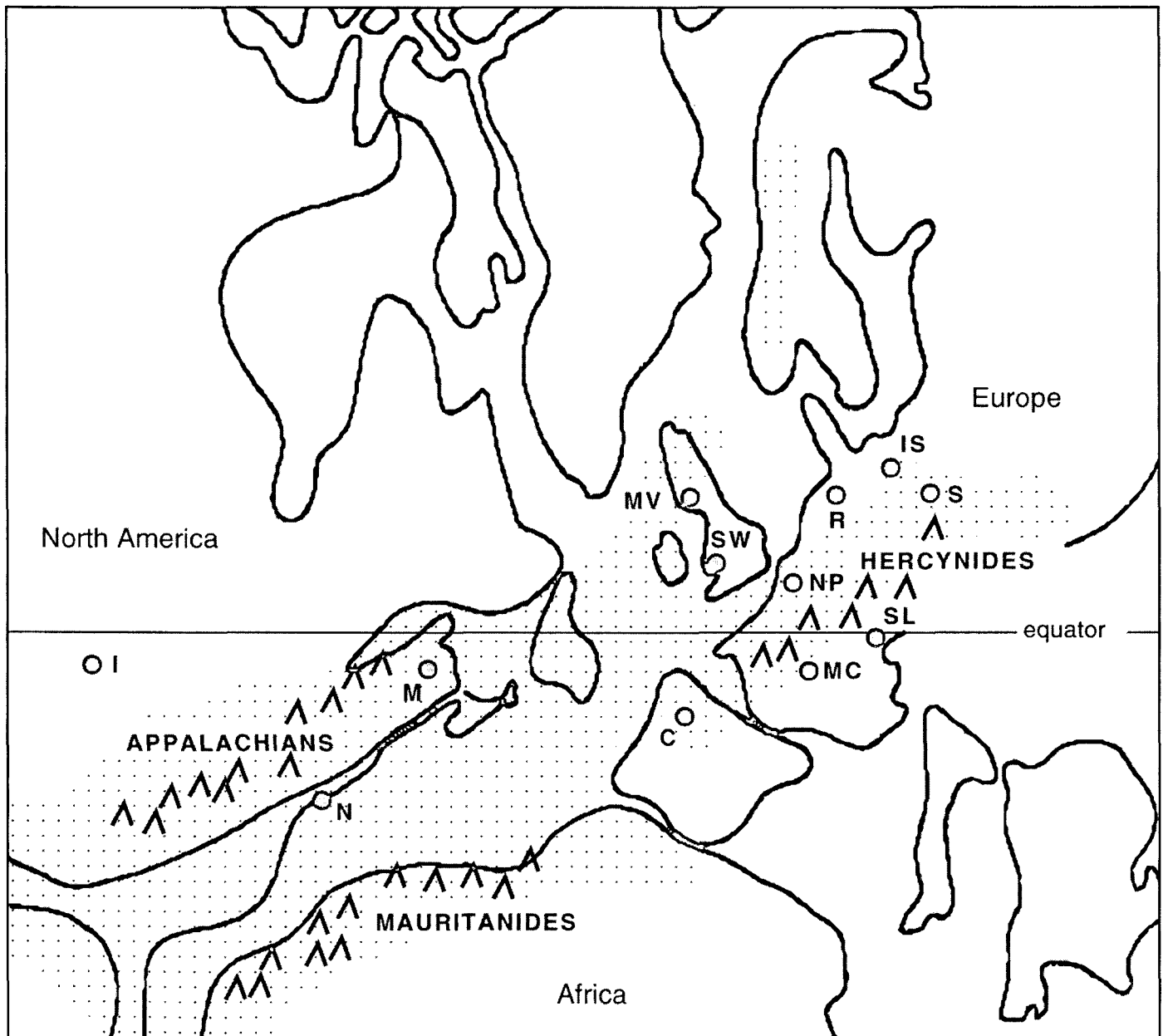


Fig. 1. Late Carboniferous palaeogeography at about 306 Ma showing the positions of major Coal basins in the Euramerican Coal Province (shaded) that contain *Aphantomartus*. I = Illinois Basin, M = Maritimes Basin, N = Narragansett Basin, C = Cantabrian Mountains Basin, MC = Massif Central Basin, NP = Nord - Pas de Calais Basin, R = Ruhr Basin, IS = Intersudetic Basin, S = Silesian Basin, SW = South Wales Basin, MV = Midland Valley Basin, SL = Saar-Lorraine Basin (after Calder and Gibling 1994).

by one of the authors (W.H.F.). Extraction pits in the Minto coalfield are continually opened and backfilled, so identification of the site is now impossible.

The Minto Formation is described as including fossiliferous sandstone, conglomerate, siltstone, shale and coal (St. Peter 1997). The Minto Formation is subdivided into two informal members (Muller 1951; Hacquebard and Barss 1970; Williams *et al.* 1985). The lower member consists of a grey, buff-weathered, commonly cross-bedded, quartzose sandstone, a pebbly sandstone, and a conglomerate. The upper member includes a greyish-green to buff coloured sandstone, a light grey mudstone and the 'Minto coal seam'. Muller (1951) and Bell (1962) assigned the Minto Formation to the Pictou Group; however, recent mapping (St. Peter 1997) placed the Minto Formation within the Cumberland Group (Williams *et*

al. 1985). Miospores indicate an early Westphalian C (Bolsovian) age for the Minto coal seam (Hacquebard 1972; Kalkreuth *et al.* 2000) assigned to the *Vestispora* Zone of Atlantic Canada, equivalent to the basal *Torispora securis-Torispora laevigata* Zone of western Europe, and the lower *Torispora securis-Vestispora fenestrata* Zone of Illinois. The base of the Westphalian C is currently set at 311 ± 3 Ma (Okulitch 1999). Flora of the Minto Formation was described by Bell (1962), and recent discoveries of vertebrates (Miller 1999) have enlarged the described fauna of the Minto Formation to include previously unrecorded sharks, acanthodians, lungfish and rhizodonts.

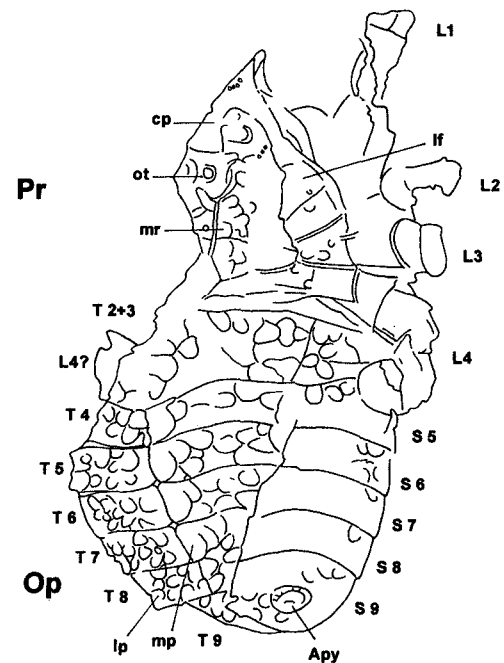
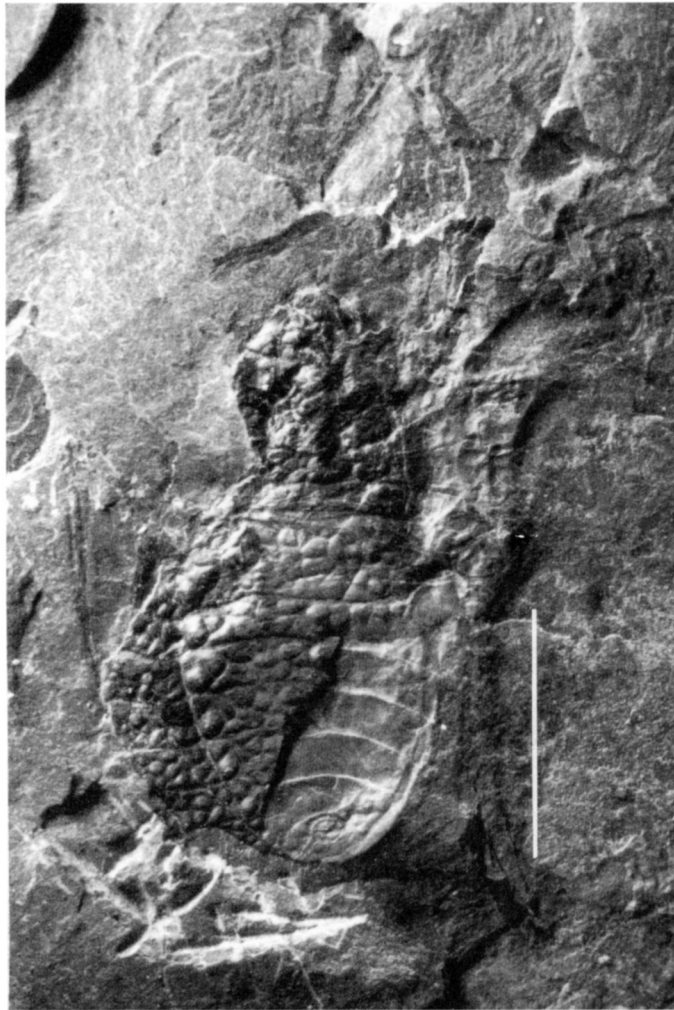


Fig. 2. Photograph and camera lucida drawing of NBMG 4594a, *Aphantomartus pustulatus* (Scudder, 1884), from the Upper Carboniferous (Westphalian C) Minto Formation near Minto, New Brunswick. Internal mould of the dorsal surface of the prosoma and opisthosoma with partial exposure of the interior ventral surface of the posterior opisthosoma. Abbreviations: Apy = anal pygidium, cp = carapace, L1-4 = walking legs 1 to 4, lf = lateral field, lp = lateral plate, mp = median plate, mr = median ridge, Op = opisthosoma, ot = ocular tubercle, Pr = prosoma, S5-S9 = sternites 5 to 9, T2-T9 = tergites 2 to 9. Scale = 5 mm.

SYSTEMATIC PALAEOLOGY

Order Trigonotarbida Petrunkevitch, 1949
 Family Aphantomartidae Petrunkevitch, 1945
 Genus *Aphantomartus* Pocock, 1911

Type species: *Aphantomartus areolatus* Pocock, 1911, from the Mynyddislwyn vein, Maes-y-cwmmmer, South Wales, U.K., Upper Carboniferous (Westphalian D).

Diagnosis: In Rössler (1998)

Discussion: Recent revision of the genus *Aphantomartus* by Rössler (1998) identified two species, *A. pustulatus* and *A. areolatus*, distinguished largely by their dorsal opisthosomal tuberculation which is larger in *A. areolatus* and smaller and more dense in *A. pustulatus*.

Aphantomartus pustulatus (Scudder, 1884)
 Figs. 2, 3

Original diagnosis: In Scudder (1884, p. 18)

Emended diagnosis: In Rössler (1998, p. 73)

Included species: See Rössler (1998) for synonymies.

Material examined: One specimen (NBMG 4594a, b) preserved as a part and counterpart in grey siltstone with carbonized plant fragments. Specimen NBMG 4594a exhibits the internal mould of the dorsal surface of the prosoma and opisthosoma with partial exposure of the interior ventral surface of the posterior opisthosoma. Specimen NBMG 4594b exhibits the external mould of the dorsal surface of the prosoma and opisthosoma. Deposited at the New Brunswick Museum, Saint John, New Brunswick, Canada.

Occurrence: Minto Formation, Cumberland Group, Westphalian C, from open pit coal mine near Minto, New Brunswick.

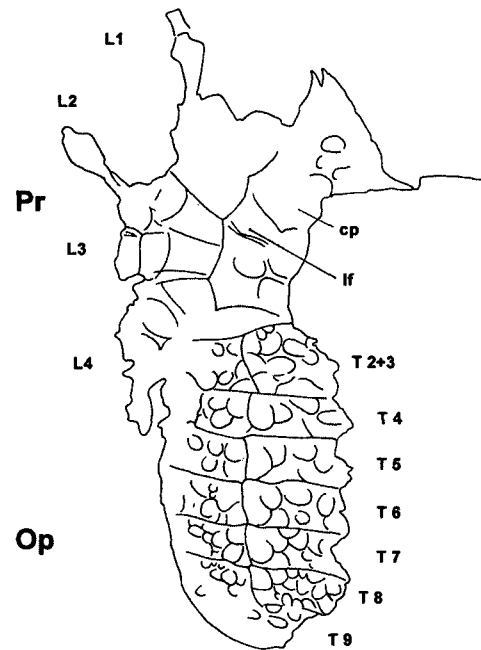
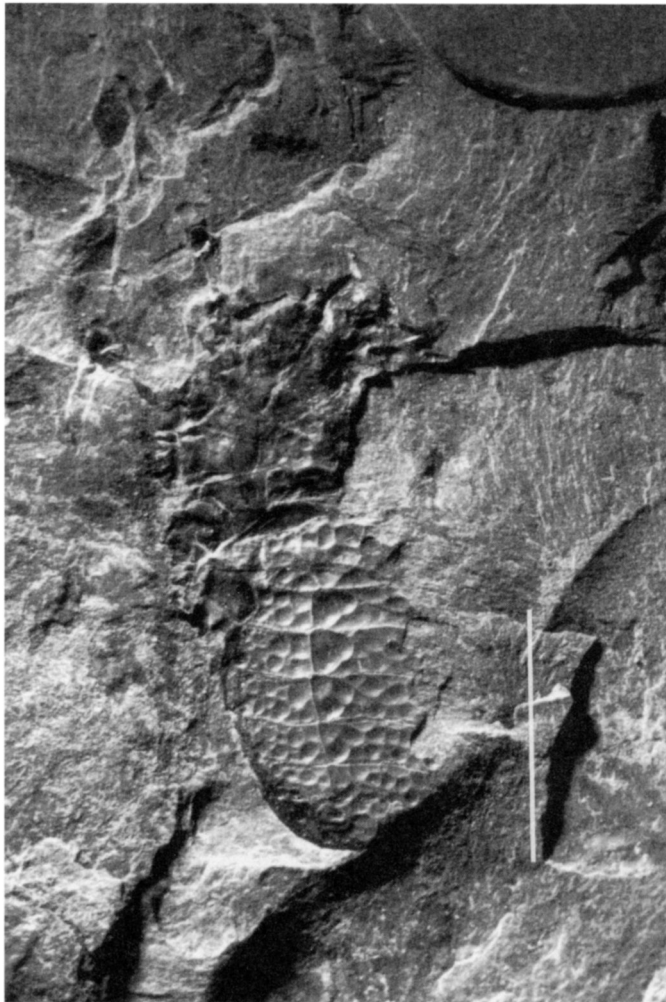


Fig. 3. Photograph and camera lucida drawing of NBMG 4594b, *Aphantomartus pustulatus* (Scudder, 1884), from the Upper Carboniferous (Westphalian C) Minto Formation near Minto, New Brunswick. External mould of the dorsal surface of prosoma and opisthosoma. Abbreviations: cp = carapace, L1-4 = walking legs 1 to 4, lf = lateral field, Op = opisthosoma, Pr = prosoma, T2-T9 = tergites 2 to 9. Scale = 5 mm.

Description: Specimen NBMG 4594 represents a partially preserved, dorsoventrally compressed trigonotarbid. Parts of the left side of the prosoma, and part of the right dorsal opisthosoma are missing. Total length of specimen is approximately 12 mm. Measurements are minimum values. On NBMG 4594a, the dorsal side of the animal is seen impressed upon the ventral side (Fig. 2). The carapace is rotated counterclockwise, revealing part of the ventral side of the prosoma. Opisthosomal sternites are preserved on NBMG 4594a with the overlying tergites preserved on the counterpart. Specimen NBMG 4594b exhibits the external mould of part of the dorsal surface of prosoma and opisthosoma (Fig. 3).

The prosoma is distorted, obscuring details. The carapace is sub-triangular in shape and slightly wider than long. Carapace length is 5 mm. The anterior apex appears to terminate in two acute cusps, although a rounded margin joins the cusps. Carapace width across posterior margin is approximately 6 mm. The carapace is divided into 4 regions. Posteriorly, a transverse rib likely runs the full width of the carapace. It is approximately 0.6 mm long, about one-tenth its width. The rest of the carapace is divided into three

longitudinal sections. A raised median ridge is flanked by a lateral field with a border scalloped into three shallow embayments. The side of the median ridge is steep where it meets the lateral field. The lateral field is well preserved on the right side of the carapace. The left lateral field is largely missing.

The median ridge, as preserved, has no clear divisions and a maximum width of approximately 3 mm. The anterior apex of the median ridge terminates in a v-shaped point opening toward the anterior of the prosoma. The ocular tubercle rests in the middle of the "v". The median ridge is divided into two lobes bisected by a median furrow. Only a portion of the left lobe is visible. The lobe is covered by low irregular-shaped tubercles. It is difficult to define detail in the middle area of the median ridge; however, no transverse furrow posterior to the ocular tubercle can be seen. Two large circular tubercles, about 0.75 mm in diameter, are found on the ocular tubercle.

The lateral field is separated from the median ridge by a furrow. It is covered in low irregular-shaped tubercles and divided by two furrows which run forward and outward from the median ridge to the scalloped lateral margin. The posterior

furrow starts near the base of the median ridge and the anterior furrow starts at about the midpoint of the median ridge.

The opisthosoma is elliptical in shape with a length of 7 mm. The width of the opisthosoma at midlength is approximately 8 mm. The dorsal surface of the opisthosoma is covered by tergites (T2+3 to T9) consisting of a median plate, and a lateral plate. The plates are separated by furrows. The tergites are ornamented by large, low elevation, posteriorly directed tubercles separated by shallow furrows. The second tergite is longer than the other tergites. Tergites 2 to 8 have a row of large, flat, multi-lobed, subtriangular tubercles running down the adaxial side of the longitudinal furrow. Tergite 9 is only partially visible. Between the large, flat, subtriangular tubercles on the median portion of the tergite there are additional less prominent tubercles. The lateral plates of each tergite are also covered in tubercles.

Sternite plates (S5 to S9) are visible on the posterior right portion of the opisthosoma (Fig. 2). There are 5 smooth plates divided by furrows. The tubercles visible on the sternites are remnants of the missing plates of the overlying tergites. The anal pygidium is located in the centre of the last sternite.

Part and counterpart of four pedal appendages (L1 to L4) of the right side are visible on NBMG 4594a, b. The pedal appendages consist of a portion of the trochanter(?) of each right leg and possibly the femur and patella on L1. A small part of the left leg (L4?) is also visible on NBMG 4594a.

Both the part and counterpart of the specimen display a fine layer of black, shiny, carbonized cuticle, easily seen under 70 percent ethanol. Dunlop (1999) described previously unseen cuticle ornament of small, rounded tubercles approximately 50 µm in diameter on the opisthosoma of *A. areolatus*. NBMG 4594 shows similar-sized tubercles on a small patch of cuticle near the anterior apex of the carapace.

DISCUSSION

The specimen described here appears consistent in most respects with *Aphantomartus pustulatus* most recently described by Rössler (1998). Rössler's (1998) revision of the Aphantomartidae recognized one genus with two species *A. areolatus* and *A. pustulatus*. The two species are similar, distinguished largely by their dorsal opisthosomal tuberculation. Rössler's (1998) emended diagnosis indicates *A. pustulatus* possesses finer tuberculation on the tergites and multiple larger tubercles at the lateral edges of the median tergites than *A. areolatus* and weak tubercles on the lateral lobes of the carapace. *A. areolatus* has a transverse furrow behind the ocular tubercle not present on NBMG 4594. The specimen is referred to *A. pustulatus* based on the density of opisthosomal tubercles, presence of multiple tubercles at the lateral edges of the median tergite plate, absence of a transverse furrow behind the ocular tubercle on the prosoma, and the presence of tubercles on the lateral lobes of the carapace.

CONCLUSIONS

The specimen described here is identified as *Aphantomartus pustulatus*, a species erected by Scudder (1884) for a fossil from Mazon Creek, Illinois. *Aphantomartus*

pustulatus and *A. areolatus* have been described from various Coal basins (Rössler 1998) within the Euramerican Coal Province (Fig. 1). Selden and Romano (1983), in their description of *A. areolatus* from the basal Stephanian of Spain, provided a critical discussion of the taxonomic difficulties that have arisen between *Trigonmartus* Petrunkevitch, 1913 and *Aphantomartus* Pocock, 1911. They concluded the two were synonymous, with *Aphantomartus* having priority. Rössler (1998) provided the most recent revision of the Aphantomartidae, including synonymies for both species and an age range for the genus from the Lower Carboniferous (Viséan, older than 327 Ma) in the Erzgebirge Basin, Germany to the Lower Permian (Asselian, about 296–298 Ma) in the Saale Basin, Germany (Rössler 1998; Rössler and Brauckmann 2000). In Europe *Aphantomartus* specimens have been described from the basal Stephanian of Spain in the southwest, to the Namurian of the Czech Republic in the east, north to the Scottish Midland Valley in the United Kingdom and southeast to the Austrian Alps (Rössler 1998; Rössler and Brauckmann 2000). The two previous occurrences in North America include *Aphantomartus pustulatus* from Mazon Creek, Illinois (Scudder 1884; Beall and Selden 1997) and *Trigonmartus woodruffi* Scudder, 1893 (Petrunkevitch 1913), likely *Aphantomartus* (Rössler 1998), from Rhode Island.

Aphantomartus pustulatus from the Westphalian C of New Brunswick places this specimen at about the middle of the known age range of *Aphantomartus*. Palaeogeographic reconstruction (Fig. 1) during deposition of the Minto Formation would place New Brunswick and the Maritimes Basin near the middle of the Euramerican Coal Province (Calder and Gibling 1994) along a trough just south of the equator between the Appalachian Mountains to the northwest and the Mauritanides-Hercynides Mountains to the southeast. The basin designations (Calder and Gibling 1994) indicate major coal-bearing regions. The specimen described here from the Maritimes Coal Basin fills a gap between the Illinois Coal Basin near the western end of the Euramerican Coal Province, the Narragansett Coal Basin in Rhode Island to the south, and the European Coal basins of South Wales, the Midland Valley of Scotland, Cantabrian Mountains, Nord-Pas de Calais, Massif Central, Saar-Lorraine, Ruhr, Intracudetic and Silesian to the east (Rössler 1998).

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