A NEW FOSSIL SCOLOPENDROMORPH CENTIPEDE FROM THE CRATO FORMATION OF BRAZIL

Federica Menon[1], David Penney[1], Paul A. Selden[1] & David M. Martill[2]

1. Department of Earth Sciences, University of Manchester, Manchester, M13 9PL, UK.
   E-mail: 1. federica.menon@stud.man.ac.uk; 2. david.penney@man.ac.uk; 3. paul.selden@man.ac.uk

2. School of Earth and Environmental Sciences, University of Portsmouth, Portsmouth, PO1 3QL, UK.
   E-mail: dave.martill@port.ac.uk

ABSTRACT
Preliminary morphological interpretation of a new, exceptionally preserved Mesozoic scolopendromorph chilopod from the Crato Formation of the Araripe Basin, north-east Brazil is presented. The centipede is preserved in right lateral view and shows features, including a tracheal spiracle, not seen in previously described fossil scolopendromorphs from this locality. All four known fossil centipedes from this Formation are morphologically indistinguishable from modern forms and extant genera from other terrestrial invertebrate orders are known from Cretaceous fossils. Therefore, the new specimen cannot be placed in a fossil taxon on the basis of age alone. Rigorous morphological comparison with extant specimens is required before the correct taxonomic status of the specimen can be determined.

INTRODUCTION
There are 581 extant species of scolopendromorph centipedes currently placed in three families and 32 genera; 57 species in two families and 11 genera are known from the Amazonian region (Schileyko 2002). Though rare as fossils, centipedes have a long geological history. They date back to the Silurian (Shear et al. 1998) and are among the earliest known terrestrial animals (Jeram *et al.* 1990; Shear *et al.* 1998). The earliest Scolopendromorpha occur in late Carboniferous strata from Mazon Creek, Illinois (Hannibal 1997). Only three specimens of centipedes have been reported from strata of Mesozoic age, all from the early Cretaceous of Brazil (Table 1, Figure 1).

Table 1

Fossil chilopods from Brazil (all described in new extinct genera);*=holotype examined by FM.

Species	Order	Reference	Figure
**Cratoraricus oberlii*	Scolopendromorpha	Wilson 2003	1A
**Fulmenocursor tenax*	Scutigeromorpha	Wilson 2001	1B
Velocipede betimari	Scolopendromorpha	Martill & Barker 1998	1C

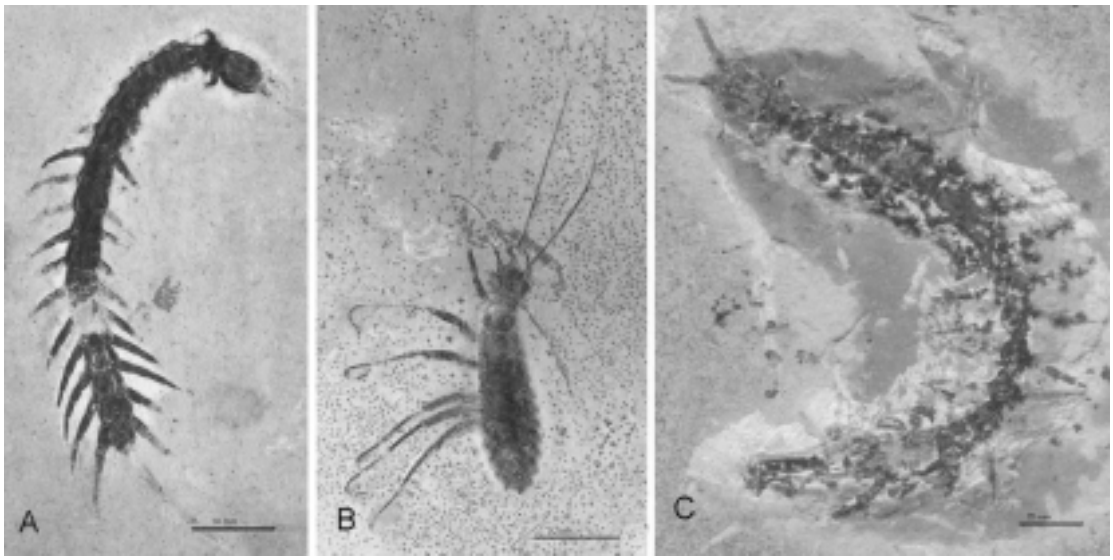


Figure 1. Holotypes and only known specimens of previously described fossil centipedes from the Crato Formation.

A. *Cratoraricus oberlii* (SMNS 64431).

B. *Fulmenocursor tenax* (SMNS 64275).

C. *Velocipede betimari* (SMNK 2345 PAL).

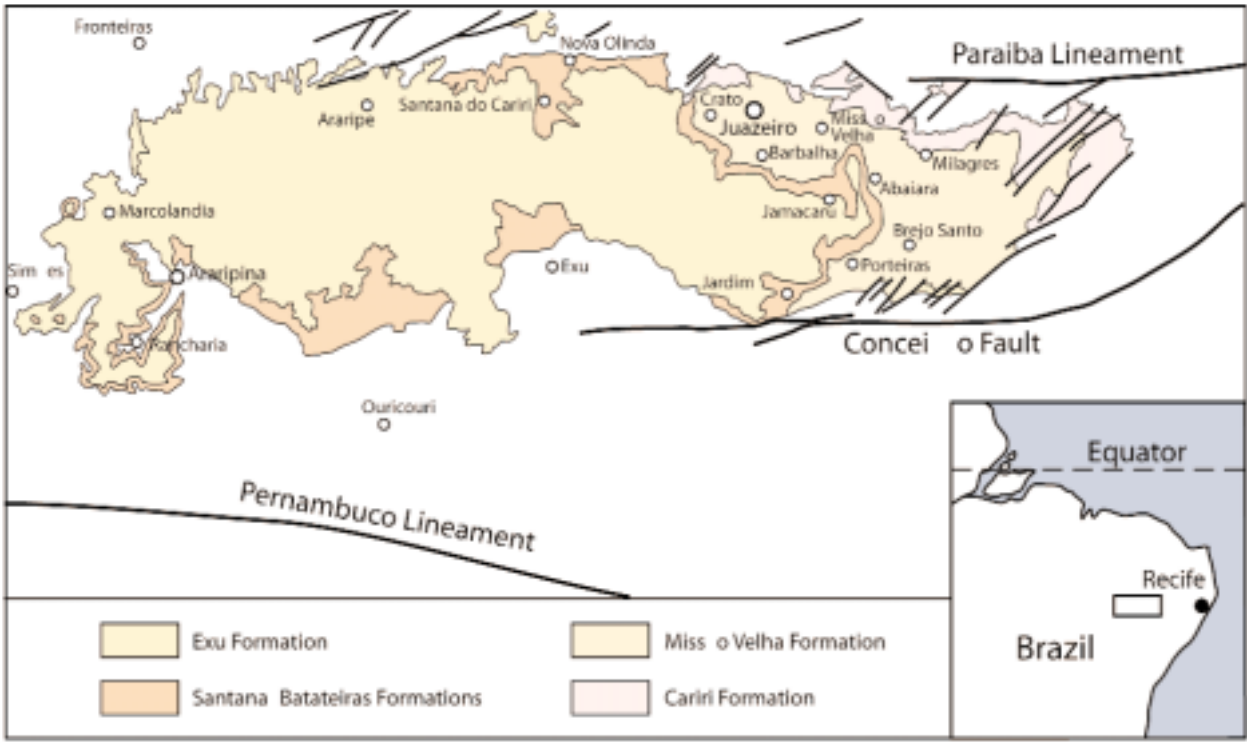


Figure 2. Locality map, geology and stratigraphy of the Chapada do Araripe.

The fossils were found in the limestone of the Crato formation, north-east Brazil (Figure 2). This formation is a series of laminated, organic-rich limestones deposited in a lagoon/lacustrine environment during the opening of the Atlantic Ocean approximately 120–115 million years ago (Albian/Aptian) and became famous following the discovery of incredibly well preserved arthropod and fish fossils (Martill 1993).

It is often the case with fossils that taxonomically important body parts are either obscured by the rock matrix or the position of the organism, and in some cases they may not be preserved. The latter is especially true for the soft parts of an organism, for example, the structure of the spiracles is useful for identification of centipedes, they are clearly visible in Recent specimens but are usually not preserved in non-amber fossils unless they are exceptionally well preserved (Figure 3A–C). However, it is clear from the Brazilian fossil centipedes that they closely resemble modern forms. Indeed, Wilson (2003) stated, “All known Mesozoic Centipedes … are morphologically indistinguishable from extant centipedes” and this is evident from Figure 1A–C and the new specimen presented here. The geological longevity of a terrestrial invertebrate taxon, such as a species, genus or family has not been determined, but there are numerous examples of extant genera present in the Cretaceous, especially from insect and spider inclusions preserved in amber. Therefore, Cretaceous fossils should not be placed in new fossil taxa on the basis of age alone; rigorous morphological comparisons with Recent specimens are required to exclude them from extant taxa. The work presented here is preliminary, and further study, especially of the fossils in comparison with a range of modern species, will be necessary before systematic conclusions can be reached.

Figure 3. Trunk segments (T) and walking legs (L) in lateral view. A. Extant *Dinocryptops miersii* (Newport) (NHM 05.1.18.3–4 [part]) showing spiracle (Sp). B. The new fossil scolopendromorph showing that the spiracle-bearing soft tissues are usually not preserved. C. A preserved spiracle on T14, inset shows the spiracle enlarged.

MATERIAL AND METHODS.

The new specimen was collected by a quarryman in the Nova Olinda and was prepared on site prior to receipt by the authors. The exact provenance of the specimen is uncertain. It is currently held in the collections of the University of Portsmouth. Figure 4B was made by scanning the specimen directly onto a UMAX Power look II flatbed scanner at full optical resolution using UMAX MagicScan v2.3.2; Figure 4A was drawn with a camera lucida attached to an Olympus SZH stereomicroscope then scanned into Photoshop v.6.0 using a Cannon N12400 A4 scanner; Figures 3 & 4C, D were taken with a 6 megapixel D1X digital camera attached to a Wild M8 stereozoom microscope. Comparative specimens of the extant genera *Rhysidia, Otostigmus, Cryptops, Scolopendra, Cormocephalus, Arthrorhabdus, Rhoda, Teatops, Newportia, Dinocryptops, Scolopocryptops* were obtained from the Natural History Museum, London (NHM).

PRELIMINARY INTERPRETATION OF THE NEW FOSSIL

The centipede is preserved in right lateral view with much of the ventral surface visible. It consists of a head and 21 leg-bearing trunk segments; length from base of antennae to base of terminal appendage = 54 mm; length of terminal appendage = 12 mm (Figure 4A–C). As in Recent chilopods the first trunk segment bears the forcipules and is fused with the head; legs are preserved on trunk segments T2–T6, T9–T12 and T20–T22. None of the leg segments, including those of the terminal appendages bear any armature (Figure 4D); one partial claw is preserved on right leg 17 and the matrix contains a faint impression of the left terminal leg claw (Figure 4C). The body is not fully extended and many of the sternites are missing; longitudinal sternal sutures are visible on T3, 19, 21 and 22 (Figure 4D). The forcipular tergite is fused with that of T2, the first leg-bearing trunk segment (Figure 4D). There is a single, oval spiracle preserved, located on T14 (Figure 3C).

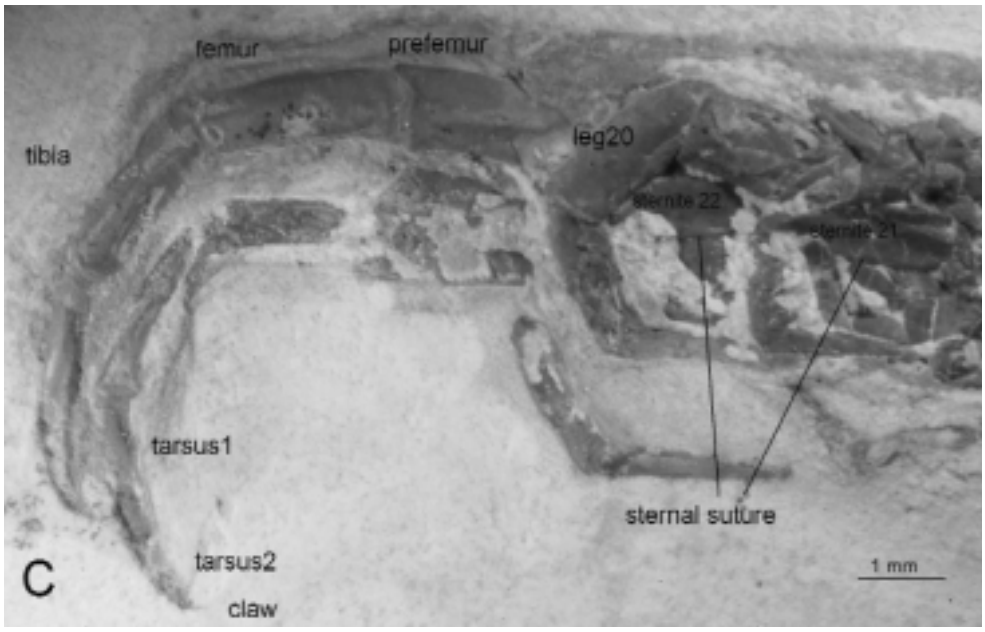
Unfortunately, the head region at the base of the antennae that would bear the eyes (if present in this species) is missing (Figure 4C). The antennae are directed forwards and are at least 16 mm long (not all the antennomeres are preserved); the basal segment is slightly wider than long, but the remaining antennomeres are at least twice as long as wide. The right forcipule shows no unusual characters, the coxosternite plate of the forcipule and the telopodite of the second maxilla are partially visible (Figure 4D).

A. Camera lucida drawing.

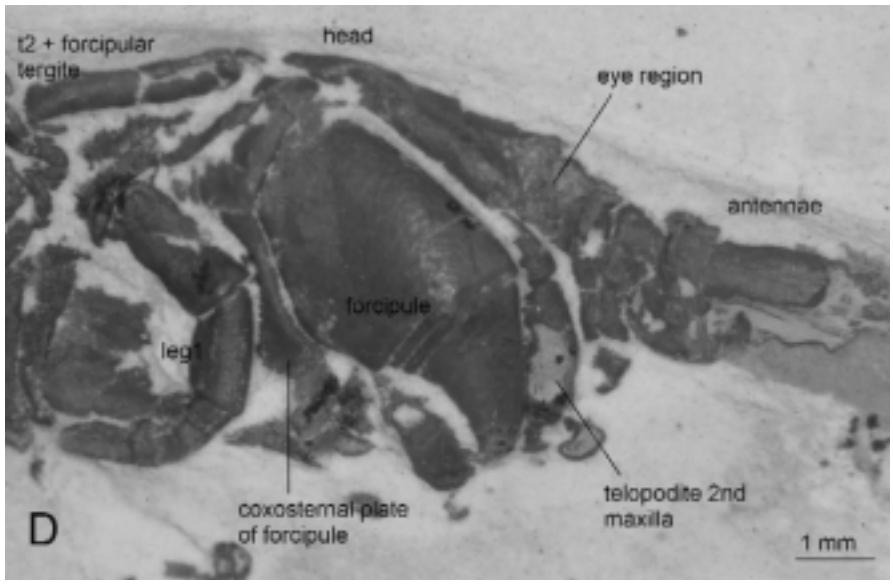
Figure 4. The recently discovered new fossil centipede.
A. Camera lucida drawing.
B. Whole specimen.
C. Close-up of head, the arrow shows the missing region where the eyes would be if they occur in this species.
D. Posterior region and terminal appendages. A, antenna; Cx, coxosternite plate of forcipule; F, forcipule; Fe, femur; H, head; L, leg; Pfe, prefemur; S, sternite; Ss, sternal suture; T2+FT, tergite of trunk segment 2 (=leg-bearing segment 1) fused with focipular tergite (= trunk segment 1); Ta1, tarsus 1; Ta2, tarsus 2; Ti, tibia; Tmx2, telopodide of second maxilla.

Figure 4 continued.

B. Whole specimen



C. Close-up of head, the arrow shows the missing region where the eyes would be if they occur in this species.



D. Posterior region and terminal appendages.

DISCUSSION

The new specimen differs from *Cratoraricus oberlii* Wilson 2003 (Figure 1A) in the relative proportions of the terminal leg segments and the lack of spines on the terminal prefemur. The dark spots visible on the prefemur and femur of the terminal leg in the new fossil (Figure 4C) are clots of manganese oxide crystals. They can be excluded as belonging specifically to the fossil because they are distributed randomly throughout the rock matrix (Figure 4B); also seen in the rock matrix containing the fossil *Fulmenocursor tenax* Wilson 2001 (Figure 1B). Wilson (2003) suggested that the lack of tarsal spines on the walking legs (not including the terminal appendages) of *C. oberlii* may have been a taphonomic artefact and that they may have been present in the living animal. Admittedly, theses leg spines are small (Figure 3A), however there are Recent genera which lack tarsal leg spines e.g. *Cormocephalus* and *Campilostigmus* (Schileyko 2002). It is not possible to determine whether the specimen differs from *Velocipede betimari* Martill & Barker 1998 without careful comparison against the holotype, which we hope to obtain in the near future. It is not known whether the new fossil scolopendromorph or those previously described possessed eyes, and this causes problems when using keys for extant genera. Schileyko & Pavlinov (1997) undertook a cladistic analysis of the extant Scolopendromorpha and concluded that the classification of the order required complete revision. Following such a revision, we hope it will be possible to place this specimen accurately, but until such work is published, the best we can do is compare it with extant genera as currently delimited. We are currently engaged in collecting sufficient comparative Recent material for this purpose.

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