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First fossil of Cylindrostethinae (Heteroptera: Gerromorpha: Gerridae) in the Paleocene of Menat, France

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ABSTRACT

Cylindrostethus gaudanti sp. nov., first fossil representative of the gerrid Cylindrostethinae, is described from the Paleocene of Menat (Centre of France). It is very modern in appearance, and its characters are sufficiently preserved to permit specific identification into the genus *Cylindrostethus*. Its presence in the European Paleogene suggests that this subfamily is very ancient, in accordance with its present disjunct tropicopolitan distribution. The modern Cylindrostethinae are restricted to the tropical rainforests, in accordance with the similar palaeoenvironment of the Menat ancient lake. Possible sexual dimorphic trait in the length of the fore femora is described for the new species.

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INTRODUCTION

The fossil record of the Gerridae is not as rich, as could be expected from a semiaquatic family, but this corresponds to a general situation for the aquatic and semiaquatic insects, compared to the fossil record of terrestrial insects. The oldest fossil is dated from Late Albian amber (Perrichot et al., 2005). Nevertheless the representatives of this family are among the gerromorphans that can be readily recognized even in compression fossils (Damgaard et al., 2014). Thus, quite a few representatives from various subfamilies have been described: Gerrinae (see overview in Damgaard, 2008a; Damgaard et al., 2014), Halobatinae (Andersen, 1998), Charmatometrinae (Andersen,

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2000) and Electrobatinae that are only known from Dominican amber (Andersen and Poinar, 1992; Andersen, 2000). Fossils of the Cylindrostethinae have not been known yet, although the Eocene Messel genus *Cylindrobates* incertae sedis could have affinities to the extant *Cylindrostethus* (Wappler and Andersen, 2004). Here, we describe a fossil from the Paleocene of Menat (France) that is attributable to *Cylindrostethus* following the key of Andersen (1982) and thus could be considered the first fossil representative of this subfamily and one of the oldest known Gerridae, after the Cretaceous *Cretogerris albianus* Perrichot et al., 2005.

MATERIAL AND METHODS

Preparation was made using a compressed air needle. The specimens were examined under a Nikon SZ10 stereomicroscope. Photos were taken with an Olympus E-3 digital camera. Several digital pictures were reconstructed using Helicon Focus and Adobe Photoshop. SEM microphotographs of the setae were taken with the Environmental SEM of the Muséum national d'Histoire naturelle Paris (MNHN) Collection Department, using the mode BSE. All measurements are given in millimetres. Materials with the labels MNHN are stored in the Laboratory of Palaeontology, Muséum national d'Histoire naturelle, Paris, France. Material with the label MNT is stored in the collection of the town of Menat. The fossils from Menat are preserved as compressions in organic-rich spongo-diatomites, which were deposited in a former small maar lake, currently dated to about 56 Ma (Palaeocene) (Vincent et al., 1977; Michon, 2000; Michon and Merle, 2001). It is also well known for the exceptional preservation of the flora and fauna (Piton, 1940; Wappler et al., 2009). This outcrop is very rich in fossil terrestrial insects, mainly beetles (Curculionoidea, Buprestidae, Cerambycidae, Cupedidae, etc.), Blattodea, and Hemiptera, mainly Heteroptera Pentatomorpha. Aquatic insects are very rare, mainly belonging to the presently described species, even if a Gyrinidae is recorded.

SYSTEMATIC PALAEONTOLOGY

Infraorder GERROMORPHA Popov, 1971
Family GERRIDAE Leach, 1815
Subfamily CYLINDROSTETHINAE Matsuda, 1960
Genus CYLINDROSTETHUS Mayr, 1865
Cylindrostethus gaudanti sp. nov.
Figures 1-6, Table 1

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Etymology. After our friend the late Dr. Jean Gaudant, specialist on Cenozoic fishes.

Material. Holotype: MNHN.F.A53794, male (Figure 1). Allotype: MNHN.F.A53795, female (Figures 2, 4.1). Paratypes: MNHN.F.A53796, male; MNHN.F.A53797, female (Figures 5.1, 6.2); MNHN.F.A53798, female (Figures 3.1, 5.2); MNHN.F.A53799, male (Figure 4.2); MNHN.F.A53800, male (Figure 3.2) (all Nel leg.); MNT-06-880AB, female (?) (Figure 6.1).

Type horizon. Palaeocene, spongo-diatomite maar Paleolake.

Type locality. Menat, Puy-de-Dôme, France.

Diagnosis. Fore tibiae widened apically. Fore femora in male longer than in female.

Description. Large-sized, body covered with dense setation; apterous gerrids with elongate, slender body: males: smaller size 14.5 mm, average length 15.8 mm, larger size 18.0 mm; females: smaller size 15.8 mm, average length 16.3 mm, larger size 17.0 mm; average distance between meso-acetabulum 3.05 mm in males and 3.07 mm in females. Body and legs covered with dense setation. Head poorly preserved, but seemingly short. Eyes not discernible. Antennae only partly preserved in all specimens, first antennomere very long (average length 5.2 mm), second antennomere much shorter, third and fourth mostly not preserved. Rostrum short and thick, not long enough to reach posterior margin of prosternum. Trichobothria could not be found on heads. Pronotum short and transverse, ca. 1 mm long, 2 mm wide (Figure 3.2). Mesonotum large and broad, ca. 4 mm long, 2 mm wide, metanotum distinct, with a medial suture, without secondary ridge. Forelegs long, average femur length 5.05 mm in males and 4.25 mm in females; tibia length 4.8 mm (both sexes together), broadened at apex; fore tarsus probably with two tarsomeres, broken at apex, together ca. 1 mm long, second tarsomere almost twice as long as first, pretarsal structures not preserved. Long and slender middle legs inserted laterally on thorax; middle femur length 12.9 mm, middle tibia ca. 10 mm long, somewhat widened apically (in specimen MNT-06-880, width at base 0.2 mm, in the middle 0.15 mm, at apex 0.2 mm). Hind legs as long as middle legs; hind femur length ca. 11 mm (both sexes together), tibia ca. 11 mm. In all three leg pairs, femora and tibiae covered with short dark setae. Abdomen ca. 8.5 mm long, almost parallel-sided. Genital segments of the male are not seen in detail, but obviously symmetrical (Figure 4.2). Male pygophor can be seen in the paratype MNHN.F.A53799, apparently

FIGURE 1. Habitus (1), left fore tarsus (2), and right fore tarsus (3) of *Cylindrostethus gaudanti* sp. nov. holotype, MNHN.F.A53794 (male). Arrows indicate tarsomeres. Scale bars equal 10 mm (1) and 1 mm (2, 3).

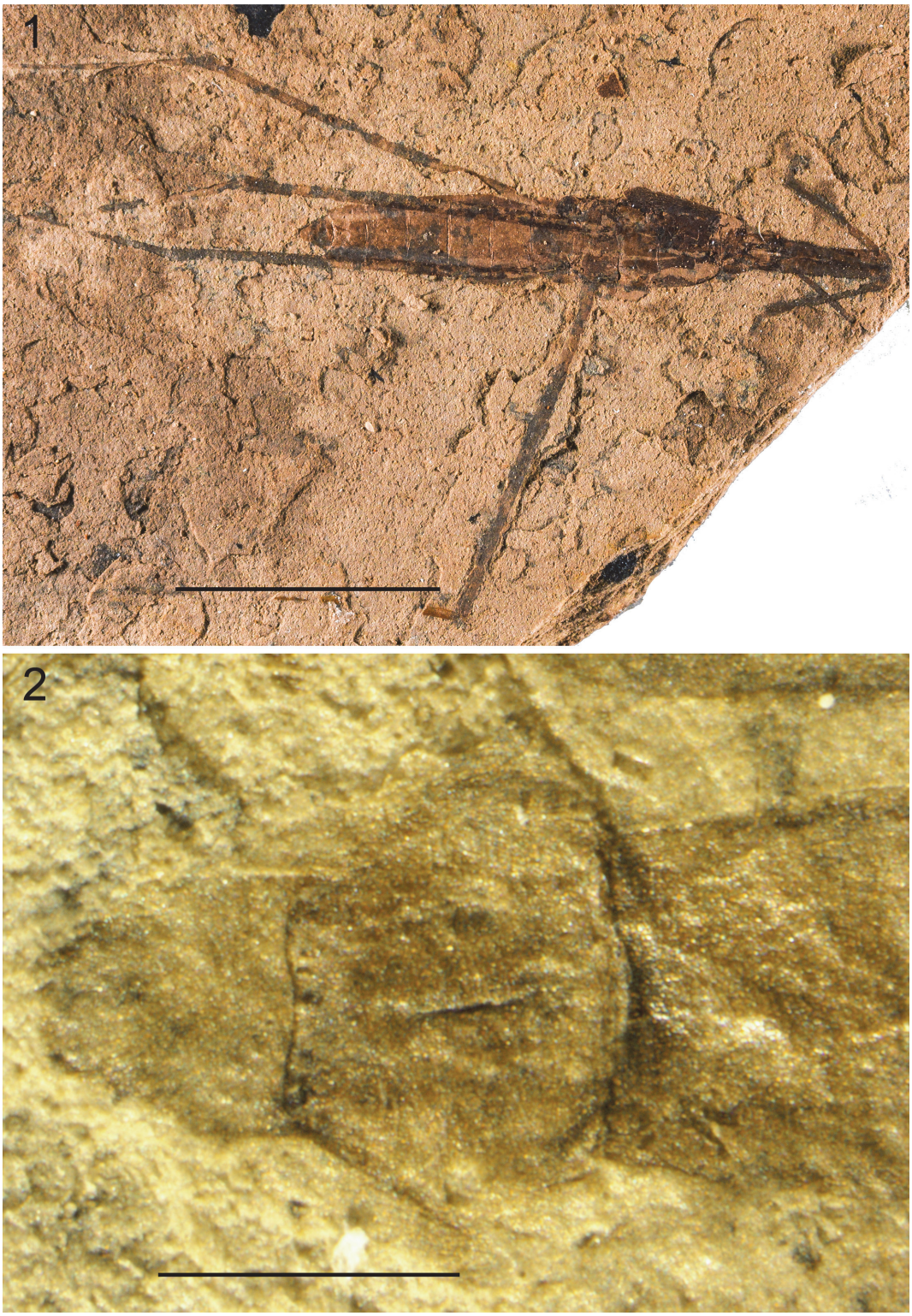

FIGURE 2. Habitus (1) and apex of abdomen (2) of *Cylindrostethus gaudanti* sp. nov. Allotype, MNHN.F.A53795 (female). Scale bars equal 10 mm (1) and 0.5 mm (2).

FIGURE 3. Head with rostrum (arrow) and antennae (1) and thorax (arrow: pronotum) (2) of *Cylindrostethus gaudanti* sp. nov. 1, MNHN.F.A53798 (paratype) and 2, MNHN.F.A53800 (paratype). Scale bars equal 2 mm.

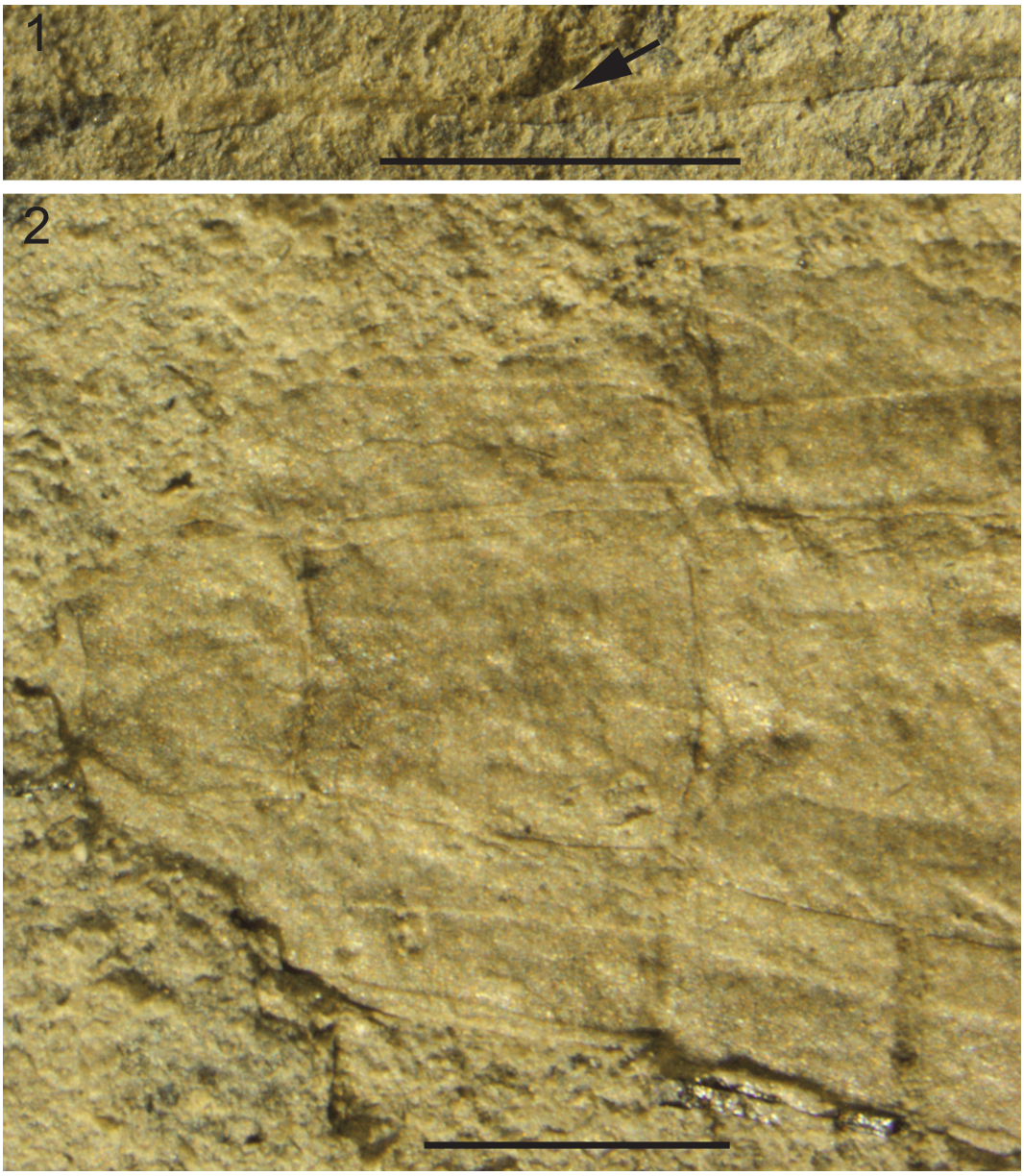

FIGURE 4. Apex of mid tibia (arrow) (1) and male terminalia (2) of *Cylindrostethus gaudanti* sp. nov. 1, MNHN.F.A53795 (allotype, female); and 2, MNHN.F.A53799 (paratype, male). Scale bars equal 1 mm (1) and 0.5 mm (2).

rounded. Female genital segments also symmetrical (Figure 2.2), average length 1.3 mm, the first gonocoxites are well seen (Table 1).

DISCUSSION

Damgaard et al. (2014) noted that representatives of the subfamily Cylindrostethinae are among the gerrid subfamilies that can hardly be separated on the basis of the fossils. Damgaard (2008b) rejected Cylindrostethinae as paraphyletic, lending more support to the idea of Matsuda (1960) who considered Gerrinae in a broader sense, including some Andersen's (1982) subfamilies as tribes, Cylindrostetini among them. At the same time, Damgaard (2008b) admitted that the non-monophyly of Cylindrostethinae in his analysis is surprising since the female heavily sclerotized second gonapophyses and molecular data (mitochondrial 16S rRNA gene sequences) provided good apomorphies in previous studies. He mentioned insufficient taxon sampling for this subfamily, which could offer an explanation for the conflicting interpreta-

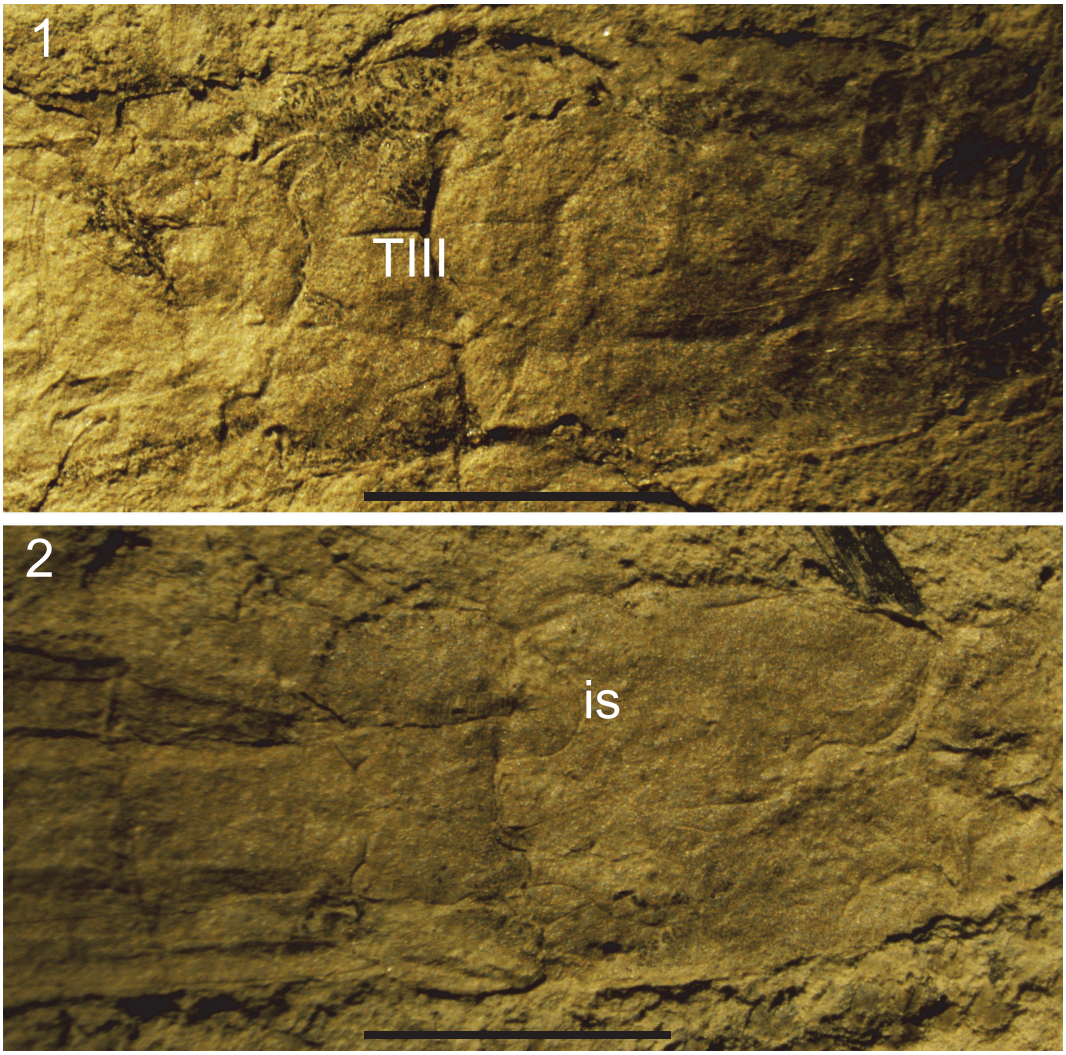

FIGURE 5. Thoraxes of *Cylindrostethus gaudanti* sp. nov. 1, MNHN.F.A53797 (paratype); and 2, MNHN.F.A53798 (paratype). Abbreviations: is, primary intersegmental suture between meso- and metathorax; TIII, metathorax. Scale bars equal 2 mm.

tions. Our specimens fit the Cylindrostethinae data matrix of Damgaard (2008b) in the few characters that are observable in the fossil.

The pronotum short, not extended into a long pronotal lobe excludes affinities with the Gerrinae and Charmatometrinae. The character “rostrum (labium) short and robust, its apex not surpassing prosternum” present in our fossils, is shared by the Cylindrostethinae, Ptilomerinae, Halobatinae, and Rhagadotarsinae. Affinities with the Rhagadotarsinae are excluded because the female ovipositor in our fossils is very short unlike in Rhagadotarsinae. The short fore tarsus, clearly shorter than one-half the length of the tibia excludes affinities with the Ptilomerinae. The metasternum of normal size, not reduced, excludes affinities with the Halobatinae. On the other side, the first segment of fore tarsus less than one-half the length of the second segment is a character of the Cylindrostethinae. The absence of a secondary transverse line on metanotum excludes affinities with the Electrobatinae (Andersen and Poinar, 1992; Andersen, 2000), while this character is shared by the Cylindrostethinae. Andersen (1982) characterized the Cylindrostethinae by two apomorphies “middle tibia and tarsus flattened” and “second gonapophyses heavily sclerotized”. The second character could not be observed in our fossils, but the distally widened middle tibia are clearly seen. Fore tibiae are widened at the apex too, which is a distinctive character for the new species.

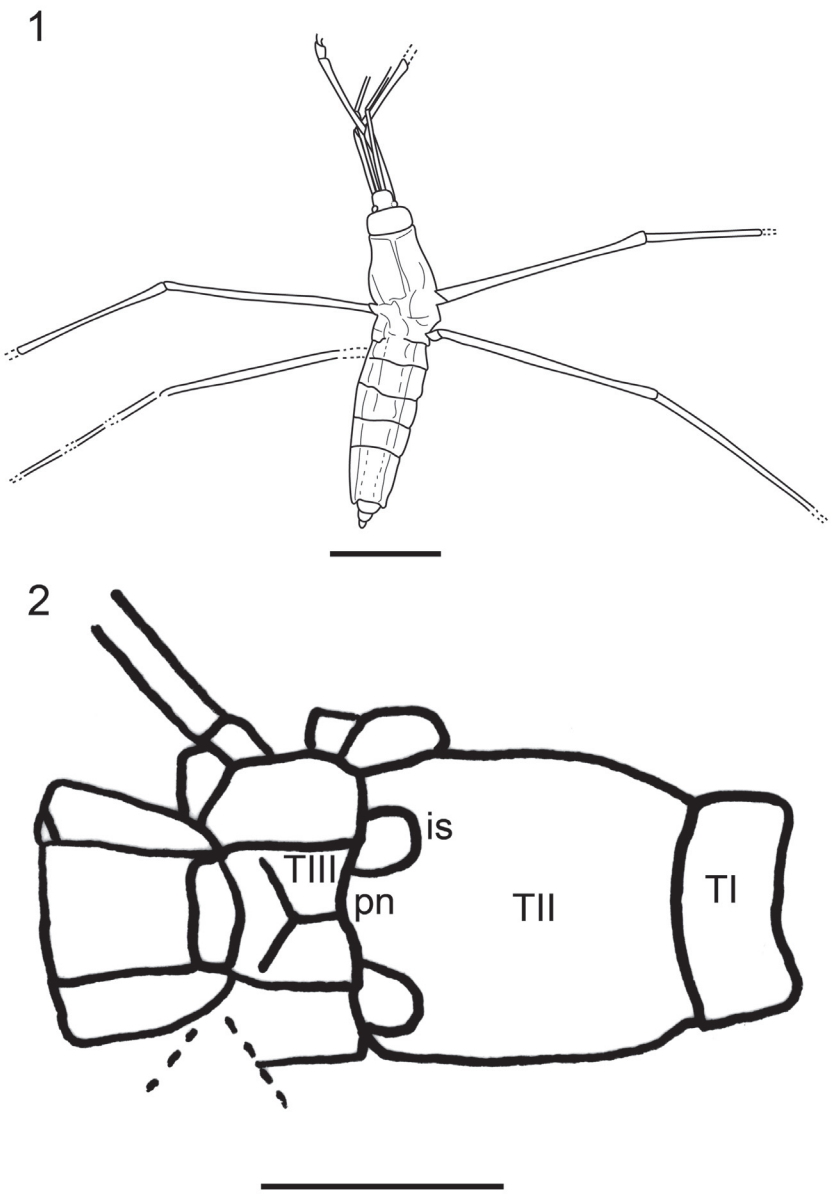

FIGURE 6. Reconstruction of *Cylindrostethus gaudanti* sp. nov. 1, body of MNT-06-880B (paratype); and 2, thorax of MNHN.F.A53797 (paratype). Abbreviations: is, primary intersegmental suture; pn, mesopostnodal margin; TI, pronota; TII, mesonota; TIII, metanota. Scale bars equal 5 mm (1) and 2 mm (2).

Within the Cylindrostethinae, our fossils fit in the genus *Cylindrostethus* rather than in the two other genera currently in this subfamily, because *Platygerris* has a body strongly flattened and a short abdomen (Matsuda, 1960), while *Potamobates* has a broader mesothorax, the male genitalia generally rotated and a short abdomen (Hungerford, 1937; Padilla-Gil and Damgaard, 2011). Lastly the Eocene *Cylindrobathes* differs from our fossils in the short fore legs, distinctly shorter than antennae, although its general habitus resembles that of our fossils (Wappler and Andersen, 2004).

Although the sample is poor (four male and two female measurements) and the fossils are compressed, the fore femora in the males are clearly bigger than in females (5.05 mm against 4.25 mm). This is more striking if we consider that the average body size of females is larger (16.3 to 15.8 mm). The larger fore femur could thus be a

TABLE 1. Measurements (in mm) of the specimens examined in this study. Blank cells show lacking body parts. In paired extremities, if both counterparts were present, still only the best preserved one of them was measured. Except for the body length, indicated dimensions correspond to the lengths.

Specimen	Body length	Body width	1st antennal segment length	Fore femur length	Fore tibia length	Fore tarsus length	Middle femur length	Middle tibia length	Hind femur length	Hind tibia length	Genitali length
Male											
A53794	14.5	2.5		5.0	4.4	1.1	13.3	9.7	8.0		ca. 0.9
A53799	15.7	3.3		5.0			12.7		11.7		
A53796	15.0	3.2	6.0	5.0	4.7		15.4				
A53800	18.0	3.2	5.0	5.2	5.1		12.4		10.3	11.0	
Female											
A53795	17.0	3.4		4.0	4.5	1.0	12.8	11.0	12.0	11.0	1.3
A53798	16.0	2.7	4.6	4.5	5.3		11.0		12.8		1.5
A53797	15.8	3.1									1.1

sexually dimorphic character in this species, although this hypothesis needs to be tested on more specimens.

The Cylindrostethinae is a tropicopolitan subfamily, with *Potamobates* present from Mexico to Peru, *Platygerris* is a South and Central American in distribution, and *Cylindrostethus* is distributed in South America, Africa, and South-East Asia (Andersen, 1982). It is practically impossible to compare with the different modern species of this genus because of the incomplete preservation of the abdomen and genitalia (Matsuda, 1960). Its presence in the Paleocene of the Central France supports a wider distribution in the past and explains it modern disjunct distribution. Also the palaeoecology of the outcrop (a rainforest surrounding a small lake connected to rivers) fits with the habitat of the modern *Cylindrostethus* (Polhemus, 1994).

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