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The first occurrence of the genus *Pristaulacus* from the Late Miocene diatomitic maar of Sainte-Reine, Cantal, France (Hymenoptera, Aulacidae)

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Abstract. – The first Miocene representative of the wasp genus *Pristaulacus* Kieffer, 1900, is described from the volcanic paleolake of Sainte-Reine in Cantal, France. Observable characters are identical to those of the extant *Pristaulacus barbeyi* (Ferrière, 1933), currently known from the southern and eastern Mediterranean regions and Iran and associated with mountainous fir forests where it is a parasitoid of buprestid beetles. Interestingly, the paleohabitat of the Sainte-Reine locality was a mountain paleolake surrounded by forests with firs (*Abies* Mill., Pinaceae) and with a rather cool climate, matching well with the occurrence of a species of *Pristaulacus*, phenetically at least, similar to *P. barbeyi*.

Résumé. – Première occurrence du genre *Pristaulacus* dans le Miocène supérieur du maar diatomitique de Sainte-Reine, Cantal, France (Hymenoptera, Aulacidae). Le premier représentant miocène du genre de guêpe *Pristaulacus* Kieffer, 1900, est décrit du paléolac volcanique de Sainte-Reine dans le Cantal, en France. Les caractères observables préservés sont identiques à ceux de *Pristaulacus barbeyi* (Ferrière, 1933), actuellement connu dans les régions sud et est de la Méditerranée et en Iran, et associé aux forêts de sapins montagneux où il est un parasitoïde des buprestes. Fait intéressant, le paléo-habitat de Sainte-Reine était un paléolac de montagne entouré de forêts avec des sapins (*Abies* Mill., Pinaceae) et avec un climat plutôt frais, ce qui correspond bien à la présence d'une espèce de *Pristaulacus* au moins phénétiquement similaire à *P. barbeyi*.

Keywords. – Insecta, Evanioidea, Upper Miocene, French 'Massif central', paleoclimate.

Wasps of the family Aulacidae (Evanoidea) are endoparasitoids of wood wasps and wood-boring beetles, and comprise 310 species in two widely distributed extant genera – *Aulacus* Jurine, 1807, with 122 species, and *Pristaulacus* Kieffer, 1900, with 188 species (SMITH & TURRISI, 2020; TURRISI & SMITH, 2020), with the latter rendering the former paraphyletic (TURRISI *et al.*, 2009). The family has fossil occurrences extending back to the mid-Cretaceous, with various fossils of the extinct subfamily Hyptiogastritinae, as well as several in the subfamily Aulacinae, although those are currently all placed in the extinct tribe Electrofoenini (ENGEL, 2017; TURRISI & ELLENBERGER, 2019). The tribe Aulacini is currently recorded only from the Cenozoic, with three species of *Aulacus* in amber from the Early Eocene of Oise (France), and the middle Eocene of the Baltic region (BRUES, 1933; NEL *et al.*, 2004; although at least two further Eocene species are also known but remain undescribed, pers. obs.). *Pristaulacus* is slightly more abundant as fossils and certainly has a much broader range of occurrences, with extinct species found as compressions in the Paleocene of Menat, France (JOUAULT & NEL, 2022) and the Eocene-Oligocene boundary of Florissant, Colorado, USA (BRUES, 1910; COCKERELL, 1916), as well as several species in middle Eocene Baltic amber (BRUES, 1923, 1933; JENNINGS & KROGMANN, 2009).

Here we describe the first Miocene representative of *Pristaulacus*, from the diatomitic maar Konservat-Lagerstätte of Sainte-Reine, near Murat (Cantal, France). Not only is the current fossil the latest fossil occurrence of the genus, but it also highlights the significant similarity between the Late Miocene fauna of France with that of Mediterranean Europe today.

MATERIAL AND METHODS

The Upper Miocene Konservat-Lagerstätte of Sainte-Reine (Fourfouilloux, Virargues village), near Murat (Cantal, France), has yielded a diverse and well-preserved entomofauna, with insects preserved as compressions, sometimes with coloration patterns (NEL, 1988; NEL *et al.*, 1996). The diatomitic unit from which the specimen originated was deposited in a lake, probably formed by a maar crater, at a comparatively high elevation (approximately 1000 m). The age of the deposit corresponds to the latest Miocene, ca. 5.60 ± 0.3 Ma (REY, 1975). ROIRON (1991) indicated that the paleoflora documents an important cooling for the period and locality. The specimen was collected in the 1990s through assistance and authorization of the Société Céliste France (Director Mr. Y. Aufauvre) in the large quarry, no longer existing, situated near the Chapelle Sainte-Reine, Fourfouilloux, and in the lower layers with diatoms of the genus *Synedra* Ehrenberg, 1830 (Diatomista, Fragilariaceae). The wasp was conserved with water-based wallpaper glue, a process that allows for the preservation of insects from this outcrop and allowing their observation under ethanol.

The specimen was studied using a stereomicroscope Nikon SMZ25 and the photographs were taken with a Canon 50D and an attached Canon 65 MPE camera lens, mounted on an automated stacking rail (StackShot). The photograph (fig. 1) is a digitally stacked composite of several individual focal planes, which were obtained using Helicon Focus 6.7. The figures were composed with Adobe Photoshop CC2022. We follow the wing venation terminology of ENGEL (2017).

SYSTEMATIC PALEONTOLOGY

Superfamily *Evanioidea* Latreille, 1802Family *Aulacidae* Shuckard, 1841Subfamily *Aulacinae* Shuckard, 1841Tribe *Aulacini* Shuckard, 1841Genus *Pristaulacus* Kieffer, 1900*Pristaulacus* sp. aff. *P. barbeyi* (Ferrière, 1933) (fig. 1-2)

Material. – Specimen IF-STR-0100 (a forewing attached to mesosoma, plus fragments of head and metasoma), provisionally stored in the Muséum national d’Histoire naturelle, Paris, to be deposited in next future in the Musée of the town of Murat (Cantal, France).

Locality and horizon. – Latest Miocene, diatom paleomaar, Sainte-Reine (quarry of Foufouilloux, Virargues village), near Murat, Cantal, France.

Description. – Mesosoma 4.5 mm long, with a series of parallel ridges. Forewing hyaline, approximately 7.5 mm long, 2.0 mm wide; pterostigma elongate, sclerotized, dark brown, 1.1 mm long, 0.4 mm wide; all visible veins tubular, 2rs-m and 2Rs+M absent; 1Rs arising far basad pterostigma base, slightly curved; 1M weakly arched,

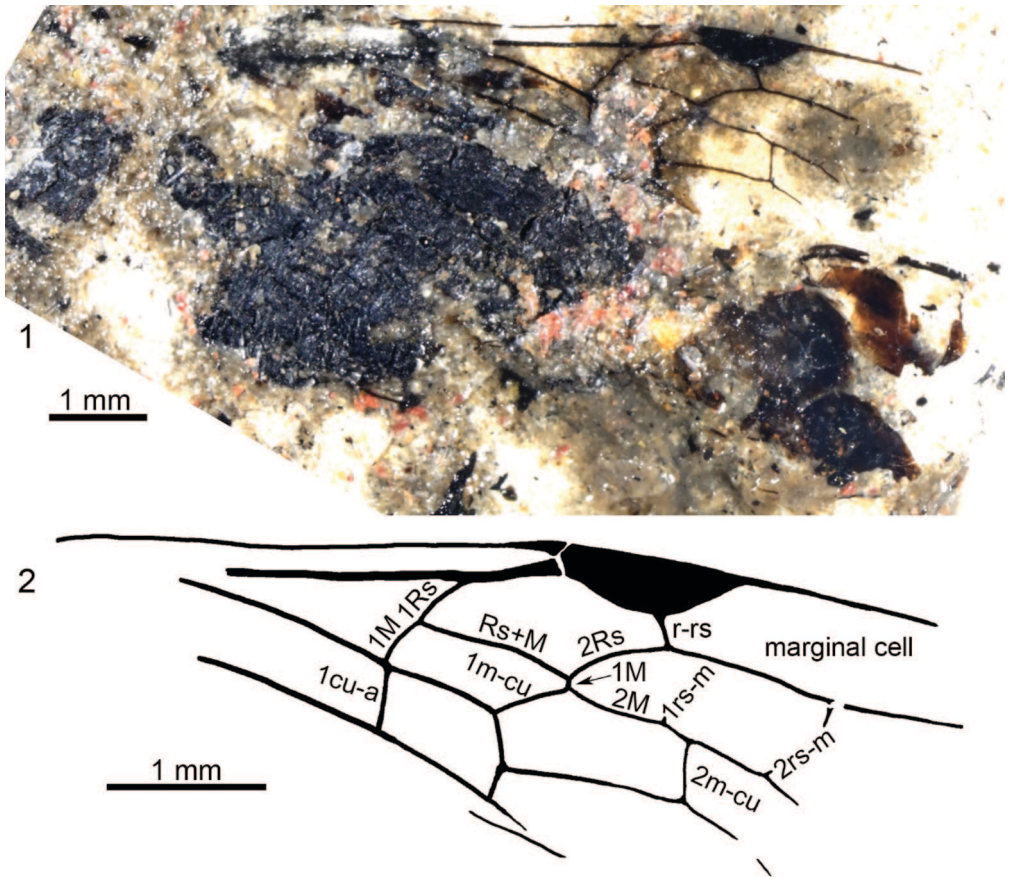


Fig. 1-2. – *Pristaulacus* sp. aff. *P. barbeyi* (Ferrière), specimen IF-STR-0100. – 1, Photograph of specimen. – 2, Line drawing of preserved elements of forewing venation.

shorter than 1Rs, nearly aligned with 1cu-a; 1cu-a oblique; Cu1a straight, as long as Rs+M; r-rs arising slightly distad pterostigmal midlength, inclined toward wing apex; 2Rs oblique, arched, shorter than Rs+M; minute 1M present, with 2M nearly meeting Rs+M; 1m-cu slightly distad 2Rs, straight; costal, radial, cubital, subdiscoidal, discoidal, first submarginal, and marginal cells closed by tubular veins; first submarginal cell slightly wider but shorter than second submarginal cell, latter of which open (= fusion of second and third submarginal cells owing to absence of 2rs-m); marginal cell large, trapezoidal, preserved borders parallel.

DISCUSSION

The pattern of forewing venation of the new fossil fits quite well with those of extant Aulacidae, and more precisely the genus *Pristaulacus*. Of note are the absence of 2Rs+M and 2rs-m (2rs-m represented by nothing more than a posterior stub), the elongate marginal cell, 2Rs longer than r-rs (2Rs closes the first submarginal cell apically), the long 1Rs, the large first submarginal cell, 1cu-a sub-aligned with 1M, the broad pterostigma, 3rs-m incomplete, and the shape of the second submarginal cell (cell open apically).

The main differences between *Aulacus* and *Pristaulacus* (hind tarsal claw pectinate or not, presence of an occipital carina) cannot be ascertained. In *Pristaulacus*, the forewing vein 2Rs+M is mostly short vs much longer in *Aulacus* (TURRISI *et al.*, 2009). As this vein is absent in the new fossil, it likely is attributed to *Pristaulacus*.

Given the relatively young age of the new fossil, we compared it only with the Palaearctic species of *Pristaulacus*, extensively revised by TURRISI (2007). The coloration and venation of the new fossil are identical to those of *Pristaulacus barbeyi* (Ferrière, 1933) (FERRIÈRE, 1933; TURRISI, 2013a: fig. 7). A series of parallel ridges transverse the mesosoma of the fossil, identical to those in *P. barbeyi* and somewhat similar to those of *P. gibbator* (Thunberg, 1822) (Europe to Siberia), and *P. rufipilosus* Uchida, 1932 (Japan). This mesoscutal ornamentation differs from that of the other extant European species (TURRISI, 2007: fig. 44-63). *Pristaulacus gibbator* has hyaline forewings, which are uniformly yellowish, quite unlike the new fossil. *Pristaulacus kostylevi* (Alekseyev, 1986) (Russia) has hyaline forewings but differs from the new fossil in the sparser parallel ridges of the mesosoma. All other Palaearctic species of *Pristaulacus* have at least a dark spot below the pterostigma (TURRISI, 2007), which is lacking in the current fossil. For example, *P. rufipilosus* has the pterostigma dark brown medially and a wide, subrectangular, dark-brown spot below the pterostigma, unlike in the fossil reported here. Affinities with *P. gloriator* (Fabricius, 1804) are excluded because it has pronounced areas of infumation on the apex of the wing membrane and below pterostigma, 2Rs+M is present, and r-rs is significantly longer than that of the new fossil (OEHLKE, 1983: fig. 11). As noted, all other Eurasian species have some degree of forewing pigmentation as well as different mesosomal sculpturing, thereby making them more disparate morphologically from the current fossil.

The Paleocene *Pristaulacus jarzembowskii* Jouault & Nel, 2022, the oldest known representative of this genus, has the basal part of vein Rs nearly perpendicular to Sc+R and to Rs+M, instead of being basally recurved and emerging from R at an acute angle as in the other fossil and extant species of this genus (JOUAULT & NEL, 2022). The Eocene *Pristaulacus mandibularis* Brues, 1933, and *Pristaulacus velteni* Jennings & Krogmann, 2009, have a 2Rs+M vein (BRUES, 1933; JENNINGS & KROGMANN, 2009).

The Eocene *Pristaulacus praevolans* Brues, 1923, and the Eocene-Oligocene *P. bradleyi* (Brues, 1910) and *P. secundus* (Cockerell, 1916) have the vein 1Rs+M twice as long as 1M vs three times as long in the new fossil (COCKERELL, 1916; BRUES, 1910, 1923). The Eocene-Oligocene *P. rohweri* Brues, 1910, has the wing membrane infuscate below the pterostigma (BRUES, 1910). Thus, the new fossil differs notably from all previously described species.

Given the few characters observable in the new fossil as preserved, it is not possible to make a more refined taxonomic assignment or to circumscribe a new species. Therefore, we left the species as indeterminate, noting that most of the observed similarities are analogous to *P. barbeyi*. This does not mean that these two species can be considered relatives as characters from elsewhere on the body and particularly any genitalic features could demonstrate that the fossil belongs to some other subordinate clade within *Pristaulacus*. Nonetheless, based on a simple phenetic assessment, it most closely approximates *P. barbeyi*.

Pristaulacus barbeyi is known from Algeria, Morocco, Greece, Turkey, Iran, and Spain (TURRISI, 2007, 2013a, b; GHAHARI, 2012), where it lives in mountainous fir forests (*Abies* Mill.: Pinaceae, Abietoideae) (GHAHARI, 2012; TURRISI, 2013a, b). Interestingly, *Abies* is recorded in the paleoflora of Sainte-Reine (ROIRON, 1991). The presence of firs together with the mountainous paleohabitat of the area collectively matches the ecological niche preferences of *P. barbeyi*. It is therefore perhaps not surprising to find such a similar species of *Pristaulacus* in the Late Miocene of Murat, where it most certainly preyed upon wood-boring beetles. *Pristaulacus barbeyi* is hypothesized to parasitize Buprestidae, and buprestid beetles are present but infrequent in the sediments of the Sainte-Reine paleolake. Aulacids are also hypothesized to be more frequent in newly burnt forests (PHAM *et al.*, 2016), likely given the increased occurrence of wood-boring beetles on the many fallen trees. Quite interestingly, evidentiary traces of forest fires are present at Sainte-Reine, including some layers with numerous fragments of burnt wood (AN, pers. obs.).

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