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SHORT NOTE

The first *Curiosivespa* Rasnitsyn, 1975 (Hymenoptera: Vespidae) from the Lower Cretaceous Crato formation (Brazil)

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Summary. The first vespid species from the Lower Cretaceous Crato formation (Brazil) is described and figured as *Curiosivespa sennlaubi* Jouault, Rasnitsyn & Nel, **n. sp.** This new species can be differentiated from the other *Curiosivespa* species, *inter alia*, by its forewing venation (e.g. Rs+M and 2-M aligned; 2 m-cu meeting M slightly prior to 2 r-m). This first occurrence of the family Vespidae in South America during the Cretaceous indicates that the family was widely distributed during this period.

Résumé. La première *Curiosivespa* Rasnitsyn, 1975 (Hymenoptera : Vespidae) du Crétacé inférieur de la formation du Crato (Brésil). La première espèce de Vespidae du Crétacé inférieur de la formation du Crato (Brésil) est décrite et figurée comme *Curiosivespa sennlaubi* Jouault, Rasnitsyn & Nel, **n. sp.** Cette nouvelle espèce peut être différenciée des autres espèces de *Curiosivespa*, *inter alia*, sur la base de la nervation de son aile antérieure (par exemple Rs+M et 2-M alignées ; 2m-cu rencontrant M légèrement avant 2r-m). Cette première occurrence de la famille Vespidae en Amérique du Sud durant le Crétacé indique que la famille était largement distribuée à cette période.

<http://www.zoobank.org/urn:lsid:zoobank.org:pub:F4A4B3A2-FB6C-42AD-9F92-AB55948345E5>

Keywords: Insecta; Vespoidea; Mesozoic; new species; paleobiogeography

The superfamily Vespoidea is today relatively speciose with more than 29,185 extant species (Pilgrim et al. 2008; Aguiar et al. 2013) and widely distributed. The recent dated molecular phylogenies estimated that the superfamily arose during the earliest Cretaceous (e.g. Peters et al. 2017), but as pointed in numerous recent papers the difference between molecular dating and stratigraphic evidences are often huge (e.g. Ronquist et al. 2012; Jouault et al. 2021). To better estimate the arising of the superfamily and of its constitutive families, a tip-dating or a total-evidence approach is needed. Within the Vespoidea, the family Vespidae is represented by 63 fossil species (e.g. Wu et al. 2020a, 2020b) and is assumed to have arisen during the early Cretaceous (Branstetter et al. 2017). Nevertheless, the vespids seem to be already well diversified during the Cretaceous since they are nearly distributed worldwide (Botswana, USA, Kazakhstan, South Africa, Russian Federation, Mongolia, and Myanmar). This vespid fossil record seems to corroborate the estimated age of origin of the family with the earliest evidences known from the Aptian period in the Zaza Formation and the Dzun-Bain Formation (now called

Khurilt Formation; Kopylov et al. 2020), respectively from Russia and Mongolia (Carpenter & Rasnitsyn 1990).

Interestingly, vespids are, to date, known from nearly all the major Cretaceous fossil insect deposits except the Crato Konservat-Lagerstätte (CKL) (note also the absence from Yixian, China), one of the most famous Cretaceous insect fossil deposits. Martill et al. (2007) mentioned the putative presence of a vespid specimen (SMNS 66295) in the CKL but they did not describe it formally. Therefore, the Gondwana fossil record of the family was previously constrained to Africa in the Upper Cretaceous Orapa deposit (Brothers & Rasnitsyn 2008). Herein we describe a new species of vespid wasps *Curiosivespa sennlaubi* Jouault, Rasnitsyn & Nel, **n. sp.**, based on material from the CKL.

Material and methods

The specimen studied herein derives from the Crato Formation, also called Crato Member of the Santana Formation. This deposit is composed of limestone outcropping near Nova Olinda in the northeast Brazilian province of Ceará (7.2°S 39.4°W: paleocoordinates 12.2°S 10.8°W) (Barling et al. 2015, figure 1; Ribeiro

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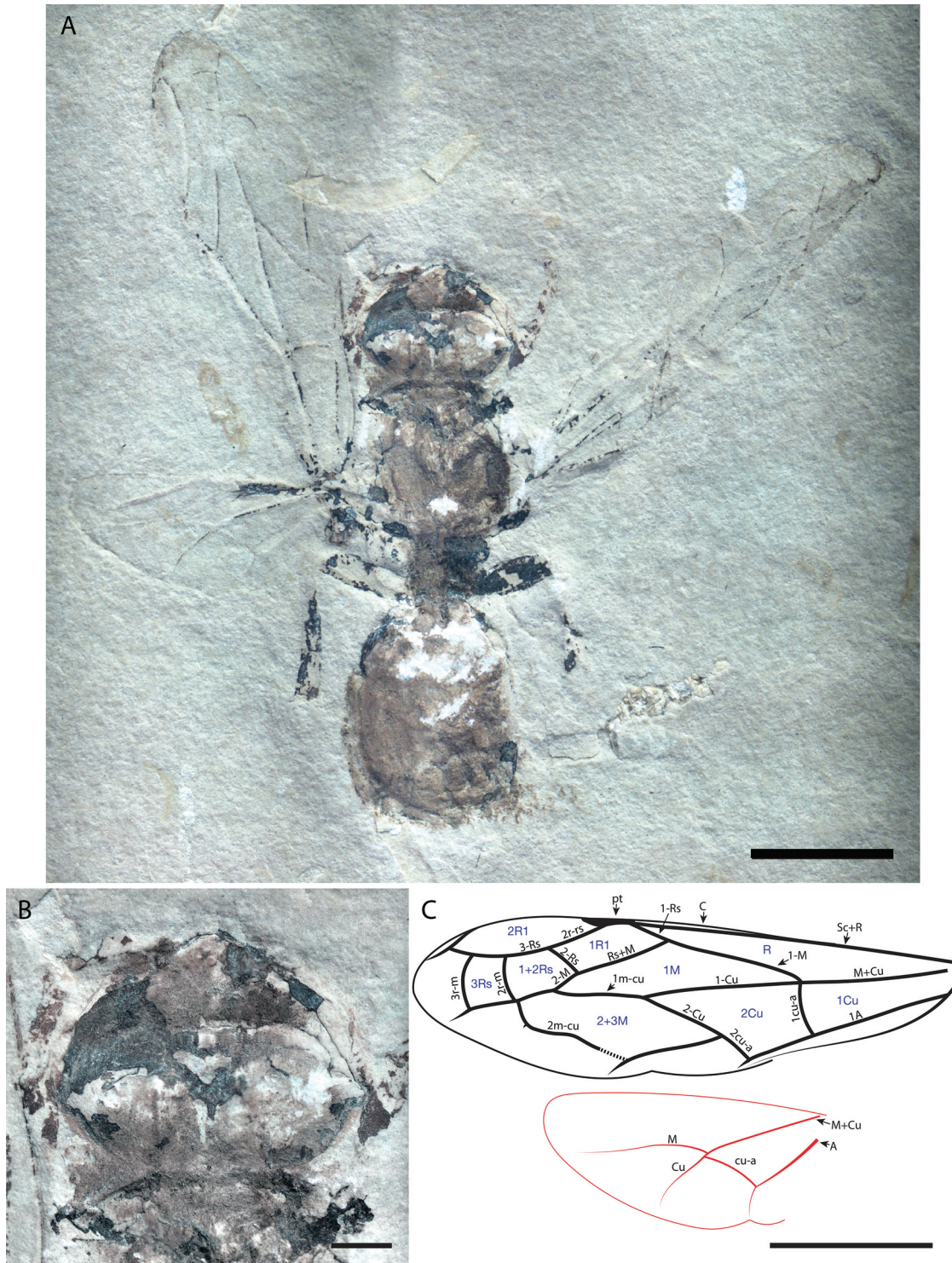


Figure 1. *Curiosivespa sennlaubi* Jouault, Rasnitsyn & Nel, n. sp., holotype MHNE.2021.7.1. **A**, Habitus in dorsal view. **B**, Detailed view of head. **C**, Interpretative line drawing of venations with labelled veins and cells (blue). Scale bars: 5 mm (A, C); 1 mm (B).

et al. 2021, figure 1). The fossiliferous unit has been dated as Aptian on the basis of its palynology (Pons et al. 1991; Varejão et al. 2021). The fossils are partly compressed, three-dimensional

mineralized replicas. The cuticle was replaced by dark brown iron hydroxide (goethite); internally, the insect body is composed largely of calcite and apatite.

The specimen was prepared by removing limestone matrix from around the body with fine blades and needles; the limestone dust was then removed with slight puffs of compressed air. The figure was composed with Adobe Illustrator CC 2019 and Photoshop CC 2019 software. We follow an adapted wing venation based on Huber & Sharkey (1993).

Systematic paleontology

Order Hymenoptera Linnaeus, 1758
Superfamily Vespoidea Latreille, 1802
Family Vespidae Latreille, 1802
Subfamily Euparagiinae Ashmead, 1902
Genus *Curiosivespa* Rasnitsyn, 1975

Curiosivespa Rasnitsyn, 1975, p. 113.

Included species

Curiosivespa curiosa Rasnitsyn, 1975 (type species); *C. antiqua* Carpenter & Rasnitsyn, 1990; *C. derivata*, 1990; *C. magna* Rasnitsyn, 1975; *C. orapa* Brothers, 1992; *C. striata* Perrard & Carpenter, 2017 (in Perrard et al. 2017); *C. zigrasi* Perrard & Carpenter, 2017 (in Perrard et al. 2017); *C. sennlaubi* n. sp.

***Curiosivespa sennlaubi* Jouault, Rasnitsyn & Nel, n. sp. (Figure 1)**

Type material

Holotype: Specimen identifier number MHNE.2021.7.1 (a well-preserved 3-D replica).

Etymology

The specific epithet honors Markus Sennlaub, who kindly allowed the specimen study and deposited it in Musée d'Histoire Naturelle et d'Ethnographie (Colmar, France); it is to be treated as a noun in genitive case.

Locality and age

Early Cretaceous, late Aptian, Crato Formation, Araripe Basin, Brazil.

Diagnosis

Forewing with distal part of M nearly straight; Rs+M and 2-M slightly angled; 2 m-cu and 2 r-m nearly aligned; 2cu-a nearly perpendicular to 2 + 3A; 1-M aligned with 1-Rs;

1cu-a opposite base of 1-M; 2 r-rs and Rs+M nearly parallel; vein 3 r-m present.

Description

Sex unknown (distal part of abdomen not preserved, and antennae incomplete). Large wasp with a wing span ca. 38.9 mm and body length as preserved about 20.04 mm long. Surface sculpture of body not preserved. No distinctive color pattern; as preserved, body reddish-brown; wings apparently hyaline with all veins sclerotized.

Head rounded slightly wider than long (ca. 4.08 mm long and 5.14 mm wide with eyes included). Eye massive located laterally, ca. 2.95 mm long and 1.93 mm wide. Clypeus pentagonal, with obtusely angular anterior margin. Antennae partly preserved, right antenna ca. 7.32 mm long and 0.31 mm wide (as preserved), several antennomeres visible but exact number unknown. Ocelli not visible.

Mesosoma (in ventral view) preserved, with structure difficult to interpret. Forelegs not preserved. Mid legs partly preserved, left mid leg with tibia ca. 3.22 mm long with two apical spurs. Hind legs partly preserved, left hind leg with femur at least 3.05 mm long, slightly widened medially; tibia ca. 4.61 mm long.

Forewing about 17.31 mm long, ca. 5.01 mm wide (measure in apical third). Membrane hyaline; right forewing nearly complete, left forewing folded, only left hind wing preserved with partly visible wing venation. Forewing costal space narrow, slightly widening toward pterostigma; C and Sc+R straight or nearly so; M+ Cu feebly curved medially, with fork located very far from pterostigma base; pterostigma short and narrow, partly preserved, slightly widened apicad; 1-Rs nearly straight, very short, 0.35 times length of 1-M; cell 1R1 rectangular with nearly parallel sides (veins 2 r-rs and Rs+M), about twice as long as wide; no vestigial 1 r-rs crossvein; 2 r-rs directed toward wing apex, longer than 2 r-m or 1-Rs; cell 2R1 elongate, about four times longer than wide, apically separated from margin by a narrow space and emitting a short stem distally; 1-M straight, longer than Rs+M, slightly shorter than Cu; 1 M cell quite elongate, trapezoidal, 4.9 times longer than wide; 1 m-cu slightly curved medially, shorter than Cu; cell 1 + 2Rs trapezoidal, slightly longer than wide, separated from cell 1R1 by 2-Rs and from cell 3Rs by a curved 2 r-m; 2-Rs slightly curved, shorter than Rs+M; cell 3Rs closed by a broadly arched vein 3 r-m (similarly shaped as 2 r-m), slightly closer to 2 r-m along Rs than along M; vein 1-Cu nearly straight, shorter than combined lengths of 1-Rs and 1-M, slightly longer than 1 m-cu; 1cu-a aligned with 1 M base, slightly curved; 2 + 3 M cell broad, shorter than cell 1 M,

closed by a strongly sigmoidal 2 m-cu vein; 2 m-cu with a short abscissa located in its apical third; 1Cu cell long, rectangular, slightly narrower basally, with M+ Cu and 1-A veins approaching at base; 2Cu cell trapezoidal, longer along Cu, shorter than cell 1 M; 2cu-a aligned with 2-Cu, about twice as shorter than 1cu-a; 1A vein long and straight, with its part distal to 1cu-a short and straight. Hind wing at least 10.0 mm long, ca. 4.03 mm wide (dimensions taken near mid-length); anterior part of hind wing not preserved; M+ Cu straight; M and Cu long tapering toward apex; cu-a slightly postfurcal; A slightly curved with an apical stem directed toward wing margin; anal lobe well developed.

Metasoma poorly preserved, 7.75 mm long (as preserved) and 5.52 mm wide, tapering toward apex; with four visible segments, first one the smallest, lengths of preserved segments (from base to apex in mm): 1.44; 2.02; 2.44; 2.02.

Discussion

The new specimen described herein is readily attributed to the Euparagiinae because of its specific venation pattern, with the 2Cu (or subdiscal) cell anteriorly produced compared to its posterior part, much more than in the Cretaceous Protovespinae and other subfamilies (Carpenter & Rasnitsyn 1990; Wu et al. 2020b). The new species is attributed to the genus *Curiosivespa* based on a combination of the reception of 1cu-a at the fork of M and Cu, the relatively straight 1cu-a (slightly curved due to wing twist during fossilization process) and the relatively long 1-Rs (excluding *Euparagia* Cresson, 1879 and *Priorparagia* Brothers & Rasnitsyn, 2008) (Brothers & Rasnitsyn 2008; Carpenter & Kimsey 2009; Perrard et al. 2017). In addition, *Curiosivespa sennlaubi* n. sp. possesses elongated antennal flagellomeres, as present in some species of the genus *Curiosivespa*, i.e. *C. curiosa*. The second and third submarginal cells of *Curiosivespa sennlaubi* n. sp. are also relatively similar in length, excluding affinities with the genus *Euparagia*. Additionally, the marginal cell is apically produced while it is truncate apically in *Priorparagia*, refuting affinities with the latter genus. The impossibility to place our specimen in any other genus of the subfamily Euparagiinae strengthens our attribution to the genus *Curiosivespa*, and this is despite the fact that this genus is probably paraphyletic (Perrard et al. 2017). Additionally, the characters proposed to distinguish the new species from the other *Curiosivespa* do not challenge the diagnosis of genus and do not seem sufficient to propose a new genus for this fossil.

Curiosivespa sennlaubi n. sp. can be easily distinguished from the other species of the genus based on wing venation characters, viz. it differs from *C. antiqua*, *C. curiosa*, *C. magna*, *C. derivata*, *C. orapa*, and

C. striata at least in having distal part of M nearly straight (vs. with a strong angle), Rs+M and distal part of M aligned (vs. with a strong angle); 2 r-m nearly aligned with 2 m-cu (vs. 2 m-cu terminating posteriorly or anteriorly to 2 r-m); 2cu-a nearly vertical (vs. nearly aligned with distal part of A in *C. magna* and *C. striata*); 1-M aligned with 1-Rs and with its base opposite 1cu-a (vs. separated from 1cu-a by a short stem in *C. curiosa*, *C. magna*, *C. orapa*, and *C. striata*); 2 r-rs and Rs+M nearly parallel (vs. not parallel). Additionally, *Curiosivespa sennlaubi* n. sp. differs from *C. zigrasi* at least in possessing a vein 3 r-m (vs. absent) and vein 2 m-cu opposite 2 r-m (vs. clearly separated).

Conclusion

The description of *Curiosivespa sennlaubi* n. sp. shows that the Vespidae were already widely distributed on continental land masses and well diversified during the Cretaceous. The description of this new species of *Curiosivespa* also shows that Vespidae were present throughout Gondwana. Therefore, the records of the genus *Curiosivespa* on the West Gondwana (South America) and on the East Gondwana (Africa) highlights the possible faunal transfer between the two landmasses before their complete separation. As for many extant lineages, the phylogeny of the family Vespidae must be studied using the new techniques of total evidence dating or tip-dating to refine the time divergence estimate and be able to provide robust scenarios on the evolution of the clade by integrating the fossil record.

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