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AN EARWIG IN LATE CRETACEOUS VENDEAN AMBER (DERMAPTERA)

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ABSTRACT

A new fossil earwig nymph is described and figured from the Late Cretaceous (Cenomanian to Santonian) amber of Vendée, northwestern France. *Vendeenympha gravesi* n. gen. and sp., is distinguished from previously recorded nymphs in other French fossil deposits and compared to modern lineages. This is the third record of earwig nymphs in French Cretaceous ambers.

Keywords: Insecta, Neodermaptera, Labiduridae, Cretaceous, France

RÉSUMÉ

Une nouvelle nymphe fossile de perce-oreilles est décrite et illustrée de l'ambre crétacé supérieur (Cénomanien à Santonien) de Vendée, dans le nord-ouest de la France. *Vendeenympha gravesi* n. gen. et sp., est comparée aux nymphes précédemment décrites d'autres gisements fossiles français et est également comparée aux lignées modernes. Il s'agit de la troisième occurrence de nymphes de perce-oreilles dans les ambres crétacés de France.

Mots-clés: Insecte, Néodermaptère, Labiduridae, Crétacé, France

INTRODUCTION

Earwigs are, unfortunately, one of the understudied lineages among insect diversity. The group is undoubtedly monophyletic and modest in their species diversity, with about 2000 described species. However, they are behaviorally and morphologically rich, with intricate systems of parental care, complicated parent-offspring interactions, and varied in their ecology (Costa, 2006). In addition, their general affinities among the other orders of polyneopteran insects remain unresolved and rather controversial (Grimaldi & Engel, 2005; Jarvis, Haas, & Whiting, 2005; Wan & others, 2012). It is exactly for this reason that a full understanding of their fossil history is vital, with those species from the Mesozoic potentially permitting a revised understanding of the timing of origin for particular dermapteran traits and reconstructing a meaningful groundplan for the order as we understand it and linking those earliest stem members to Late Paleozoic or other Triassic lineages among the Polyneoptera (e.g., Zhao & others, 2010). In this light, the discovery and documentation of fossil Dermaptera is an integral component of resolving long-standing debates pertaining to their origins and thereby the origination and evolution of their various biologies.

Whether preserved as inclusions in amber or compressions, earwigs are typically uncommon to rare in most deposits throughout the world. Naturally, there are isolated exceptions to this pattern but overall, Dermaptera have a remarkably sparse record despite the fact that the lineage is undoubtedly ancient, with records going back to the Triassic (e.g., Wappler, Engel, & Haas, 2005; Grimaldi & Engel, 2005). Jurassic earwigs are restricted to few fossils remarkably preserved as impressions in sedimentary rocks (e.g., Zhao & others, 2010). In amber, most records have come from those rich deposits of the Baltic region or Dominican Republic (Wappler, Engel, & Haas, 2005; Engel, unpubl. data), both from the Tertiary, while in the Cretaceous the most diverse fauna is that of the Albian-Cenomanian amber from Myanmar (e.g., Engel & Grimaldi, 2004; Engel, 2011,

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unpubl. data). For all other Cretaceous amber deposits, earwigs are represented by usually one or a few individuals (Engel, 2009; Engel, Ortega-Blanco, & Azar, 2011; Perrichot & others, 2011), not all of which are sufficiently preserved for meaningful study (e.g., those presently in Turonian amber from New Jersey: Engel, pers. obs.). Here is reported the third record of Dermaptera from the Cretaceous ambers of France. The new specimen is represented by an isolated nymph and is compared with the older specimens from Archingeay (Engel, 2009; Perrichot & others, 2011), as well as other living and fossil Dermaptera.

MATERIAL AND METHODS

The nymph was entombed within a small piece of clear yellow amber generally free of debris (Fig. D1.1, D1.2), with one biting midge (Diptera: Ceratopogonidae – described by Choufani & others, 2014: 10H in this volume) and one scelionine wasp (Hymenoptera: Scelionidae) as syninclusions. The piece was cut into three parts to obtain an optimal view of each inclusion. The specimen is missing most of its dorsum but preserves many important diagnostic features. The posterior border of the head is missing, although the lateral surfaces are complete back to the posterolateral corners, and the posterior dorsal portion of the head integument is similarly absent, with small bubbles trapped within the emptied head capsule. The dorsal sclerites of the thorax are missing and the prosternum is absent, the latter more likely having become greatly cleared and dissolved as the setae are still in place demarcating where it and some of the other ventral sclerites once were. Much of the dorsum of the abdomen is gone, although for some segments lateral extremities of the terga remain. The cerci are complete, although a fracture through the amber piece does cut across them, but does not deter from their examination and study. Much of the integument is cleared and permits a wonderful view of fine details of sculpturing. A sizeable bubble is preserved alongside the specimen's venter but does not obscure any details (Fig. D1.1).

The amber was collected in 2002 by Didier Graves from a deposit which was temporarily exposed during construction along the highway D32 between La Garnache and Challans, department of Vendée, northwestern France. The exact dating of the amber remains uncertain within the Middle Cenomanian–Early Santonian interval (97–85 Ma). More details on the geology will be provided elsewhere (see Perrichot & Néraudeau, 2014: 10A in this volume)

Photographs were prepared with a Canon 7D digital camera attached to an Infinity K-2 long-distance microscope lens and also with a Canon 5D Mark II attached to a Leica MZ APO stereomicroscope, while measurements were taken with an ocular micrometer on an Olympus SZX-12 stereomicroscope. Morphological terminology generally follows that used elsewhere for Dermaptera (e.g., Giles, 1963; Günther & Herter, 1974; Engel, 2009, 2011; Engel, Ortega-Blanco, & Azar, 2011; Perrichot & others, 2011), while the classification followed herein is that of Engel and Haas (2007).

SYSTEMATIC PALEONTOLOGY

Suborder NEODERMAPTERA Engel, 2003
Genus VENDEENYMPHA new genus

Type species.—*Vendeenympha gravesi* n. sp.

Diagnosis.—Small individual, ca. 4.6 mm in total length (excluding antennae); body as preserved apparently not compressed dorsoventrally (*cf*. with the more compressed body of *G. walleri*: Perrichot & others, 2011), with sparsely scattered fine setae, not chaetulose; integument where evident matt and imbricate. Head prognathous, apparently slightly broader than long, preserved portions of posterior angles rounded, not acute. Maxillary palpus with five palpomeres, sparsely and finely setose, apicalmost palpomere and penultimate palpomere of approximately equal length, apicalmost palpomere not distinctly larger (Fig. D1.3). Compound eyes small, not prominent, near to antennal base, separated from posterior border of gena by length more than compound eye diameter; post-ocular ridge absent; ocelli apparently absent (posterior dorsum of head is damaged and missing but surface where ocelli should be is preserved and there is no evidence of them). Antenna with scattered, ultrafine setae; scape short and thick, shorter than distance between antennal bases, length slightly less than twice width; pedicel short, about as long as wide; six flagellomeres present (based on form of apex of flagellomere VI antenna appears to be complete); flagellomere I elongate and longest of flagellomeres, length approximately 5 times width, slightly thicker than remaining flagellomeres; flagellomeres II–VI, longer than wide, individual lengths three-quarters that of flagellomere I and nearly 4 times as long as wide. Genal carina absent; coronal line apparently absent (again, dorsum of head is damaged posteriorly but anteriorly there is no line present). Prosternum not preserved but setae remain, position of such setae (particularly the prominent erect setae usually associated with the margins) serve to demarcate its relative position and boundaries (given the uncertainty involved with this portions deduced from setal positions are placed in braces); apparently subquadrate with lateral margins weakly converging posteriorly between procoxae; small, fine setae anterior to this and very near medioanterior margin of prosternum suggest that the posterior ventral cervical sclerite was touching prosternum (as is typical in the "forficuloid neck"). Mesosternum subtrapezoidal, with lateral margins converging posteriorly; anterior margin slightly convex, posterior margin slightly convex (somewhat similar to the more distinctly convex condition found in Anisolabidinae); with prominent, erect, stiff setae anteriorly near or on margin, two particularly elongate prominent seta on lateral margin just anterior to mesocoxae; mesocoxae articulating in posterior, near mesosternum-metasternum juncture). Metasternum large, anteriorly wider than posteriorly, laterally slightly constricted in posterior half at metacoxae, with a couple of prominent, erect, stiff setae anterolaterally and a single prominent seta in posterolateral corner, corners rounded; anterior margin slightly convex, posterior margin straight. Legs not elongate; procoxae near posterior margin of prosternum (although prosternum is not preserved, the setae from the surface of the cervical sclerites and prosternum are still present to demarcate its area roughly; this combined with the position of the procoxae and mesosternum serve to determine their position in life); femora not compressed and not carinate or keeled, ventral surface flattened but not depressed; profemur more swollen than other femora; tibiae not greatly elongate but longer than tarsi, particularly so for metatibia; tarsi trimerous, second tarsomere greatly reduced, not widened apically and not greatly projecting beneath base of third tarsomere (Fig. D1.4), apex of second tarsomere truncate and slightly slanted such that ventral length is slightly more than dorsal

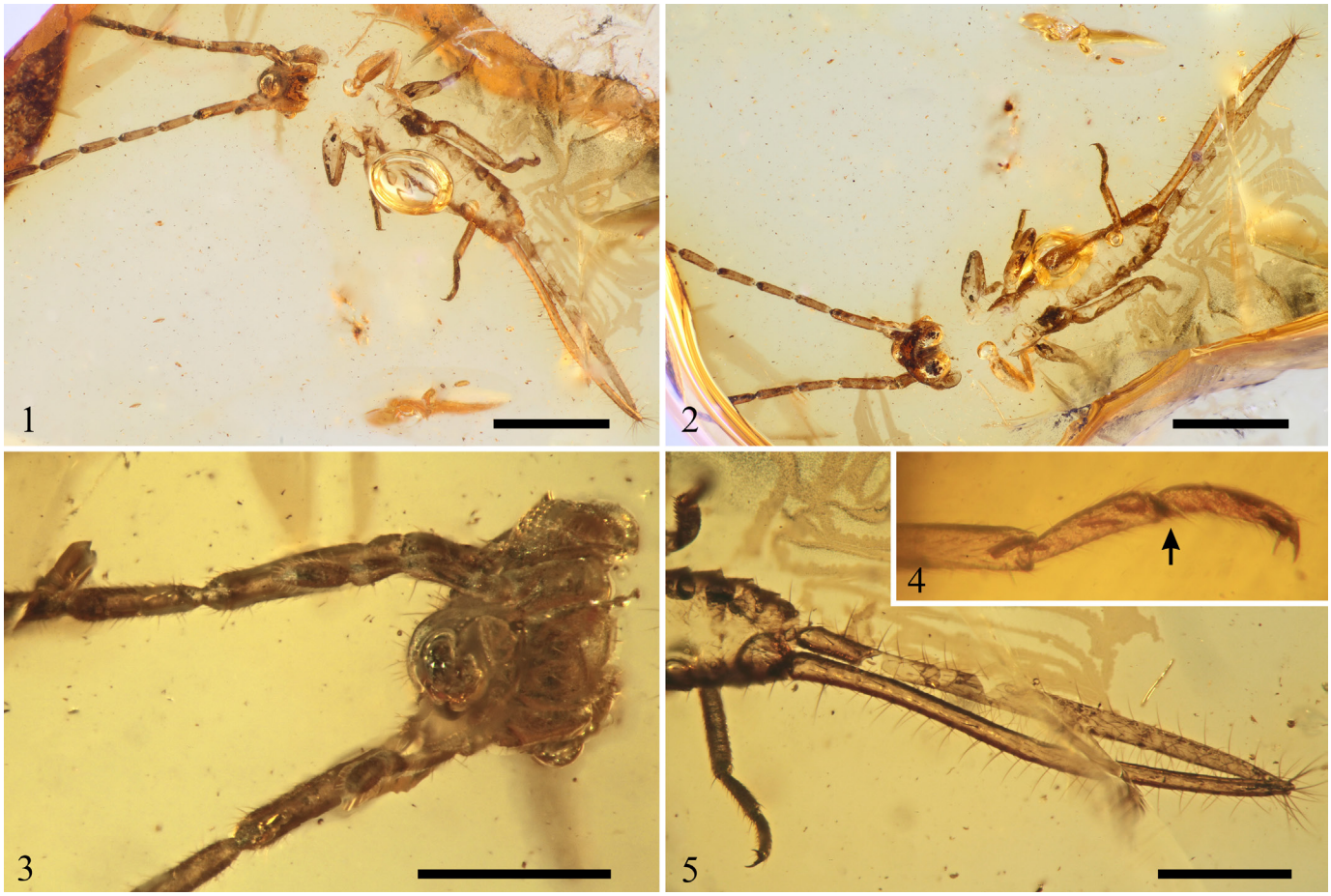

Figure D1. *Vendeenympha gravesi* n. gen. and sp., holotype nymph, IGR.GAR-72.2, in early Late Cretaceous Vendean amber, NW France; *1*, habitus in ventral view; *2*, habitus in dorsal view; *3*, head in ventral view; *4*, left metatarsomeres, with indication of the reduced second tarsomere (arrow); *5*, right hind leg and cerci in ventral view (scale bars: 1, 2 = 1 mm; 3, 5 = 0.25 mm).

length; pretarsal ungues simple except for minute bump near base, arolium absent. Abdominal segments apparently transverse, wider than long; penultimate segment not modified or distinct from preceding segments; where tergal and sternal integument is preserved surface is finely imbricate; cerci formed of a single cercomere, greatly elongate, nearly twice length of abdomen and only slightly shorter than combined lengths of abdomen and thorax; bases of cercal forceps nearly touching, cerci somewhat tubular and simple over entire length, slightly curved in apical half such that apices come together and partially overlap, cercal apex acutely rounded, surface with numerous, erect, stiff, and somewhat elongate setae, such setae particularly numerous at apex (Fig. D1.5).

Etymology.—The new genus-group name is a combination of Vendée, the department from which the amber originate, and *nympha* (Latin, meaning "young woman"). The name is feminine.

VENDEENYMPHA GRAVESI, new species
Figure D1

Type material.—Holotype nymph (sex indeterminate), IGR.GAR-72.2 (ex coll. Graves), in Late Cretaceous (Middle Cenomanian to Early Santonian, 97–85 Ma) Vendean amber; deposited in the Geological Department and Museum of the University Rennes 1, France.

Type locality.—La Robinière, departmental road D32, about 2.5 km south-west of La Garnache, Vendée, France.

Etymology.—The specific epithet is a patronym honoring Didier Graves, the specimen's collector.

Diagnosis.—As for the genus (see above).

Description.—Nymph. As described for the genus, with the following minor additions: Total body length 4.6 mm (as preserved, excluding antennae), head width across compound eyes 0.64 mm; integument brown to light brown (coloration in most parts largely artifact of degree of postmortem clearing that has taken place); flagellomere I length 0.43 mm, maximum width 0.086 mm; integument of head more finely and weakly imbricate than elsewhere, with a few erect, stiff setae near compound eye, antennal base, and frontoclypeal margin. Thoracic length 1.01 mm; preserved portions of pleural distinctly imbricate, similar to sculpturing present on legs. Abdomen of moderate length, length 1.14 mm as preserved, 0.45 maximum width as preserved; integument imbricate, with scattered fine setae, more apical segments with some sparse prominent, erect setae laterally and/or apically; from preserved portions of cleared sterna abdominal segments transverse, with straight posterior margins on sterna. Cerci elongate tubular, length 1.92 mm, basal width

0.08 mm, basal separation between cerci 0.026 mm, individual cerci longer than abdomen, without dentition, crenulations, or serrations, slightly curved, of relatively uniform width over most of length, tapering slightly and gently apical to acutely rounded apex; apex with dense elongate, stiff, erect setae, such setae sometimes more than three times cercal diameter.

DISCUSSION

The holotype of *V. gravesi* is likely a first-instar nymph for largely the same reasons provided for staging the material discussed by Engel (2009). Most notably the elongate meriston is suggestive of an early instar, as is the long form of the succeeding flagellomeres and the reduced number of total flagellomeres (in this case merely six) (Günther & Herter, 1974). Familial placement is rather questionable. Certainly the species belongs to the Neodermaptera owing to the trimerous tarsi and absence of ocelli, and can be excluded from the Diplatyidae and Karschiellidae by the non-annulated cerci, and from the Forficulidae and Chelisochidae by the unmodified second tarsomere. The fossil may also be excluded from the epizoic families Arixeniidae and Hemimeridae by the absence of their large suite of peculiar modifications associated with living on bats and rats, respectively (Günther & Herter, 1974). Placement within Pygidicranidae seems unlikely given the absence of carinate or keeled femora and, if the assertions regarding the ventral cervical sclerites are correct, the presence of a "forficuloid neck". The pygidium and other critical features are unfortunately not preserved and so refining the placement beyond this is impossible other than to note that the significantly elongate form of the cerci in such a young instar is suggestive of the family Labiduridae, and the form of the preserved thoracic sterna do not outright contradict such an assignment. Moreover, labidurids are well known from the Cretaceous and so there is no contradiction with the limited phylogenetic-stratigraphic correlations available for lineages of earwigs (e.g., Grimaldi & Engel, 2005).

Among the three forms of immature earwigs preserved in French Cretaceous ambers, *Vendeenympha* can be distinguished quickly from the previously known taxa. *Vendeenympha* differs most noticeably from *Gallinympha* Perrichot & Engel (in Perrichot & others, 2011) in the form and number of the antennal segments (six flagellomeres, each much longer than wide and finely setose in *V. gravesi versus* 10 flagellomeres, the basal ones being distinctly compact and more densely setose in *Gallinympha*), body not noticeably dorsoventrally compressed (distinctly compressed in *Gallinympha*), ventral surfaces of femora not depressed (distinctly depressed in *Gallinympha*), cervix presumably of "forficuloid" type (definitely of "blattoid" type in *Gallinympha*), and the form of the thoracic sterna (refer above to those for *V. gravesi* and to Perrichot & others, 2011, for *Gallinympha*). From the nymphs described by Engel (2009) as ARC-240, *V. gravesi* differs in the absence of the coronal line (present in ARC-240), compound eyes separated from posterior corner of temples by length greater than eye diameter (separated by compound eye diameter in ARC-240), longer flagellomeres II and III relative to length of meriston (shorter in ARC-240 and if all of the same instar, then likely informative), more noticeably dense patch of elongate setae at apex of cerci (not so in ARC-240), and close basal approximation of the cerci (more widely separated in ARC-240). As outlined briefly here, there are now at least three diagnosable groups of earwigs present in the paleontologically rich French Cretaceous ambers. It is greatly hoped that continued exploration will bring further material and ideally complete adults from which to elucidate more clearly the relationships of these taxa.

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