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First fossil records of Tingidae from Madagascan Copal with description of two new species (Hemiptera, Heteroptera)

Eric GUILBERT & Ernst HEISS

A b s t r a c t : The extant fauna of Tingidae of Madagascar is very diverse and shows a high level of endemicity reaching about 72% of the known species. It has been studied first by SIGNORET (1861), followed by the well known ancient heteropterists e.g. STÅL (1873), BERGROTH (1894), DISTANT (1904) and HORVATH (1910, 1912). However most of the species were described in the 20th century by DRAKE (1957, 1958) and DUARTE RODRIGUES (1992), additions most recently by LIS (2002, 2006, 2009). To date about 90 species of Tingidae belonging to 30 genera are known, but no fossil record is yet documented (GÖLLNER-SCHEIDING 2004, LIS 2009).

In this paper seven specimens of Tingidae, belonging to five species are reported from inclusions in Madagascan Copal, of which two species, *Phatnoma madagascariensis* nov.sp. and *Cysteochila copal* nov.sp. are described as new.

K e y w o r d s : Hemiptera, Heteroptera, Tingidae, fossil records, new species, Madagascan Copal.

Introduction

The island of Madagascar was deeply wedged within Gondwana when the fragmentation of the Gondwana landmass started with the separation of Africa from the India-Madagascar block some 165 million years ago, opening a first coast west to Madagascar. During 118 million years, the "relations" between Madagascar and Africa were stable, even if they were separated by the Mozambique Channel, 400 km wide and 3.000 meters deep. Some 130 million years ago, the India-Madagascar block separated from the Antarctic-Australian block. Finally, Madagascar separated from India some 88 million years ago. Today, Madagascar is the fourth largest island of the world and the second largest continental island with around 587,000 square km. Its geographic position is south of the Ecuador between 12° and and 27° South and 45° and 54° East.

The topography of Madagascar shows distinct geographical regions. The northern- and eastern coasts of the island are deeply sloping into deep water, while the western coast forms a plateau descending gradually to the Mozambique Channel. The height of the central highlands ranges from 800 to 1800 m, the highest mountain is in the northern part and 2,876 meters high. It is not surprising that based on this wide range of different geographical regions and respective habitats, a very high diversity and endemicity developed in their flora and fauna.

The Tingidae are a family of small sized true bugs of which about 2,500 species are described showing a worldwide distribution. The fauna of extant Tingidae of Madagascar includes to date 90 species of 30 genera, its level of endemicity is very high (72 %) (DUARTE RODRIGUES 1992). Despite this high diversity, the fauna of Madagascar is still insufficiently studied. The first Tingidae species from Madagascar was described by SIGNORET (1861), but most of the species known today were described later by DRAKE (1957a,b, 1958) and DUARTE RODRIGUES (1992). Since then only few additional new species were reported (LIS 2003, 2006, 2009).

Fossil Tingidae were mainly described from amber deposits (Baltic, Oise, Dominican, Mexican, Burmese) dating back from Oligocene to Mesozoic age. 54 fossil species of Tingidae are described to date. For an overview, see WAPPLER (2003), supplemented by NEL et al. (2004), Perrichot et al. 2006, GOLUB 2001, GOLUB & POPOV (2003, 2005, 2007, 2008, 2012), GOLUB et al. (2008), HEISS (2008, 2009, 2013), HEISS & GOLUB (2013), HEISS & GUILBERT (2013), WAPPLER (2006), WAPPLER et al. (2015), JEPSON et al. (2011), and COTY et al. (2014).

We identified seven specimens of Tingidae inclusions in Madagascan Copal belonging to five species, of which two are new to science and thus described and illustrated below.

Material and methods

The origin of the copal inclusions is supposed to be from the area of Montagne d'Ambre in the northern part of Madagascar. After cutting and polishing the stones for a better visibility of the included fossils, some of them were embedded in a block of epoxyd resin, they are deposited in the collection of the second author.

Measurements were taken with a micrometer eyepiece and are given in millimeters.

Taxonomy

Family T i n g i d a e LAPORTE, 1832

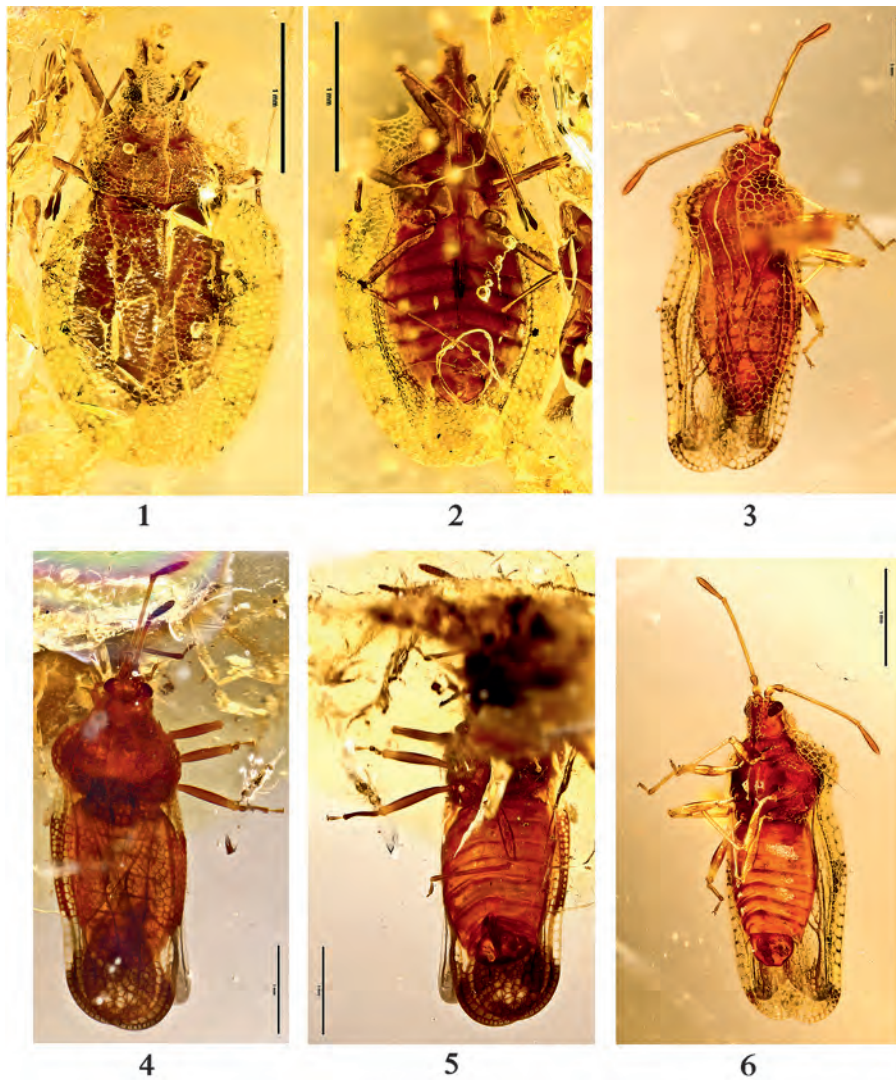
Subfamily P h a t n o m i n a e DRAKE & DAVIS, 1960

***Phatnoma madagascariensis* nov.sp. (Figs 1, 2)**

M a t e r i a l e x a m i n e d : Holotype male in a honey-coloured block of Copal, antennae and legs bent ventrally, dorsal and ventral side visible.

D e s c r i p t i o n : Body length, 3.00 mm; width, 1.55 mm; colouration uniformly yellowish, with some secondary transversal veinlets darker (brownish) on the costal area, antennal segment IV brown.

H e a d : Oblong, armed with seven spiny tubercles, an occipital pair, a frontal pair, a jugal pair and a median clypeal tubercle; the occipital tubercles the longest, the clypeal ones longer than the frontal and the jugal pairs; antenniferous lobes short and spiny; sulcus straight and narrow; bucculae long, extending in front of clypeus, apex straight and not contiguous; rostrum long, reaching the fourth visible abdominal segment; antennae long and slender, length of antennal segments: I and II much shorter than III and IV but not measurable; III 1.0 mm; IV 0.2 mm.



Figs 1-6: Tingidae in Madagascan Copal: (**1**) *Phatnoma madadascariensis* nov.sp., holotype male, dorsal view; (**2**) ditto, ventral view; (**3**) *Cysteochila impressa*, male dorsal view; (**4**) *Cysteochila copal* nov.sp., holotype female, dorsal view; (**5**) ditto, ventral view; (**6**) *Cysteochila impressa*, male, ventral view. Scales 1 mm.

P r o n o t u m : Wider than long, length 0.58 mm; width 1.1 mm; tricarinate, carinae with one row of areolae, the median carina slightly higher than the lateral ones; paranota wide and expanded anterolaterally, widening in front, with five areolae at its widest part, with two anterolateral angles projecting like a spiniform process and directed forward; the posterior pronotal process reduced to a row of areolae; rostral groove wider on meso- and metasternum than bucculae, their lateral laminae straight, with one row of areolae. Scutellum reduced to a tubercle.

H e m e l y t r a : Length 1.92 mm; width 1.55 mm; lateral margin rounded, surface divided into the usual areas, all areolae round and of the same size; R+M and Cu veins raised with one row of areolae, these are larger than those of the hemelytral areas; costal area almost of the same width along its whole length, with four to five small round areolae, six at the base and about four at the apex; subcostal area wider than costal area with six areolae wide at its widest part, with three or four secondary transversal veins, dividing the area into four to five subareas; discoidal area longer than half the length of hemeytra with five areolae at its widest part, with at least two secondary transversal veins dividing the area; sutural area enlarging backward with nine areolae at the apex.

E t y m o l o g y : Named after the country of its origin.

D i s c u s s i o n : The general habitus of his new species is very similar to *Phatnoma hova* SCHOUTEDEN 1957, which is the only known species of *Phatnoma* from Madagascar. However, it shows a different combination of areolae on the hemelytra and paranota. There are four rows of areolae at the apex of the costal area and six at the base, while *P. hova* has three rows of areolae at the apex and seven at the base. The subcostal area of *P. madagascariensis* nov.sp. is six areolae wide, while there are seven in *P. hova*. The discoidal area is five areolae wide and shows six areolae in *P. hova*. The width of paranota of this new species ranges from three to five areolae, while there are four areolae in *P. hova*. In addition, the areolae of *madagascariensis* nov.sp. are generally larger than those of *P. hova*.

Subfamily T i n g i n a e LAPORTE, 1832

***Cysteochila impressa* HORVATH, 1910 (Figs 3, 6)**

M a t e r i a l e x a m i n e d : Male, antennae and legs complete, preserved in a half-lateral position.

The holotype of *impressa* is deposited in the Naturhistoriska Riksmuseet in Stockholm, Sweden: HT, male, Kilimandjaro: Kibonoto, 6. Oktober 1905, 1300-1900 m.

D i s t r i b u t i o n : Kenya, Tanzania, Comores, Madagascar, Senegal.

Host plant: unrecorded.

D i s c u s s i o n : The fossil specimen is regarded as *C. impressa*, although there are some small differences between the type and the fossil specimen: the areolae and the hood seem to be larger in the fossil specimen, however, these slight differences do not justify to consider it as a new species.

***Cysteochila copal* nov.sp. (Figs 4,5)**

M a t e r i a l e x a m i n e d : Holotype female, embedded in a block of epoxyd resin, 13x13x6mm, head and prosternum ventrally obscured by impurities of the Copal, the structural details are not recognizable.

D e s c r i p t i o n : Body length, 4.05 mm; width, 1.55 mm, coloration uniformly brownish, the posterior part of hemelytra darker; base and third quarter of costal area yellowish.

H e a d : Short, armed with five small and slender tubercles, an occipital pair, a frontal pair and a median tubercle; bucculae short, not extending in front of clypeus, contiguous in front; rostrum reaching metasternum; antennae long and slender, length of antennal segments I 0.18 mm; II 0.15 mm; III 0.95 mm; IV 0.45 mm.

P r o n o t u m : Length, 2.0 mm; width, 1.5 mm; swollen, punctate, with areolae on collar and on posterior process; disk tricarinate, carinae raised and uniseriate, the areolae subquadrate; lateral carinae diverging posteriorly; collar inflated forming a small hood; paranota wide with 12 areolae at its widest part, reflexed onto the pronotum, concealing the lateral carinae but not meeting on the top, composed by two inflated parts, one lateral, the other one above the level of lateral carinae; rostral sulcus not visible.

H e m e l y t r a : Length, 2.8 mm; width 1.55 mm, divided into the usual areas; costal area narrow, of the same width along its whole length, with two rows of small round areolae at anterior fourth, uniseriate and with larger areolae opposite to apex of discoidal area; subcostal area biseriate, uniseriate posteriorly to apex of discoidal area; discoidal area longer than half the length of the hemelytra, six areolae wide at its widest part, these areolae slightly larger than on subcostal and costal area; sutural area large, nine areolae wide at its widest part, areola larger than on other areas.

E t y m o l o g y : Refers to the Madagascan Copal resin, where this new species was trapped.

D i s c u s s i o n : This species is similar to *C. impressa*, but the costal area is mostly uniseriate while it is completely biseriate in *C. impressa*. It resembles also *C. expleta* DRAKE & MAA 1954, described from India by the uniseriate costal area, but *C. expleta* has a biseriate part at the middle of the costal area. In addition, it has paranota not concavely impressed and ridge-like in the middle like *C. impressa*.

Hovatlas invaginatus DUARTE RODRIGUES, 1992 (Figs 9-11)

M a t e r i a l e x a m i n e d : Two females, antennae and legs complete, specimen Fig. 10 with damaged, dorsally depressed pronotal hood.

The holotype of *invaginatus* is deposited in the Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia: HT, male, Madagascar Est, Périnet, 13.III.1935 (Olsoufieff).

D i s t r i b u t i o n : Endemic to Madagascar, only known from Ranomafana National Park, Anabohazo forest and Bemahara Tsingy National Park.

Host plant: unrecorded.

D i s c u s s i o n: Several specimens belonging to the species *Hovatlas invaginatus* have an almost entirely biseriate costal area, while the holotype of the species has been described as having the costal area anteriorly uniseriate. Specimen Figs 10, 11 exhibits a costal area not entirely biseriate but uniseriate at the base. In addition, the rostrum of this specimen is shorter than in that of Fig. 9 and the rostral sulcus is wider. As the pronotal hood is damaged in specimen Figs 10, 11, it is not obvious that it really belongs to *H. invaginatus*.

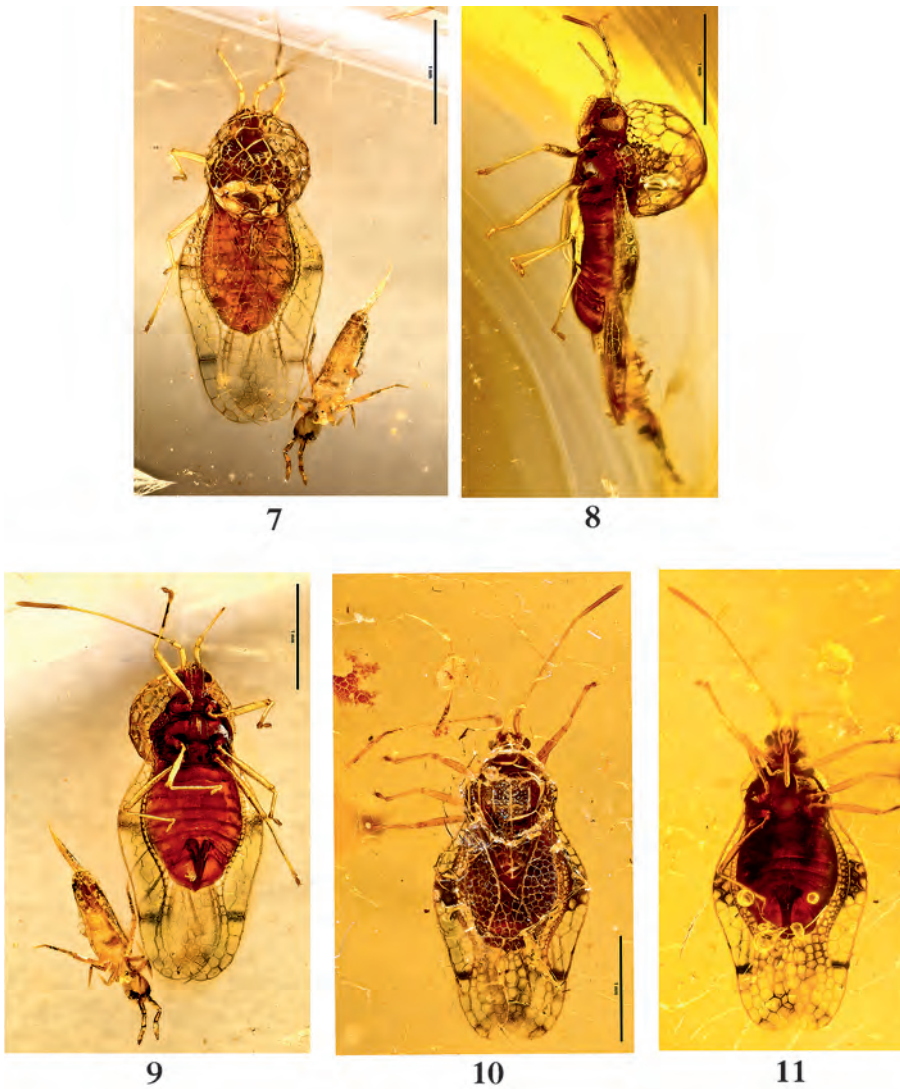
Gitava fusca SCHOUTEDEN, 1957 (Figs 12-16)

M a t e r i a l e x a m i n e d : One male (Figs 12,13) with complete appendages, hemelytra spread laterally, embedded in a block of epoxyd resin 12x18x6 mm, and one female (Figs 14-16), also with complete legs and antennae in a piece of yellowish transparent Copal.

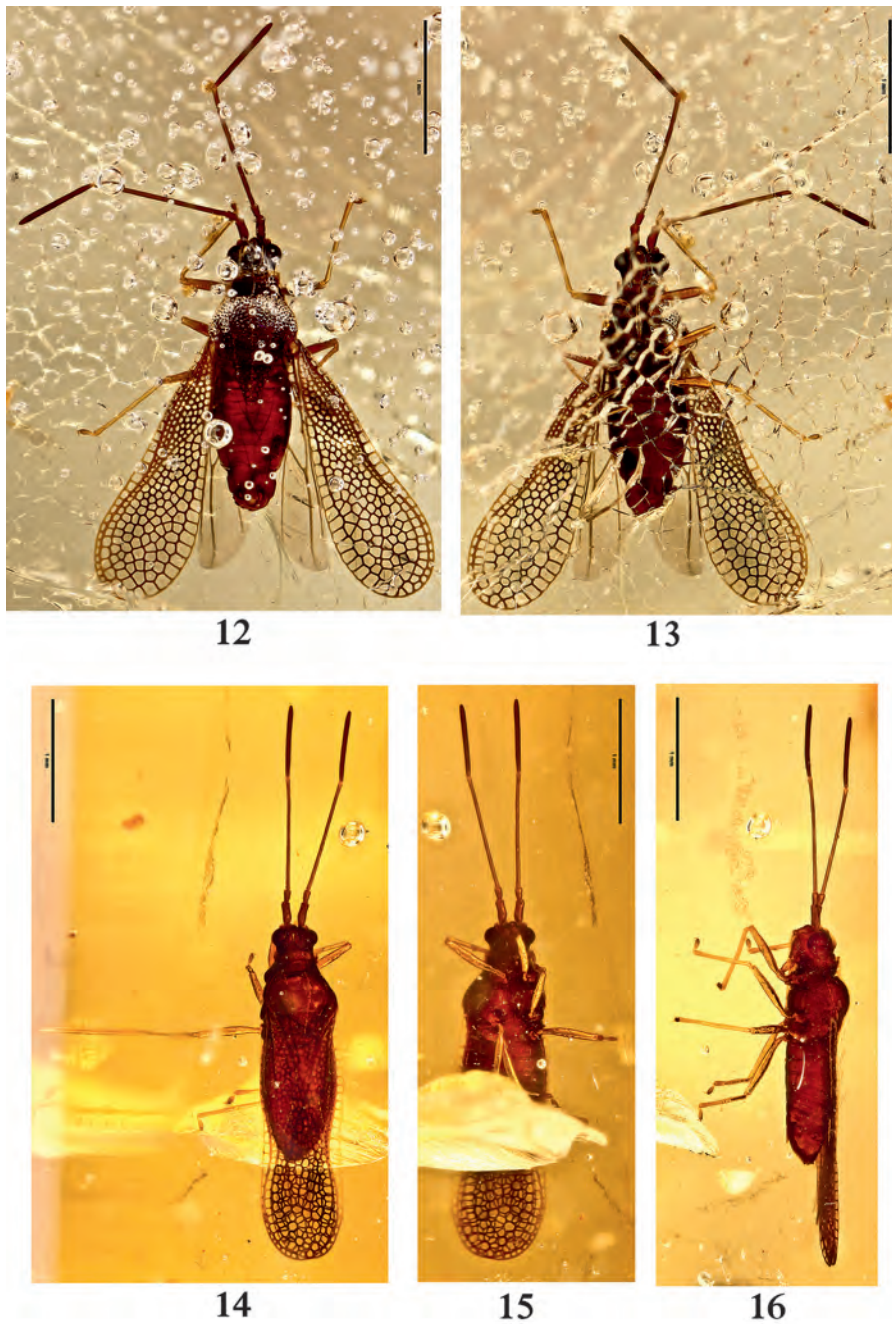
The lectotype is deposited in the Muséum National d'Histoire Naturelle, Paris, France: LT, designated by FROESCHNER, Madagascar, coll. Sicard.

D i s t r i b u t i o n : Only known from Madagascar.

Host plant: unrecorded.



Figs 7-11: Tingidae in Madagascan Copal: (**7**) *Hovatlas invaginatus*, specimen 1, female, dorsal view; (**8**) ditto lateral view; (**9**) ditto ventral view; (**10**) *Hovatlas invaginatus*, specimen 2, female, dorsal view; (**11**) ditto ventral view. Scales 1 mm.



Figs 12-16: Tingidae in Madagascan Copal: (**12**) *Gitava fusca*, specimen 1, male, dorsal view; (**13**) ditto ventral view; (**14**) *Gitava fusca*, specimen 2, female, dorsal view; (**15**) ditto ventral view; (**16**) ditto lateral view. Scales 1 mm.

Discussion

The Copal of Madagascar represents an unusual younger fossil deposit with different physical and chemical properties than the well known and species rich amber deposits of Oligocene Dominican Amber, Eocene Baltic Amber and Cretaceous Burmese Amber .

Copal from Madagascar is supposed to be quite recent. Its age ranges from several months to several hundred thousand years when dated with radioactive carbon method (WUNDERLICH 2004). It has been stated that most, or all, of the inclusions in Copal may be recent species (POINAR 1992: 63, 1999), however some inclusions have been reported as representing extinct species (HILLS 1957).

It is of great interest to examine fossilized specimens and comparing them with extant ones. Such a study should provide interesting terminals for phylogenetic trees, for which nodes need to be calibrated and dated. In addition, knowing the high diversity of species in Madagascar and the fact that new species still remain to be discovered, it could be possible that the fossil specimens described here belong to extant species.

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Zusammenfassung

The aktuell bekannte Fauna der Heteropterenfamilie Tingidae (Netzwanzen) zeigt einen auffallend hohen Anteil von 72% an endemischen Arten. Die erste Tingide von Madagascar hat SIGNORET 1861 beschrieben, weitere Beschreibungen erfolgten durch die Altmeister der Heteropterologie wie STÅL, BERGROTH, DISTANT and HORVATH. Die meisten Arten wurden jedoch erst im 20. Jahrhundert durch DRAKE, DUARTE RODRIGUES und rezent durch LIS beschrieben.

Zur Zeit sind von Madagascar 90 Arten Tingidae aus 30 Gattungen bekannt, jedoch sind keine fossilen Belege dokumentiert. In der vorliegenden Arbeit werden erstmals 7 Exemplare in Copal vorgestellt, welche 3 rezenten Arten zuzuordnen sind und 2 weitere Arten, *Phatnoma madagascariensis* nov.sp. und *Cysteochila copal* nov.sp. als neu beschrieben werden..

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Authors addresses:

Dr. Eric GUILBERT
Muséum national d'Histoire naturelle, UMR 7179
MNHN-CNRS, CP50 - 57 rue Cuvier, F-75005 Paris, France
E-mail: guilbert@mnhn.fr

DI Dr. Ernst HEISS
Research Entomologist, Tiroler Landesmuseum Ferdinandeum
A-6020 Innsbruck, Austria
E-mail: aradus@aon.at