

**New or rare Madagascar tiger beetles - 16.
Physodeutera (Axinomera) horimichioi sp. nov.
and a new record of *Paraphysodeutera naviauxi*
from western Madagascar (Coleoptera: Cicindelidae)**

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Abstract. *Physodeutera (Axinomera) horimichioi* sp. nov. is described as new to science, from the Tsingy de Bemaraha National Park near Antsalova in western Madagascar. The new species is compared to the related species, referring to their redescrptions and illustrations based on type and other relevant specimens in the recently published monograph (Moravec 2002a) of the Madagascar endemic genus *Physodeutera* Lacordaire, 1843. The new species is illustrated in colour photographs both of the habitus and diagnostic characters. A revised key to ten species of the subgenus *Axinomera* Jeannel, 1946 is presented here in order to supplement the key previously published in the cited monograph. In addition, a new, recent record of Madagascar endemic tiger beetle *Paraphysodeutera naviauxi* Moravec, 2002 is presented from the Tsingy de Bemaraha National Park.

INTRODUCTION

The endemic Madagascar tiger beetle genus *Physodeutera* Lacordaire, 1843, first briefly revised by Rivalier (1967) was recently revised and monographed by the first author. In the monograph (Moravec 2002a), based on a thorough examination of type and other relevant specimens deposited both in institutional and private collections, 63 species and 6 subspecies of eight subgenera were distinguished. Despite the continuous deforestation of Madagascar, two other species of the genus, *Physodeutera (Minideutera) kamilmoraveci* and *Ph. (Diarrhiza) murzini* were subsequently described from eastern Madagascar (Moravec 2004) with revised keys to species of the subgenera *Diarrhiza* Jeannel, 1946 and *Minideutera* Moravec, 2002, in order to supplement the relevant keys previously published in the cited monograph. Further more, a great number of new species of the Madagascar endemic genus *Pogonostoma* Klug, 1835 and other genera occurring in Madagascar were described in series of papers published by the first author before and in the concluding publications (Moravec (2007, 2010). Likewise, the discovery of another new species of *Physodeutera* described herein from adults recently caught in the Tsingy de Bemaraha National Park in western Madagascar by Prof. Michio Hori (Kyoto, Japan), together with the second author during their field research in the large island, has confirmed that some areas, particularly isolated forest communities, deserve further research.

The new species, *Ph. (Axinomera) horimichioi* sp. nov. has been compared with the type and other specimens of related *Physodeutera (Axinomera) flagellicornis* (W. Horn, 1897) and *Ph. (A.) rectipenis* (W. Horn, 1934), referring to their relevant redescrptions and illustrations in the monograph by Moravec (2002a).

In addition, a new, recent record of a very rare tiger beetle *Paraphysodeutera naviauxi* Moravec, 2002 of a monobasic genus *Paraphysodeutera* Moravec, 2002, is presented here.

MATERIAL AND METHODS

Body length is measured without labrum and is the distance from the anterior margin of the clypeus to the elytral apex (including the sutural spine). The width of the pronotum includes the lateral margins of the proepisterna (as the proepisterna are visible from above and copy the invisible or only partly visible notopleural sutures). The width of the head is measured across the eyes, the distance between their outer margins. The term "aedeagus" here refers to the median lobe of the organ (without parameres). All dimensions of aedeagi are measured (and primarily figured) in their left lateral position where the basal portion (with basal orifice) points to the right and the left lateral outline (with dorsoapical orifice) faces dorsally, provided that the ventral outline of the median portion is settled in its vertical position, and the apex of the aedeagus is perfectly settled in its horizontal position. The treatment and mounting of the aedeagi, in order to observe the structure of the internal sac followed the usual procedure as modified and in the terms that appear in Moravec (2002a, 2010). The position of the aedeagus is also very important for establishing the real shape of the sclerites that form the structure of the internal sac.

The colour photographs of the habitus and diagnostic characters, including aedeagi, were taken by the first author with a Nikon Coolpix 990 digital camera through an MBS-10 stereo microscope.

The morphological terminology is mostly adopted from Torre-Bueno Dictionary (Nichols 1989), those describing the surface macrosculpture partly from Harris (1979), but many terms were proposed by Moravec (2002a, 2007, 2010).

Labels are cited in the following manner: lines on the same label are separated by a slash /, separate labels are indicated by a double-slash //; each specimen or a series of specimens are separated by a full stop.

Following abbreviations of type status are used in the descriptions and captions below the illustrations: HT = holotype; PT = paratype, AT = allotype.

Abbreviations for the collections:

CCJM	Collection Cicindelidae Jiří Moravec, Adamov, Czech Republic;
CJVB	Collection Jan Vybíral, Židlochovice u Brna, Czech Republic;
MHCW	Collection Michio Hori, Wakayama, Japan;
MNHN	Muséum national d'Histoire naturelle, Paris, France;
OSAKA	Osaka Museum of Natural History, Osaka City, Japan;
ZUAC	University of Antananarivo, Madagascar.

TAXONOMY

Physodeutera (Axinomera) horimichioi sp. nov.

(Figs. 1-18)

Type locality. Western Madagascar: Mahajanga Province, region of Melaky, Andranopasazy Forest of the Tsingy de Bemaraha National Park, 10 km southeast of Antsalova.

Type material. Holotype ♂ in OSAKA labelled: "W. Madagascar: Mahajanga Province / Tsingy de Bemaraha N.P., 10 km SE / Antsalova, Andranopasazy Forest, / 6-8.XII.2014 leg. Michio Hori / & Elysé H. Razanajaonarivalona" [printed]. Allotype ♀ in MNHN: *ibid.* Paratypes. 1 ♂, 1 ♀ in ZUAC, 1 ♂ in MNHN, 1 ♂ in CCJM, 2 ♂♂, 3 ♀♀ in MHCW, 1 ♂ in CJVB: *ibid.* 3 ♂♂, 1 ♀ in MHCW: "W. Madagascar: Mahajanga Province / Tsingy de Bemaraha N.P., / Andamozavaky Forest, 18 km N of / Bekopaka, 9.XII.2013 leg. Michio Hori / & Elysé Hugo Razanajaonarivalona" [printed]. All type specimens labelled: "Holotype (Allotype or Paratype respectively) / *Physodeutera (Axinomera) horimichioi* sp. nov. / det. Moravec & Razanajaonarivalona 2015" [red, printed].

Description. Body (Fig. 1) 8.60-10.0 (HT 9.50) mm long, 2.60-3.10 (HT 3.00) mm wide.

Head (Fig. 9) with large eyes but slightly narrower than body, 2.50-2.70 mm wide, diffusely to bright blue, green-blue, with green, violaceous, rarely reddish iridescence (depending on angle of illumination).

Frons slightly convex, obliquely sloping towards clypeus and indistinctly separated from it, surface nearly smooth with only indicated longitudinal wrinkles; supraantennal plates slightly raised, bluntly triangular, mostly violaceous-blue; frons-vertex fold widely obtuse, passing fluently into vertex.

Vertex almost flat with very shallow central impression, anterior area including frons-vertex fold finely irregularly wavy-rugulose, passing to almost parallel longitudinal rugae but again very irregular in middle; juxtaorbital areas large, rather densely parallel striate, on their anterior area the striae usually irregularly fragmented; coarser striae on sublateral areas when passing onto temples; posteromedian and occipital area very irregularly and finely wavy to vermicular rugulose.

Genae metallic green-blue, often with violaceous lustre, finely parallel-striate.

Clypeus diffusely to iridescent metallic blue to green-blue, nearly smooth.

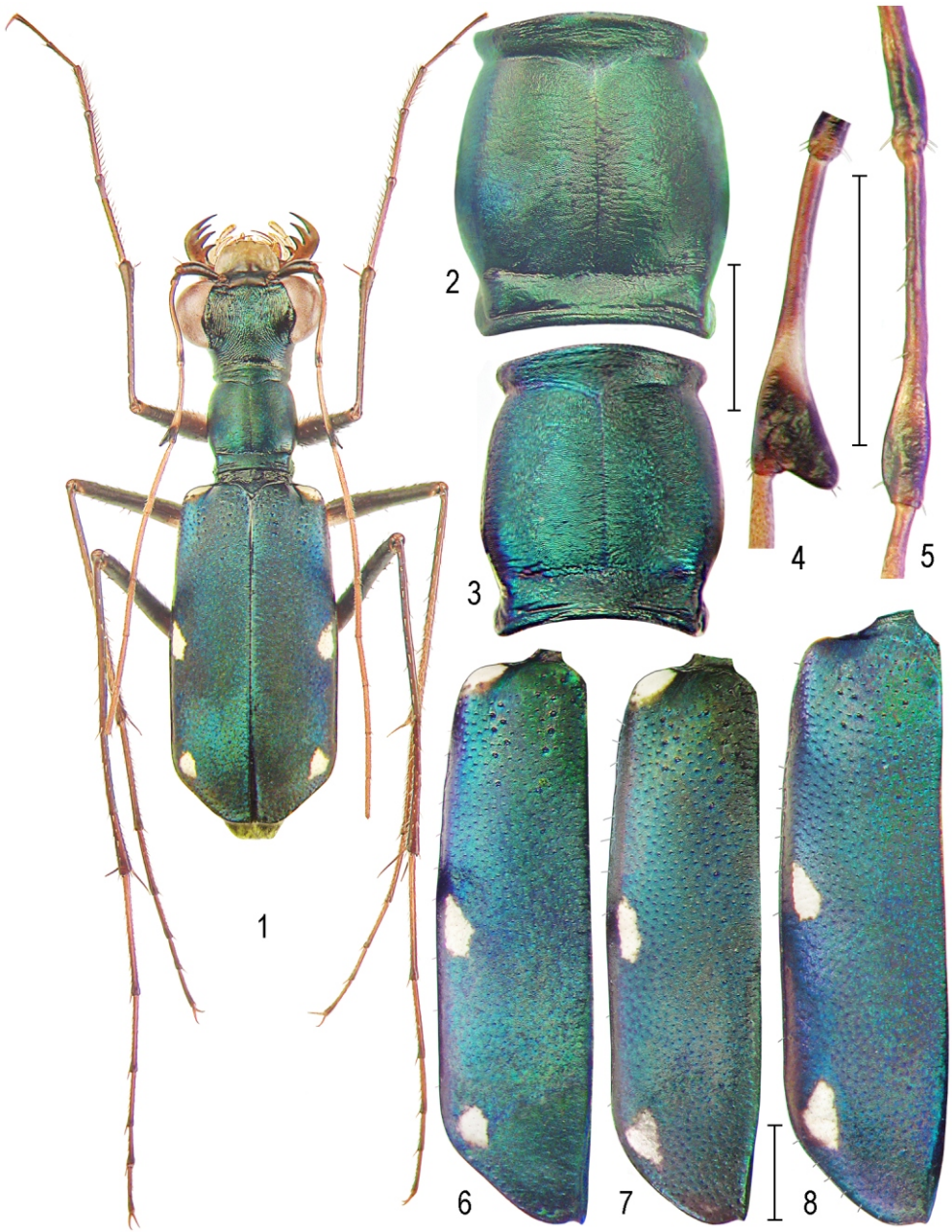
Labrum with four setae, sexually dimorphic; male labrum (Figs. 10-11) short, length 0.55-0.62 mm, width 1.05-1.15 mm, ivory to ochraceous with only small, black-brown basomedian area, lateral margins rounded, lacking teeth, anterior margin subtruncate to truncate; female labrum (Fig. 12) longer, length 0.90 mm, width 1.25 mm, distinguished by almost acute medial tooth between two smaller, subacute anterolateral teeth; coloration of female labrum much darker, brownish-testaceous with black sublateral-basal areas or with median area metallic-brown with greenish lustre.

Mandibles (Fig. 9) almost uniformly cinnamon-brown to dark brown except for narrow ochre-testaceous basolateral stripe; with four teeth (and basal molar), asymmetrical: left mandible with second tooth notably narrower, but almost of the same length as the wider third tooth; fourth tooth much smaller; inner teeth of the right mandible robust, becoming gradually smaller towards the basal molar.

Palpi (Fig. 9). Both labial and maxillary palpi in male ivory-yellow to ochraceous except for somewhat ochre-testaceous darkened apex of terminal palpomeres; female palpi darker, testaceous, with brownish terminal palpomeres; penultimate palpomeres of labial palpi cylindrical, only indistinctly dilated towards apex, width 0.15 mm.

Antennae very long, in male as long as the body, in female somewhat shorter; scape with only apical white seta, together with pedicel metallic black or black-brown; antennomeres 3-4 with sparse indistinct greyish setae, in male ochre-yellow except for apex of antennomere 3 and widely lobed apex of antennomere 4, which are metallic black (Fig. 4); in female antennomeres 3-4 much darker, black-brown with only testaceous median or subapical area and apex of antennomere 4 only moderately dilated (Fig. 5); antennomeres 5-11 in both sexes yellow-ochraceous with usual micropubescence.

Thorax. Pronotum (Figs. 2-3) diffuse to iridescent metallic blue to blue-green, often with diffusing olivaceous tinge (depending on angle of illumination), rarely with diffusely cupreous lustre on basal area of disc, moderately elongate, length 1.90-1.95 mm, width 1.65-1.70 mm, anterior and posterior sulci well pronounced, anterior lobe as wide as posterior lobe or very slightly narrower; disc sub-ellipsoidal, with lateral margins convex, narrower at the anterior sulcus, then distinctly dilated towards base, widest before the constriction towards the posterior sulcus; discal surface nearly smooth only very indistinctly coriaceous-wrinkled and with few, more distinct,



Figs. 1-8. *Physodeutera (Axinomera) horimichioi* sp. nov.: 1- habitus, ♂, 9.5 mm, Andranopasazy, HT (OSAKA); 2-3- pronotum: 2- ♂, HT; 3- ♂, Andamozavaky, PT, (MHCW); 4- antennomere 4, ♂, Andamozavaky, PT (MHCW); 5- Antennomere 4, ♀, Andranopasazy, AT (MNHN); 6-8: elytron: 6- ♂, HT; 7- ♂, Andamozavaky, PT, (MHCW); 8- ♀, AT. Bars = 1 mm.

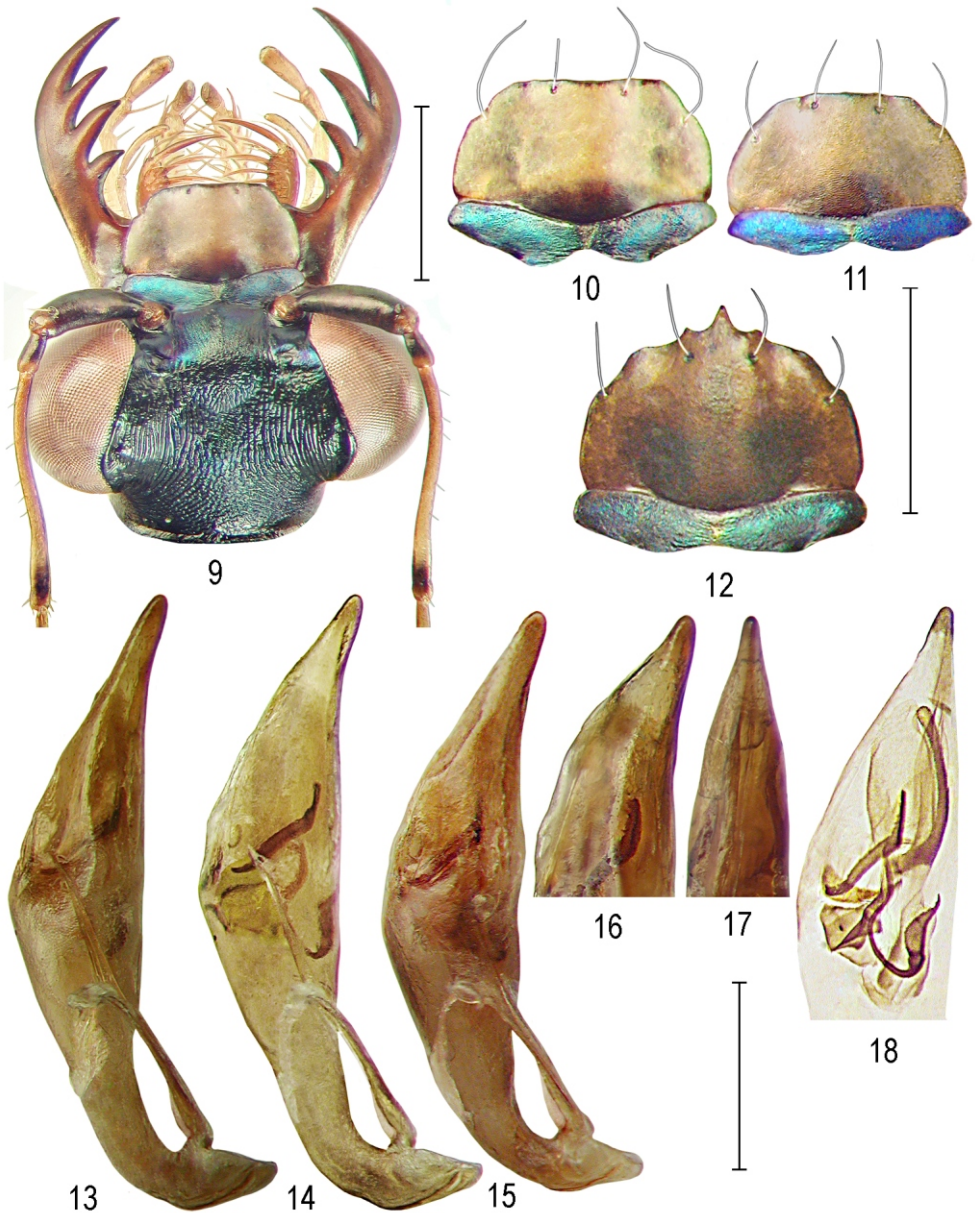
sparse and fine wrinkles along the thin median line; posterior sulcus with distinct basal rim, dorsolateral bulges only moderately pulvinate-raised; notopleural sutures almost invisible in dorsal view (as running in the same line with lateral margins of proepisterna), partly obvious only on posterior constriction; lateral and ventral sterna dark metallic blue, usually with greenish or violaceous lustre, almost smooth; mesepisterna smooth, female mesepisternal coupling sulci present in form of a deeper, dorsally placed sulcus, thus only slightly differing from mesepisterna in male.

Elytra (Figs. 6-8) elongate, length 5.80-6.20 mm, surface moderately convex, more distinctly on posterior part of elytral disc, almost even except for rather distinct juxtahumeral and apical impressions while discal impression and basodiscal convexity are moderate; humeri rounded in male, obtusely subquadrate in female, lateral margins in both sexes subparallel, slightly dilated in middle, antepical angles arcuate, then obliquely running towards apices which are rounded and indistinctly emarginated towards small, blunt sutural spine; microserrulation indistinct; elytral surface rather finely isolate-punctate on whole elytral length, punctures predominantly small, almost regularly and rather sparsely distributed, several larger bluish setigerous punctures arranged in short row posteriad of juxtahumeral impressions and on basodiscal convexity, and some larger punctures also on base along but distant from suture; punctures on subhumeral-lateral area possess notably raised anterior margins; punctation on posterior elytral half finer, smallest and indistinct punctures are before and on posterior declivity, almost effaced at antepical angles, but elytral apices covered with larger, rather sparse punctures; elytral coloration almost uniformly diffusely to bright blue or green-blue, sometimes with violaceous lustre on lateral areas and brighter greenish iridescence on posterior declivity, and olivaceous-brownish or dark velvety diffuse tinge on elytral disc along sutures (the coloration changeable depending on angle of illumination); white elytral maculation consisting of three maculae: humeral macula in male large, in female placed in ventral humeral angle and invisible in dorsal view; large sublateral-median macula of irregular shape, rarely moderately elongate; antepical macula usually large (absent only in one female); elytral surface glabrous except for the indistinct and easily abraded setae arising from the short rows of setigerous punctures on elytral basal area, and short, very sparse juxtaepileural setae.

Abdomen. Ventrites metallic black-blue, smooth, their surface glabrous, hairlike sensory setae only at anterior margins of the ventrites.

Legs. Pro- and mesocoxae metallic black with sparse, white anterior setae, metacoxae metallic blue, glabrous; trochanters and ventral-basal portion of femora ivory to ochraceous, the pale area more extended on profemora; other femoral surface metallic black to black-brown, covered with sparse, short, decumbent to semi-erect setae; tibiae ochre to brownish-testaceous (darker in female) with darkened apices, covered with sparse, almost thorn-like setae, basal third of pro- and mesotibiae with dense pad of short, griseous setae; tarsi very long, ochre-testaceous to pale mahogany brownish with black-darkened apices, first three protarsomeres in male only moderately dilated, elongate, with fine rather sparsely arranged brownish setae; claws testaceous.

Aedeagus (Figs. 13-18) elongate, 3.05-3.35 mm long, 0.75 mm wide, conically attenuating towards moderately ventrally directed, blunt apex; in dorsal view there is a rather sharp, longitudinal median edge which is sometimes barely obvious in re-hydrated aedeagi; internal sack (Fig. 18) consisting of basoventral spur with thin, arcuate projection and less sclerotized, dorsally placed stiffening rib, composed basodorsal sclerite, long, irregularly bent arciform piece with strongly sclerotized and dentate straight apex, combined with basal piece, and prominent, elongate ventral-upper piece with rounded apex.



Figs. 9-18. *Physodeutera (Axinomera) horimichioi* sp. nov.: 9- head, ♂, Andranopasazy, HT (OSAKA); 10-12- labrum: 10- ♂, HT; 11- ♂, Andamoavaky, PT, (MHCW); 12- ♀, Andranopasazy, AT (MNHNI); 13-18 - aedeagi: 13- HT (dried); 14- ditto, rehydrated; 15- Andamoavaky, PT, (MHCW); 16- Andranopasazy, PT (CCJM); 17- ditto, ventral view; 18- ditto, internal sac. Bars = 1 mm.

Variability. Apart of the slight variability in coloration, which in fact is mostly changed by different angles of illumination, one male from Andamozavaky has its left elytron (Fig.7) with an additional apical macula indicated in form of a barely visible ochre-brownish spot, while both elytra of one female (not illustrated here) from Andranopasazy are missing the anteapical macula; moreover, the labrum of this female is with a strong metallic lustre.

Differential diagnosis. Related to *Physodeutera (Axinomera) flagellicornis* (W. Horn, 1897) and *Ph. (A.) rectipenis* (W. Horn, 1934), but *Ph. (A.) flagellicornis*, which inhabits north-eastern Madagascar, immediately differs in having the labrum in both sexes longer and of a very different shape, testaceous with whole median area up to the anterior margin metallic black, its male labrum is semicircular and the female labrum triangular with only median tooth protruding. Moreover, the arciform piece in the internal sac of the aedeagus is in *Ph. (A.) flagellicornis* smaller, and the ventral spur and most of the other sclerites are of a different shape.

Ph. (A.) rectipenis, which inhabits Sambirano and northern Madagascar, immediately differs in having the male labrum with three, small but distinct, subacute to acute anterior teeth, the shape of the female labrum is similar to the new species, but both the male and female labrum have their whole median area metallic black with green lustre. Moreover, the elytra of *Ph. (A.) rectipenis* possess additional, central-discal macula and its aedeagus has much narrower apex, and the internal sac possesses different sclerites. The shape of the aedeagus of *Ph. (A.) horimichioi* sp. nov. is immediate between these two compared species.

Other species of the subgenus *Axinomera*, including *Ph. (Axinomera) antsalovensis* Moravec, 1999, also described from Antsalova, can be immediately distinguished by a very different pattern of white elytral maculation (see Moravec 1999, 2002a).

For comparison of the habitus, diagnostic characters of *Ph. (A.) flagellicornis* and *Ph. (A.) rectipenis* see the detailed redescrptions and illustrations of their type and other specimens in Moravec (2002a, figs 117-133, 694-696 and 143-155, 698-999).

Etymology. Dedicated to the renowned Japanese entomologist and ecologist Prof. Michio Hori (Kyoto University, Japan), who, together with his Malagasy student, the second author of this paper, discovered the new species during their recent research of Madagascan tiger beetle fauna.

Biology and distribution. Known only from western Madagascar, the Tsingy de Bemaraha National Park (the same map of distribution for *Ph. (Axinomera) antsalovensis* Moravec, 1999, published in Moravec (2002a, fig. 173). The Tsingy de Bemaraha Integral National Park and Nature Reserve is located in the district of Antsalova in the central-west Madagascar, in the region of Melaky of the province of Mahajanga (= Majunga). Its total area is 152,000 ha and comprises karstic landscapes of an unique limestone massif of pinnacles ("tsingy") up to 100 metres high, with a spectacular gorge of the Manambolo river.

Besides the type locality which is the Andranopasazy Forest, it inhabits also the Andamozavaky Forest 18 km north of Bekopaka, both localities in the same national park. The biotope of these two places is a moist valley with many boulders and rocks of limestone, in a dry deciduous forest of the Bemaraha Massif. The adults are diurnal and good flyers, flying and hunting on the boulders of dry bed of a small river, but any breeding behaviour was not observed. The larva is unknown. Adults of *Physodeutera (Diarrhiza) janthina* (Fairmaire, 1903) were much more common in the locality than those of the new species. No adult of *Ph. (Axinomera) antsalovensis*

was found there. However, in an adjoining place of the type locality, but mostly at the base of the much larger limestone boulders or walls, adults of *Paraphysodeutera naviauxi* Moravec, 2002 were simultaneously caught by Michio Hori and the second author.

REVISED KEY TO THE SPECIES OF *PHYSODEUTERA (AXINOMERA)*.

- 1 Mandibles subsymmetrical. Body medium-sized. Pronotum finely scabriculous-wrinkled. Elytra predominantly bronze-reddish, with long white humeral lunule in male, which is combined with cinnamon-coloured humeral portion in female; white large longitudinal-elongate sublateral-median macula and anteapical macula; rarely also small, ochre to brownish basal macula present. Aedeagus with short, straight, slightly dorsally emarginated blunt tip. Antennomere 4 in male dilated *Ph. (A.) dorri* (Fleutiaux)
- Mandibles asymmetrical (at least in male) 2
- 2 Elytral central macula (or band) present at least in aberrant specimens, sublateral-median macula present, anteapical and apical macula present or absent 3
- Elytral white maculation consisting of only rounded humeral, sublateral-median and anteapical macula (that is exceptionally absent). Male labrum ivory to ochre, except for small basal area black; lacking teeth, its anterior margin subtruncate to truncate; female labrum ochre to brownish testaceous with only sublateral-basal areas black, with rather long median tooth protruding between two smaller anterior teeth. Antennomere 4 in male widely lobed. Aedeagus conically attenuated into moderately ventrally directed, blunt apex *Ph. (A.) horimichioi* sp. nov.
- 3 Aedeagus robust, with dorsally hooked tip; antennomere 4 in male widely lobed. Elytral anteapical macula present, apical macula absent 4
- Aedeagus narrower, with ventrally directed or nearly straight apex. Antennomere 4 widely lobed or only moderately dilated 5
- 4 Elytra in male with white humeral macula posteriad-prolonged in form of elongate, cinnamon-coloured wide lateral band that is in female entirely cinnamon-coloured also in its humeral portion; white sublateral-median macula connected with yellow-cinnamon central macula, forming together obliquely-transverse (moderately posteriad directed) band *Ph. (A.) andriai* (Rivalier)
- Elytra with short, simple humeral macula (white in male, brownish in female), white sublateral-median macula separated from central macula *Ph. (A.) pseudotrimaculata* (W. Horn)
- 5 Elytra in male with white humeral macula posteriad-prolonged in form of cinnamon-coloured wide lateral band; in female the humeral band is entirely cinnamon-coloured. Antennomere 4 in male widely lobed 8
- Elytral humeral macula simple; Labrum with whole median area up to the anterior margin metallic brown to black, in female concolorous with male, or entirely darkened 6
- 6 Antennomere 4 widely lobed. Aedeagus with elongate, ventrally directed tip. Palpi pale testaceous with only darkened or blackened apex of terminal palpomeres 7
- Antennomere 4 only moderately dilated, entirely metallic black. Male labrum step-pyramidal. Aedeagus small, conically attenuated into nearly straight blunt tip. Terminal palpomeres in male and both terminal and penultimate palpomeres of maxillary palpi in female metallic black. Elytral apical macula absent *Ph. (A.) skrabali* Moravec
- 7 Male labrum semicircular, lacking teeth; female labrum almost triangular and with only anterior medial tooth *Ph. (A.) flagellicornis* (W. Horn)
- Male labrum with emarginated anterior margin between two anterolateral distinct teeth, or with also indistinctly indicated medial tooth; female labrum with tridentate median lobe. Elytral central macula present, apical macula present, or absent *Ph. (A.) rectipenis* (W. Horn)
- 8 Aedeagus small with elongate, ventrally directed tip. Elytral central macula white, apical macula present. Pronotum nearly smooth. Male labrum subtruncate. Body small *Ph. (A.) boraensis* Moravec
- Aedeagus robust with ventrally directed apex. Elytral central macula ochre-yellow, apical macula absent or inconspicuously indicated. Pronotum finely scabriculous-wrinkled. Body large 9
- 9 Apex of aedeagus rather short and wide, rounded. Male labrum with emarginated anterior margin between two anterolateral small, pointed teeth *Ph. (A.) antsalovensis* Moravec
- Apex of aedeagus narrower and notably elongate. Male labrum truncate, lacking teeth *Ph. (A.) vybirali* Moravec

A NEW RECORD OF *PARAPHYSODEUTERA NAVIAUXI* MORAVEC, 2002

10 adults (5 ♂♂ and 5 ♀♀) were recently caught in the Andranopasazy Forest of the Tsingy de Bemaraha National Park near Antsalova (province of Mahajanga, district of Melaky, western Madagascar).

They are labelled: "Andranopasazy Forest, near / Antsalova, Bemaraha N. P. / Mahajanga Dist., Madagascar / Dec.5-8.2014 / Michio Hori & Elysé Hugo Razanajonarivalona leg."

The specimens are deposited as follows: 1 ♂, 1 ♀ in ZUAC, 1 ♂ CCJM, 3 ♂♂ and 3 ♀♀ in MHCW, 1 ♀ in CJVB.

The adults were foraging and flying infrequently in daytime on large boulders in a dry western deciduous forest of a moist valley. When disturbed they flew onto other boulders, but it was difficult to locate them because of the understory surrounding the large boulders, which makes the places very dark despite the collecting during fine sunny days. Larva is unknown.

Paraphysodeutera naviauxi was hitherto known from the only male holotype (MNHN) and female paratype (CCJM) caught 34 years ago by André Peyriearas and labelled merely "Antsalova" (see Moravec 2002b, 2010).

This new, recent record of this very rare tiger beetle of a monobasic genus *Paraphysodeutera* Moravec, 2002 comes for the first time from the exactly specified locality and this species is sympatric there with *Ph. (Axinomera) horimichioi* sp. nov.

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