ZooKeys 256: 1–34 (2013)
doi: 10.3897/zookeys.256.3871
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Two new species of zooplanktivorous haplochromine cichlids from Lake Victoria, Tanzania

Marnix P. de Zeeuw[1,†], Irene Westbroek[2,‡], Martien J.P. van Oijen[1,§], Frans Witte[1,2,|]

1 *Naturalis Biodiversity Center, The Netherlands* **2** *Institute of Biology Leiden, Leiden University, The Netherlands*

† *urn:lsid:zoobank.org:author:4C0D3262-F1C3-4E99-ADD1-A6C9C921B580*
‡ *urn:lsid:zoobank.org:author:1B11560C-B057-496F-8E18-7BC6703C75D9*
§ *urn:lsid:zoobank.org:author:B833A2BB-55A5-49DE-9573-BD585CC0068C*
| *urn:lsid:zoobank.org:author:75D7B71F-41D7-4572-A1DD-EA17A1623AF2*

Corresponding author: *Frans Witte* (F.Witte@biology.leidenuniv.nl)

Academic editor: *C. Baldwin* | Received 18 August 2012 | Accepted 5 December 2012 | Published 2 January 2013

urn:lsid:zoobank.org:pub:B96FF5D6-46C8-461D-90EA-5D07FCA33298

Citation: de Zeeuw MP, Westbroek I, van Oijen MJP, Witte F (2013) Two new species of zooplanktivorous haplochromine cichlids from Lake Victoria, Tanzania. ZooKeys 256: 1–34. doi: 10.3897/zookeys.256.3871

Abstract

Two new species of zooplanktivorous haplochromine cichlids from Lake Victoria, Tanzania, are described and illustrated. These species closely resemble each other. Their affinities to other zooplanktivorous haplochromines from Lake Victoria are discussed. *Haplochromis argens* **sp. n.**, which featured under nicknames (mainly *H.* "argens") in more than 50 papers, was caught both in the Mwanza Gulf and the Emin Pasha Gulf, whereas *H. goldschmidti* **sp. n.** was only found in the Emin Pasha Gulf. Of the latter species only males are available, but it seems unlikely that it represents a case of male colour polymorphism as several presumably unrelated characters differ in sympatry between the two species, suggesting that there is no gene flow. Statistical analysis revealed that the overall difference between the two species is greater than that between the populations from the two locations. Body depth of the two species in sympatry in the Emin Pasha Gulf was more similar than that of *H. goldschmidti* **sp. n.** and the allopatric population of *H. argens* **sp. n.** from the Mwanza Gulf, which may indicate an overall environmental effect. However, several measurements related to the width of snout and mouth differed more between the populations of the two species in sympatry than between the allopatric populations. In contrast to a group of zooplanktivorous species that recovered successfully after environmental changes in the lake, *H. argens* **sp. n.** is among a group that became extremely rare and probably is in danger of extinction; the conservation status of *H. goldschmidti* **sp. n.** is currently unknown.

Keywords
Allopatric populations, Cichlidae, colour polymorphism, East Africa, endangered species, *Haplochromis*, zooplanktivores

Introduction

In this paper two zooplanktivorous haplochromine species from Lake Victoria are described. One of these species, nicknamed *Haplochromis* "argens," was common in the Mwanza Gulf until 1985 and also caught in other areas in the Tanzanian part of the lake. Since the late 1970s, this species has been the subject of studies on ecology (e.g. Witte 1984b, Goldschmidt et al. 1990), morphology (e.g. van der Meer and Bowmaker 1995, van der Meer et al. 1995), behavioral biology (Smith and Wooton 1994) and physiology (Rosenberger and Chapman 2000, Melnychuk and Chapman 2002). The second species, which closely resembles *H.* "argens," was nicknamed *H.* "dusky argens". It was only caught in the Emin Pasha Gulf in 1985 and 1986, concomitantly with *H.* "argens" (Goldschmidt and de Visser 1990).

Up to the 1980s, the zooplanktivorous haplochromines were, both in number and biomass, the second most abundant group of demersal fishes in sub-littoral areas of the Mwanza Gulf. A one hour tow of a bottom otter trawl (head rope 25 m) contained on average 1140 kg of haplochromines, of which 27% (more than 100,000 individuals) were zooplanktivores (Goldschmidt et al. 1993, Witte et al. 2012b). During the 1980s it became clear that the ecosystem of Lake Victoria was subject to a perturbation of an enormous magnitude. The population of Nile perch, *Lates niloticus* (Linnaeus 1758), an introduced predator, boomed (Ogutu-Ohwayo 1990, Goudswaard et al. 2008) and concomitantly widespread eutrophication became apparent (e.g. Kaufman 1992; Witte et al. 1992a; Hecky 1993; Hecky et al. 1994, 2010; Seehausen et al. 1997a; Wanink et al. 2001). As a result, the haplochromine cichlids in the sub-littoral waters of Lake Victoria almost vanished (Ogutu-Ohwayo 1990; Witte et al. 1992b).

From 1987 to 1992, haplochromines were extremely rare in trawl catches in the Mwanza Gulf; however, with the subsequent decline of Nile perch due to heavy fishing, a slow recovery of some zooplanktivorous species was noticed (Seehausen et al. 1997b; Witte et al. 2000, 2007a, b). This resurgence is continuing till the present day. In 2005 the zooplanktivorous haplochromines, which used to be second in importance after the detritivorous haplochromines, were the dominant trophic group and even more abundant than before the environmental changes (Witte et al. 2007a). Initially, *H.* "argens" was not present among the resurgent zooplanktivores, but the species has been caught again since 2002, albeit in very low numbers (Wanink JH, Kishe-Machumu M and Witte F, unpublished data).

As *H.* "argens" has already made its appearance in more than 50 articles, is bred in captivity by scientists and hobbyists, and currently is caught again in the lake, a formal taxonomic description is urgently needed and presented in this paper.

In the Emin Pasha Gulf, males of *H.* "argens" and males that resembled this species were caught in the same hauls. The latter males differed from *H.* "argens" in aspects of their overall nuptial body colouration, the colour of their caudal fin, and number and position of the egg spots on the anal fin (Goldschmidt and de Visser 1990). These males were referred to as *H.* "dusky argens" by Goldschmidt and de Visser (1990). The taxonomic status of these specimens is investigated, and they are described as a new species in this paper.

Material and methods

The type specimens of both species were collected in the Tanzanian part of Lake Victoria. All type material was collected between May 1975 and August 1986, before the collapse of the haplochromines in the Tanzanian part of the lake due to the Nile perch upsurge and eutrophication (e.g. Witte et al. 1992a, b, 2012a; Seehausen et al. 1997a; Wanink et al. 2001; Goudswaard et al. 2008). *Haplochromis* "argens" was collected in the Mwanza Gulf (between Nyamatala Island and Hippo Island, depth range about 6–16 m) and in the Emin Pasha Gulf (Fig. 1), mainly with bottom trawls, occasionally with gill nets. The type material of *H.* "argens" comprises 77 specimens (size range of 53.1–77.4 mm SL): 36 males and eight females from the Mwanza Gulf and 33 males and no females from the Emin Pasha Gulf. The type specimens (51 males; size range 50.7–69.2 mm SL) of *H.* "dusky argens" were collected in the Emin Pasa Gulf with bottom trawls on 22 and 23 July 1985, at two localities (depth range 4–8 m; Fig. 1). The live colours of some individuals were photographed in a small perspex tank filled with water (Barel et al. 1977). Immediately after they were caught, the fish were stored on ice. In the laboratory they were preserved in 10% formalin neutralized with borax. After several months to several years the fishes were sent to the Netherlands, where they were rinsed with tap water and stepwise transferred to 70% ethanol.

Ten male specimens of *H.* "argens" were dissected. The oral jaws were removed from nine specimens and the pharyngeal jaws from four specimens. From six specimens the first gill arch was dissected. Of *H.* "dusky argens," six specimens were dissected. From five specimens the oral jaws and the intestines were removed and from three specimens the pharyngeal jaws and the first gill arch. The description of the shape of the oral and pharyngeal jaws and their dentition was based on the dissected elements, as were the counts of the gill filaments.

Linear measurements and counts were collected from 57 specimens of *H.* "argens" and 19 specimens of *H.* "dusky argens." Counts included numbers of scales, teeth, gill rakers and vertebrae, the latter obtained from radiographs. Additional specimens for which counts and measurements were not made are also designated as type specimens; these include specimens used for colour descriptions (from colour slides) and other qualitative characters, specimens used for dissection, and specimens from which tissue samples for DNA analysis had been taken. Terminology and measurements follow

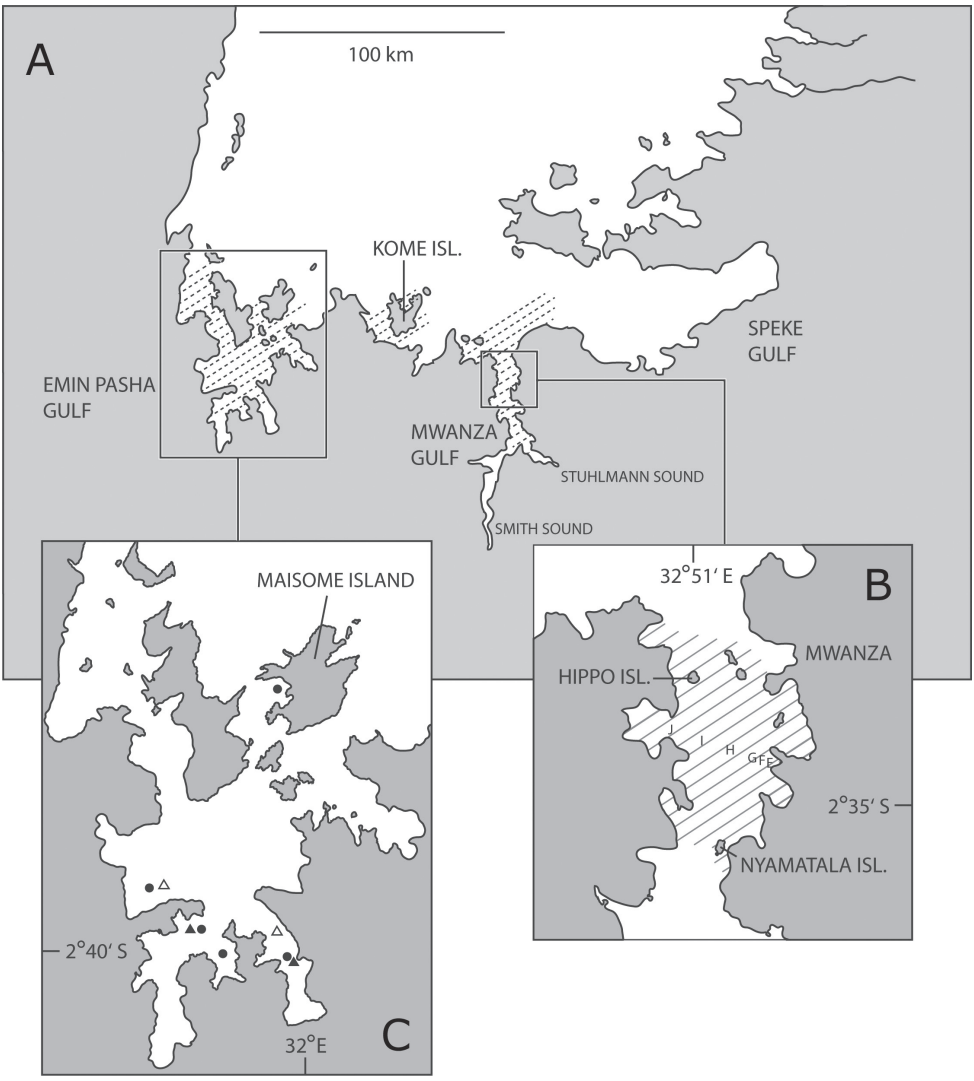


Figure 1. Tanzanian part of Lake Victoria. **A**, distribution of *Haplochromis argens* sp. n. (hatched area) **B** Mwanza Gulf with catch localities of type specimens of *H. argens* sp. n. (hatched area); E to J represent stations along the research transect where data on abundance of *H. argens* sp. n. were collected **C** Emin Pasha Gulf with catch localities of type specimens of *H. argens* sp. n. (filled circles) and type specimens of *H. goldschmidti* sp. n. (filled triangles); open triangles indicate other catch localities of *H. goldschmidti* sp. n.

Barel et al. (1977), Hoogerhoud and Witte (1981) and Witte and Witte-Maas (1981). Abbreviations used in the text are explained in Table 1.

Measurements were taken to the nearest 0.1 mm using digital callipers with needles glued to the ends. For comparison with earlier described haplochromine species from Lake Victoria (e.g. Greenwood 1981) we transformed the measurements to proportions (percentages) of standard length (SL) or head length (HL). We present the

Table 1. Measurements of *Haplochromis argens*, proportional to standard length or head length. Means and standard deviations were calculated over all measured type specimens, including the holotype.

		Holotype	Paratypes (n = 56)	Mean ± SD (n = 57)
standard length SL (mm)		67.3	53.1–75.5	63.1 ± 5.4
body depth (BD)	%SL	28.8	26.0–30.7	28.2 ± 1.1
pectoral fin length (PFL)	%SL	27.3	25.4–30.9	27.8 ± 1.2
caudal peduncle length (CPL)	%SL	21.7	18.5–23.5	20.7 ± 1.1
caudal peduncle depth (CPD)	%SL	9.7	9.1–11.1	10.0 ± 0.5
caudal fin length (CFL)	%SL	22.7	20.1–25.5	23.9 ± 1.0
head length (HL)	%SL	31.7	31.0–35.6	32.9 ± 0.9
snout length (SnL)	%HL	26.3	23.6–29.7	26.6 ± 1.6
snout width (SnW)	%HL	27.6	20.6–27.8	24.5 ± 1.7
head width (HW)	%HL	41.3	32.0–43.8	40.0 ± 1.8
interorbital width (IOW)	%HL	22.1	18.8–23.8	20.8 ± 1.1
preorbital width (POW)	%HL	24.4	20.6–25.7	23.4 ± 1.2
lachrymal width (LaW)	%HL	21.6	17.3–23.2	20.2 ± 1.4
preorbital depth (POD)	%HL	15.5	13.1–18.7	15.3 ± 1.2
eye length (EyL)	%HL	36.6	30.9–39.0	35.7 ± 2.1
eye depth (EyD)	%HL	33.4	27.4–35.2	31.6 ± 1.7
cheek depth (ChD)	%HL	16.9	11.9–20.5	16.7 ± 1.7
lower jaw length (LJL)	%HL	40.4	37.6–44.3	40.5 ± 1.5
lower jaw width (LJW)	%HL	13.6	11.0–15.6	13.2 ± 1.0
EyD/EyL		0.9	0.8–1.0	0.9 ± 0.04
LJL/LJW		3.0	2.6–3.8	3.1 ± 0.27

proportional measurements to the nearest 0.1%, but it should be noted that they may deviate ± 0.2% because measurements were only accurate to the nearest 0.1 mm; the same is true for measurements presented in other species descriptions of Lake Victoria haplochromines. Unless stated otherwise, qualitative characters described as being relatively small or large refer to size relative to that of *Haplochromis* (*Astatotilapia*) *elegans* Trewavas, 1933. Morphologically, this insectivore from Lake George is a modal haplochromine cichlid. Its skeletal elements are described in Barel et al. (1976).

A comparison was made between *H.* "dusky argens" and the two populations of *H.* "argens" from the Mwanza Gulf and the Emin Pasha Gulf. As no females are available for *H.* "dusky argens," we only compared males. To test for differences in linear measurements of the three populations in general, MANCOVA was used. ANCOVAs were used to identify differences among the three populations in specific linear measurements. Data were log-*e* transformed to achieve linearity. The factors "Species" (two species) and "Location" (two locations) were investigated, and log standard length (SL) was used as covariate. Parameter estimates derived from the GLM (analysis of covariance) procedure were used to define and plot the power function between SL and individual taxonomic measurements and to calculate the relative differences in individual measurements between *H.* "dusky argens" and the two populations of *H.* "argens". For testing of interactions and main effects, Sum of Squares Type II was

used. Whether the residuals followed a normal distribution was investigated with the Kolmogorov-Smirnov Test. For statistical analysis of the morphometric data, SPSS version 14.0 for Windows was used.

Live (juvenile) *H. (Psammochromis) cassius* Greenwood & Barel, 1978, are similar to *H.* "argens". To compare *H.* "argens" with *H. cassius* which was described from only five females (some of them much larger than *H.* "argens"), we used measurements from six specimens of *H. cassius*: three specimens from the collection of Naturalis Biodiversity Center (RMNH.PISC.63199, RMNH.PISC.63200 and RMNH.PISC.74187) and three specimens from the collection of the Natural History Museum, London (BMNH 1987.2.4.1, BMNH 1987.2.4.2 and BMNH 1987.2.4.5). These specimens have a size range (67.4 – 79.3 mm SL) comparable to that of *H.* "argens".

To describe changes in abundance of *H.* "argens" during the period 1979 to 2011, we compared the frequency of occurrence (= percentage of catches containing one or more individuals of *H.* "argens") and the average numbers of individuals that were caught in trawl tows of 10 minutes duration with a small boat (20 or 25 hp) on a research transect in the Mwanza Gulf (Fig. 1; Witte et al. 1992). A bottom otter trawl (head rope 4.6 m, codend mesh 5 or 15 mm) was used during the day and a surface trawl (beam 4.5 m, codend mesh 5 mm) during the night.

Specimens referred to in this study are deposited in the Naturalis Biodiversity Center, Leiden (RMNH), the American Museum of Natural History, New York (AMNH), the Natural History Museum, London (BMNH) and the National Museum of Nature and Science, Tsukuba (NSMT), Japan.

Results

Species descriptions

***Haplochromis argens* de Zeeuw, Westbroek & Witte, sp. n.**
urn:lsid:zoobank.org:act:B0288AFB-9C11-4D81-9B7B-E551951A7B2D
http://species-id.net/wiki/Haplochromis_argens
Figs 2–5, Tables 1,2

Cheironyms used. Haplochromis argens: Goldschmidt 1994: 179, 199–200; *Haplochromis argens*; Verheyen et al. 1989: 93, 94, 96; van der Meer 1995: 26, 30–32; van der Meer and Bowmaker 1995: 232–239; Goldschmidt 1996: 164, 184–185; Hilder and Pankhurst 2003: 194; Collin et al. 2004: 769; Carleton et al. 2008.

Haplochromis "argens"; Zihler 1982: 568; Barel 1983: 384, 385, 407, 418; Witte 1984a: 604, 611; Witte 1984b: 159–161, 163; Barel 1985: chapter 1, 384, 385, 407, 418; Gottfried 1986: 1029; Witte 1987, chapter 1: 611, chapter 2: 67, 76, chapter 3: 8–13, 19; Goldschmidt 1989a: 24, 27, 29–39, 41, 42, 44, 45, 53, 55, 58, 59, 61–63, 65–69, 71–75, 77, 82, 84, 86–89, 97–101, 103, 118, 119, 148, 158, 160, 162, 166; Goldschmidt 1989b: 122–126, 129–131; Wanink et al. 1989: 25; van der Meer 1989:

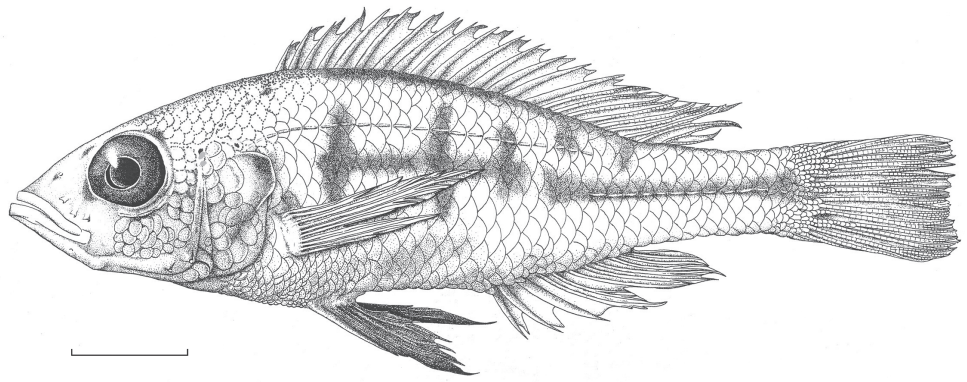


Figure 2. Habitus of *Haplochromis argens* sp. n. ♂ (holotype, RMNH.PISC.83588). Scale bar equals 10 mm. Drawing by I. Westbroek, missing (= dotted) scales added by M. van Oijen.

52, 53; Goldschmidt and de Visser 1990: 129, 130, 132; Goldschmidt et al. 1990: 344, 346–351, 353; Goldschmidt and Witte 1990: 356–367; Barel et al. 1991: 262; Goldschmidt 1991: 181, 182, 185, 187; van der Meer 1991a: 91–94, 96; van der Meer 1991b: 3, 5, 6, 9–12, 14–22, 24–26, 28, 68, 76, 77, 83, 85–87, 89–93, 99, 101, 104; Goldschmidt and Witte 1992: 104; Kaufman 1992: 848, 849; Witte et al. 1992b: 11, 13, 17, 25, 27, 28; Barel 1993: 366; Smith and Wootton 1994: 99–103; Balshine-Earn 1995: 5; Seehausen 1995: 143, 146; Seehausen and Witte 1995: 101; van der Meer et al. 1995: 116–129; Smith and Wootton 1995: 12; Anker and Dullemeijer 1996: 4–11; de Visser and Barel 1996: 4; Seehausen 1996: 51, 55, 255, 256; Smit and Anker 1997: 9–17; Seehausen et al. 1997b: 899; Witte et al. 1997: 591; Wanink 1998: 159, 232; Rinkes 1999: 46, 47, 54, 56–58, 60, 62, 76, 77, 79, 97; de Visser 2000: 18; Tacon et al. 2000: 63; Witte and Wanink 2000: 78–81, 84; Seehausen et al. 2003: 272; Witte et al. 2005: 320; Kishe-Machumu 2012: 35; van Rijssel and Witte 2012.

H. "Argens"; Kaufman and Seehausen 1995: 148.

Haplochromis (?) "argens"; Wanink and Witte 2000: 563; Witte et al. 2000: 234, 235, 237; Witte et al. 2003: 108; Niemantsverdriet 2005: 151, 155; Witte et al. 2007a: 1153.

Haplochromis sp. "argens"; Mizoiri et al. 2008: 228, 241, 254.

Yssichromis argens; van Staaden et al. 1995: 168; Chapman et al. 1995: 1277, 1279–1282, 1285; Huber et al. 1997: 170; Rosenberger and Chapman 2000: 498; Melnychuk and Chapman 2002: 107.

Yssichromis sp. "argens"; Mizoiri et al. 2008: 228.

Type-locality. Tanzania, Lake Victoria, Mwanza Gulf (ca 2°29'–2°36'S; 32°48'–32°54'E) and Emin Pasha Gulf (ca 2°18'–2°41'S; 31°47'–31°59' E).

Holotype. RMNH.PISC.83588[4], ♂, 67.3 mm SL, Tanzania, Lake Victoria, Mwanza Gulf, 8.iii.1979, HEST.

Paratypes. All type specimens collected by *Haplochromis* Ecology Survey Team (HEST) in Mwanza Gulf, Tanzania, Lake Victoria, except where noted otherwise.

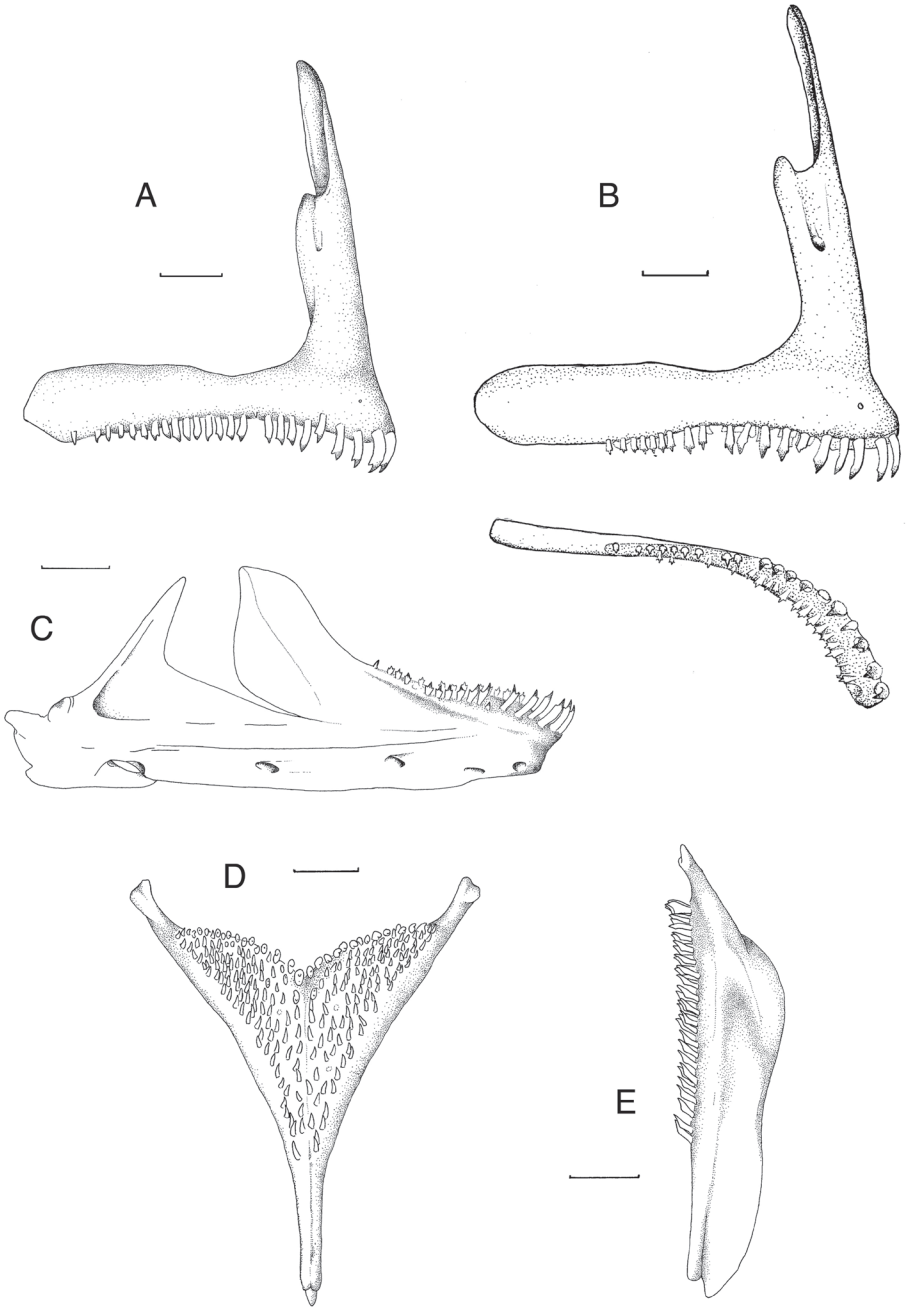


Figure 3. Skeletal elements of *Haplochromis argens* sp. n. **A** Right premaxilla, lateral view (RMNH. PISC.83705) **B** Right premaxilla, lateral (top) and occlusal (bottom) views (RMNH.PISC.83621), illustrating, for this species, a rare case of a posteriorly edentulous premaxilla **C** Right lower jaw, lateral view (RMNH.PISC.83697) **D** Lower pharyngeal element, dorsal view (RMNH.PISC. 83706) **E** Lower pharyngeal element, lateral view (RMNH.PISC.83706). Scale bars equal 1 mm. **A, C, D** drawn by I. Westbroek, **B** by M. van Oijen.

Size of specimens given as standard length. RMNH.PISC.72831[5], ♀, 71.0 mm, 30.v.1980; RMNH.PISC.72884[5, 6], ♂, 74.4 mm, 31.v.1980; RMNH.PISC.73097, ♀, 71.3 mm, 27.ix.1977; RMNH.PISC.81202[5], ♀, 65.6 mm, 11.v.1978; RMNH.PISC.83587, ♂, 77.4 mm, 31.v.1975; RMNH.PISC.83589[4], ♀, 75.5 mm, 21.iv.1980; RMNH.PISC.83590[4], ♂, 68.2 mm, 22.iv.1980; RMNH.PISC.83606[4], ♂, 73.7 mm, 22.iv.1980; RMNH.PISC.83607[4], ♂, 65.7 mm, 15.iv.1980; RMNH.PISC.83608[5], ♂, 65.7 mm, 31.v.1975; RMNH.PISC.83609[4], ♂, 67.4 mm, 22.iv.1980; RMNH.PISC.83610[4], ♂, 66.2 mm, 30.ix.1977; RMNH.PISC.83611[4], ♂, 69.5 mm, 30.ix.1977; RMNH.PISC.83612[4], ♀, 71.1 mm, 30.ix.1977; RMNH.PISC.83613[4], ♀, 68.1 mm, 30.ix.1977; RMNH.PISC.83614[4], ♀, 71.9 mm, 8.ix.1977; RMNH.PISC.83615[4], ♂, 57.7 mm, 8.ix.1977; RMNH.PISC.83616[4], ♂, 70.2 mm, 19.viii.1977; RMNH.PISC.83617[4], ♀, 71.5 mm, 19.viii.1977; RMNH.PISC.83618[4], ♂, 66.1 mm, 7.ix.1977; RMNH.PISC.83619[4], ♂, 66.5 mm, 21.xii.1977; RMNH.PISC.83620[4], ♂, 65.8 mm, 10.x.1977; RMNH.PISC.83621[1], ♂, circa 70 mm, 30.ix.1977; RMNH.PISC.83622[5], ♂, 59.3 mm, 22.vi.1985, Emin Pasha Gulf; RMNH.PISC.83623[5], ♂, 57.2 mm, 22.vi.1985, Emin Pasha Gulf; RMNH.PISC.83624[5], ♂, 59.6 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83625[4], ♂, 58.3 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83626[4], ♂, 58.5 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83627[4], ♂, 54.3 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83628[4], ♂, 59.6 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83629[4], ♂, 55.4 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83630[4], ♂, 53.1 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83631[4], ♂, 66.8 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83632[4], ♂, 67.0 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83633[4], ♂, 60.4 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83634[4], ♂, 53.9 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83635[4], ♂, 62.6 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83636[4], ♂, 66.6 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83637[4], ♂, 69.2 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83638[4], ♂, 65.8 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83639[4], ♂, 61.3 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83640[4], ♂, 73.4 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83641[4], ♂, 64.1 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83642[4], ♂, 63.1 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83643[4], ♂, 63.7 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83644[4], ♂, 62.1 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83645[4], ♂, 64.1 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83646[4], ♂, 61.6 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83647[4], ♂, 59.8 mm, 25.viii.1981; RMNH.PISC.83648[4], ♂, 61.6 mm, 10.x.1977; RMNH.PISC.83649[4], ♂, 61.5 mm, 21.xii.1977; RMNH.PISC.83650[4], ♂, 57.7 mm, 6.iii.1979; RMNH.PISC.83651[4], ♂, 60.6 mm, 13.vii.1979; RMNH.PISC.83652[4], ♂, 58.0 mm, 1.ii.1979; RMNH.PISC.83653[4], ♂, 53.5 mm, 18.xi.1981; RMNH.PISC.83655[4], ♂, 61.8 mm, 14.v.1979; RMNH.PISC.83656[4], ♂, 59.0 mm, 27.iii.1979; RMNH.PISC.83657[4], ♂, 61.6 mm, 27.iii.1979; RMNH.PISC.83660[4], ♂, 56.8 mm, 12.iii.1979; RMNH.PISC.83661[4], ♂, 57.9 mm, 12.iii.1979; RMNH.PISC.83662[4], ♂, 59.7 mm, 14.v.1979; RMNH.PISC.83663[4], ♂, 58.6 mm, 14.v.1979; RMNH.PISC.83673[4], ♂, 55.5 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83688[1–3],

Figure 4. Live colours of *Haplochromis argens* sp. n. **A** sexually active ♂, 59.3 mm SL (paratype, RMNH.PISC.83622), Emin Pasha Gulf **B** sexually active ♂, 72.1 mm SL (paratype, RMNH. PISC.84067), Mwanza Gulf.

♂, 61.4 mm, 6.iii.1979; RMNH.PISC.83689[1–3], ♂, 62.2 mm, 14.v.1979; RMNH. PISC.83694[1, 5], ♂, 63.1 mm, 21.vi.1985, Emin Pasha Gulf; RMNH.PISC.83697[1, 5], ♂, 59.1 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83698[1–3, 5], ♂, 61.0 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83703[3, 6], ♂, 66.4 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83704[1, 3, 6], ♂, 68.4 mm, 23.vi.1985, Emin Pasha Gulf; RMNH.PISC.83705[1–3, 6], ♂, 67.5 mm, 23.vi.1985, Emin Pasha Gulf; RMNH. PISC.83706[1, 5], ♂, 68.8 mm, 27.vi.1985, Emin Pasha Gulf; RMNH.PISC.84067[5, 7], ♂, 72.1 mm, 15.viii.1986; AMNH 255035[4], ♂, 62.2 mm, 14.v.1979; BMNH 2012.1.5.2 [4], ♂, 62.8 mm, 3.v.1979; NSMT-P 106959[4], ♂, 62.6 mm, 3.v.1979.

[1] dissected to describe oral jaws; [2] dissected to describe pharyngeal jaws; [3] dissected to count gill filaments; [4] proportional measurements taken (Table 1); [5]colour picture available; [6]colour picture of anal fin available; [7] specimen of which Dr E. Verheijen, Royal Belgian Institute of Natural Sciences, has taken a tissue sample for DNA analysis.

Diagnosis. Small sized (< 8 cm SL), slender (BD < 31% SL), micrognathic (LJL < 45% HL) zooplanktivorous *Haplochromis* species with slightly curved to straight dorsal head profile. Relatively long and slender, mainly bicuspid, teeth in oral jaws. Premaxillary dentigerous area extending almost to caudal end of dentigerous arm. Both

males and females silvery with conspicuously ivory-white lips. Three to five, generally faint vertical stripes on flank; faint traces of a dark mid-lateral band occasionally present. Males with yellow to greenish sheen on flank.

Description. Proportional measurements of type material given in Table 1.

Habitus. See Fig. 2. Body slender. Dorsal head profile straight to slightly curved, occasionally moderately curved. Premaxillary pedicel slightly prominent. Mouth oblique. Lips not thickened. Medial part of premaxilla slightly expanded. Caudal part of maxilla not bullate. Vertical through caudal tip of maxilla running through iris, just rostral to pupil. Lateral snout outline isognathous and obtuse, in larger specimens slightly prognathous. Jaws equal anteriorly or lower jaw slightly protruding. Mental prominence slightly pronounced. Retro-articular processes of right and left mandible touching each other, interrupting ventral body outline. Eye approximately circular and medium to large. Generally an aphakic aperture present in pupil. Cephalic lateral line pores not enlarged.

Scales. Cheek, gill cover and rostral part of dorsal head surface covered with cycloid scales. Nape and rostral part of dorsum with mixture of cycloid and weakly ctenoid scales. Chest with ctenoid, weakly ctenoid and some cycloid scales. Scales on remaining part of body mainly ctenoid. Scales on chest smaller than those on ventral and ventro-lateral part of body; size transition gradual. Small elongated scales on basal quarter to half of caudal fin. Three to seven (mode 6) scales between upper lateral line and dorsal-fin origin, four to eight (mode 6) between pectoral- and pelvic-fin bases.

Fins. Pelvic fins just reaching or slightly surpassing rostral-most point of anal-fin origin. Pelvic fins with first soft rays slightly produced in both sexes, in males occasionally filamentous. Caudal tip of anal fin not reaching caudal-fin origin. Caudal-fin outline truncate to slightly emarginate.

Gill apparatus. Description based on lateral gill rakers and lateral hemibranch of first gill arch. Number of gill rakers on lower part of gill arch 11–12. Lower two to three rakers reduced (= very short), next one to two short, followed by two to six slender and longer ones. Remaining rakers hooked, bifid, trifid or quadrifid. Rakers generally closely set, viz. touching each other over major part of length. Number of gill filaments 94 to 106.

Viscera. Ratio between intestine length and SL: 1.0–1.4 (n = 25).

Oral jaws. (Fig. 3 A–C) Premaxillary ascending arm equal to or longer than dentigerous arm (asc./dent. arm ratio 1.0 to 1.1). Angle between the arms 77° to 81°. Symphyseal articulation facet not present. Lower jaw slightly more elongated than generalized type (length/height ratio 2.3 to 2.5). Upper half of dentary with distinct outwardly directed flare. Mental prominence slightly pronounced.

Oral teeth shape. (Fig. 3 A–C) Generally teeth in outer row of both premaxilla and lower jaw bicuspid or weakly bicuspid, with some unicuspid or tricuspid teeth interspersed. In specimens over 65 mm SL, weakly bicuspids and unicuspids may dominate. Major cusp of bicuspids isoscelene to subequilateral, protracted and acutely pointed. Flange generally absent, when present very small. Minor cusp weakly developed to distinct, relatively short compared to major cusp. Cusp gap wide. In labial view, neck slender to moderately slender, crown not or slightly expanded. In lateral

Figure 5. Preserved colours of *Haplochromis argens* sp. n. ♂ 67.3 mm SL (holotype, RMNH. PISC.83588). Scale bar equals 10 mm.

view, crown compressed. Outer-row teeth in both premaxilla and lower jaw recurved. Inner rows in both jaws with mainly tricuspid or weakly tricuspid teeth.

Oral teeth size. Outer-row teeth relatively long and slender, gradually decreasing in size from rostral to caudal.

Dental arcade and tooth band. (Fig. 3B) Rostrally dental arcade rounded. Outer row generally occupying almost total length of dentigerous arm of premaxilla, in two specimens (RMNH.PISC.83697 and RMNH.PISC.83621; Fig. 3B) edentulous part about 25% of arm. Outer row in lower jaw not, or just, reaching coronoid wing in most dissected specimens. In one case caudal-most tooth relatively high on coronoid wing. One or two inner rows in rostral part of both jaws, decreasing to zero in caudal part.

Teeth counts and setting. Outer row of upper jaw (l+r premaxilla) with 30–52 teeth. In both jaws outer-row teeth regularly set, their placement wider rostrally than laterally.

Tooth implantation. Outer-row teeth of premaxilla rostrally erect. Inner-row teeth recumbent. Outer-row teeth of lower jaw slightly procumbent, inner-row teeth erect.

Lower pharyngeal element. (Fig. 3 D,E) Lower pharyngeal element relatively small and slender (length/width ratio 1.2–1.3). Dentigerous area slightly broader than long (length/width ratio = 0.7–0.9). Suture straight.

Pharyngeal teeth counts. Caudal-most transverse row with about 30–38 teeth, medial longitudinal rows with eight to 11 teeth.

Pharyngeal teeth shape. Teeth in caudal-most transverse row hooked, major cusp only slightly incurved, blunt to slightly acute. Other teeth bevelled or pronounced. All teeth relatively fine and slender, medial teeth not coarser than other teeth.

Vertebrae. Total number of vertebrae in 57 specimens: 30 (12), 31 (39) or 32 (6), comprising 13–14 abdominal and 16–19 caudal vertebrae.

Live colouration males. (Fig. 4 A,B) Sexually active males with ivory to grey snout and cheek. Lips remarkably ivory-white with no or few pigment spots. Eye with grey outer ring and silver to golden inner ring. Lower jaw and interoperculum whitish. Gill cover silver, sometimes with grey to dusky flush. Dorsal head surface, dorsum and

flank silvery-grey, dorsum with bluish to purplish sheen, flank with yellow to greenish sheen. Chest, belly and ventral side silvery-white.

Pelvic fins black; in specimens of Emin Pasha Gulf, medial side sometimes red. Anal fin rostrally faintly to distinctly red, rest of fin hyaline. One to two dark yellow to orange egg dummies with hyaline ring present on caudal part of anal fin. Caudal fin orange-red to wine-red. Dorsal fin hyaline with red streaks and spots. Lappets hyaline or reddish, rostral lappets sometimes dusky.

Dark grey to blackish markings: Nostril-, interorbital-, and supraorbital stripes, sometimes rather distinct. Lachrymal stripe distinct, but relatively short (i.e. small blotch at caudal end of lachrymal generally not reaching caudal tip of maxilla), sometimes extending over iris. Irregular preopercular vertical bar generally present. Opercular blotch distinct. Three to five, generally faint vertical stripes on flank. Traces of dark-grey mid-lateral band occasionally present.

Live colouration females. Live females basically with same colours as males, lacking bluish-purplish and yellow-greenish sheens and distinct red colouration in fins, but sometimes with faint red flush in caudal fin. In females upper lip usually with more pigment than in males. Of markings on head, only lachrymal stripe and opercular blotch distinct. Mid-lateral band sometimes more distinct than in males, vertical stripes faint.

Preserved colouration of males and females. (Fig. 5) Body light brown, dorsally darker than ventrally. Snout, lips and lower jaw coloured as old ivory. Fins hyaline and light grey-brown in both sexes, except for black pelvic fins in adult males. Same markings, but slightly more distinct, as in live specimens.

Distribution. *Haplochromis argens* is only known from the Tanzanian part of Lake Victoria. Specimens were caught in the Mwanza Gulf (from entrance of Stuhlmann Sound to entrance of gulf in north), in the south-western part of the Speke Gulf (near its entrance), in the area around Kome Island, and in the Emin Pasha Gulf (Fig. 1).

Habitat. *Haplochromis argens* is a pelagic species from the littoral and sub-littoral zone. At night the species is virtually restricted to the two upper metres of the water column (Witte 1984b, Goldschmidt et al. 1990). By day, the highest densities were found at two to three metres from the surface, but individuals of this species were also caught with bottom trawls over sand and mud bottoms, and in gill nets and traps near rocks (Goldschmidt et al. 1990, Witte et al. 1992b).

Abundance. During 1979–1982, *H. argens* was present in 70% of the bottom-trawl tows by day and in 100% of the surface trawl tows at night; the mean numbers of individuals per tow ranged from 6.2 to 18.3, respectively (Table 2). In 1987–1988, it occurred in 3% of the bottom trawl tows and the mean number of individuals per tow was 0.03; the species was absent in surface trawls. Thirty-four bottom-trawl tows in 1990–1999 captured no *H. argens*. From 2001 to 2011 more than 150 bottom-trawl tows contained about 15 individuals of *H. argens*, corresponding to a decline in catch per unit effort of more than 50 times compared to the 1979–1982 captures; no individuals were caught with surface trawls.

Table 2. Frequencies of occurrence (Foo) in trawl tows and mean numbers (± SD) per tow of *Haplochromis argens*. Tows of 10 minutes duration were made with bottom trawls (day) at stations E to J (depth range 7–14 m) and with surface trawls (night) at station G (14 m deep); in the period 1990-1999 no surface trawls were made; n indicates number of trawl tows.

Station	Bottom trawl day	1979–1982† n = 104	1987–1988† n = 29	1990–1999‡ n = 34	2001–2011§ n > 150
E–J	Foo	70 %	3 %	0 %	< 10 %
	Mean nr	6.2 ± 12.2	0.03 ± 0.19	0	< 0.1
	Surface trawl night	**1981/1982 n = 8**	**1987-1988| n = 26**	-	**2001-2011§ n = 15**
G	Foo	100 %	0 %	-	27 %
	Mean nr	18.3 ± 12.4	0	-	0.5 ± 0.9

† Data from Witte et al. (1992b); ‡ data from Witte et al. (2000); §unpublished data from J.H Wanink; M.A. Kishe-Machumu, J.C. van Rijssel and F. Witte; | data from Wanink and Witte (1998).

Food. Before the ecological changes in Lake Victoria, the diet of *H. argens* comprised mainly zooplankton during the day; *Chaoborus* larvae were important at night (Goldschmidt et al. 1990). The current diet is unknown, but all the studied resurgent species in the Mwanza Gulf changed their diet (e.g. van Oijen and Witte 1996, Katunzi et al. 2003, Kishe-Machumu et al. 2008).

Breeding. *Haplochromis argens* is a female mouth brooder. Spawning sites are located at depths < 9 m (Goldschmidt and Witte 1990).

Etymology. In reference to the silver male colouration, *H. argens* was given the nickname "argens" under the false assumption it was Latinized Greek for silver. Since this species is well known under its cheironym, we think it is best to upgrade the nickname to the species' epithethon.

Comparisons. The zooplanktivorous species *H. (Yssichromis) laparogramma* Greenwood & Gee, 1969, *H. (Y.) pyrrhocephalus* Witte & Witte-Maas, 1987 and *H. (Y.) heusinkveldi*, Witte & Witte-Maas, 1987, have shorter bicuspid teeth in the oral jaws than *H. argens*, and generally the premaxillary dentigerous arm is edentulous over the caudal $^{1}/_{4}$ -$^{1}/_{3}$ versus the dentigerous portion extending almost to the caudal end of the dentigerous arm. The dental features of the zooplanktivorous/insectivorous *H. tanaos* van Oijen & Witte, 1996 and *H. thereuterion* van Oijen & Witte, 1996, are more or less similar to those of *H. argens*, but the former two species have more unicuspids. *Haplochromis argens* is further distinguished from these and other species by its colouration. Sexually active males of *H. tanaos* are dark blue, the females silvery with a distinct mid-lateral band and slightly less distinct dorso-lateral band. Sexually active males of *H. thereuterion* are black, the females coloured like females of *H. tanaos* (van Oijen and Witte 1996). The body of *H. argens* is less slender (BD 26.0–30.7% of SL, mean 28.2%, Table 1) than that of *H. tanaos* and *H. thereuterion* (22.1–27.1% and 24.4–27.6% of SL, respectively; Tables 3 and 7 in van Oijen and Witte 1996). Live *H. argens* is similar to (juvenile) *H. cassius* in colouration and general habitus. However, *H. cassius* has a broad, well defined mid-lateral band (Greenwood and Barel 1978), more and distinctly longer unicuspid teeth, more

Table 3. Measurements of *Haplochromis goldschmidti* sp. n., proportional to standard length or head length. Means and standard deviations were calculated over all measured type specimens, including the holotype.

		Holotype	Paratypes (n = 18) (n = 18)	Mean ± SD (n = 19) (n = 19)
SL (mm)		60.3	51.7–69.2	61.2 ± 4.6
BD	%SL	25.2	25.0–27.3	26.2 ± 0.7
PFL	%SL	27.4	24.2–29.3	27.4 ± 1.3
CPL	%SL	19.4	17.8–22.6	20.2 ± 1.1
CPD	%SL	9.0	8.5–10.4	9.6 ± 0.5
CFL	%SL	23.9	22.2–25.2	24.4 ± 0.8
HL	%SL	30.5	31.0–34.6	32.9 ± 0.9
SnL	%HL	26.6	23.7–29.7	26.4 ± 1.3
SnW	%HL	26.1	24.1–27.8	25.8 ± 1.2
HW	%HL	42.9	37.2–44.2	40.6 ± 1.7
IOW	%HL	21.7	19.3–21.7	20.7 ± 0.8
POW	%HL	26.1	22.1–27.3	24.1 ± 1.4
LaW	%HL	22.3	19.8–24.4	22.0 ± 1.3
POD	%HL	13.6	11.7–18.0	14.4 ± 1.8
EyL	%HL	35.9	32.7–40.2	36.5 ± 2.2
EyD	%HL	34.2	28.5–35.0	32.1 ± 1.8
ChD	%HL	14.1	13.1–16.3	15.0 ± 1.1
LJL	%HL	42.1	39.0–45.6	41.0 ± 1.6
LJW	%HL	12.5	11.7–18.0	14.0 ± 1.5
EyD/EyL		1.0	0.8–0.9	0.9 ± 0.0
LJL/LJW		3.4	2.2–3.6	3.0 ± 0.3

curved and more widely set teeth, and thicker lips than *H. argens*. The maximum size of *H. cassius* (99.0 mm SL) is larger than that of *H. argens*, but when comparing similar size ranges (see material and methods) *H. argens* has: a smaller head (ratio HL/SL: 31.0 – 35.6%, mean 32.9% versus 35.0 – 36.0%, mean 35.5% in *H. cassius*); a shorter snout (ratio SnL/HL: 23.6 – 29.7%, mean 26.6% versus 29.8 – 32.6%, mean 31.2% in *H. cassius*); larger eyes (ratio EyL/HL: 30.9 – 39.0%, mean 35.7% versus 26.8 – 28.8%, mean 28.3% in *H. cassius*). For comparison with *Haplochromis goldschmidti* sp. n., see below.

***Haplochromis goldschmidti* Witte, Westbroek & de Zeeuw, sp. n.**
urn:lsid:zoobank.org:act:06762084-8C0C-49CC-A48D-065244CF8457
http://species-id.net/wiki/Haplochromis_goldschmidti
Figs 6–9, Table 3

Cheironyms used. *Haplochromis* "dusky argens"; Goldschmidt 1989a: 148, 158, 160, 162, 166; Goldschmidt and de Visser 1990: 129, 130, 132; Goldschmidt 1991: 182, 187; van der Meer 1991b: 9–11, 15, 16, 19–22; van der Meer et al. 1995: 116, 117, 122–124, 126, 127.

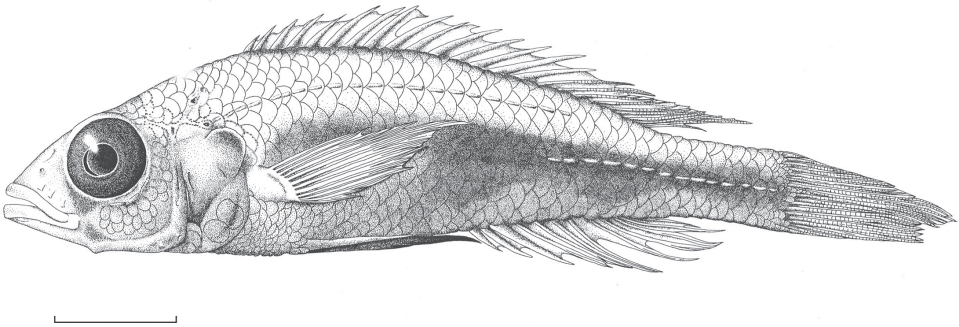


Figure 6. Habitus of *Haplochromis goldschmidti* sp. n. ♂ (holotype, RMNH.PISC.83573). Scale bar equals 10 mm. Drawing by I. Westbroek, missing (= dotted) scales added by M. van Oijen.

Type-locality. Tanzania, Lake Victoria, Emin Pasha Gulf (ca 2°35'–2°41'S; 31°47'–31°59'E).

Holotype. RMNH.PISC.83573[3], ♂, 60.3 mm SL, 23.vi.1985, HEST.

Paratypes. Collected by the *Haplochromis* Ecology Survey Team (HEST). Size of specimens given as standard length. RMNH.PISC.80480[4], ♂, 53.6 mm, 23.vi.1985; RMNH.PISC.80481, ♂, 56.8 mm, 23.vi.1985; RMNH.PISC.80482[4], ♂, 63.4 mm, 23.vi.1985; RMNH.PISC.80483[4], ♂, 52.9 mm, 23.vi.1985; RMNH.PISC.80484[4], ♂, 65.3 mm, 23.vi.1985; RMNH.PISC.80485[4], ♂, 69.2 mm, 23.vi.1985; RMNH.PISC.80493[4], ♂, 50.7 mm, 23.vi.1985; RMNH.PISC.80494[4], ♂, 52.2 mm, 23.vi.1985; RMNH.PISC.80495[5], ♂, 58.7 mm, 23.vi.1985; RMNH.PISC.80496[5], ♂, 57.4 mm, 23.vi.1985; RMNH.PISC.80497[5], ♂, 55.0 mm, 23.vi.1985; RMNH.PISC.80498[5], ♂, 60.4 mm, 23.vi.1985; RMNH.PISC.80499[5], ♂, 67.4 mm, 23.vi.1985; RMNH.PISC.80501[5], ♂, 61.1 mm, 23.vi.1985; RMNH.PISC.80502[5], ♂, 62.6 mm, 23.vi.1985; RMNH.PISC.80503[5], ♂, 57.7 mm, 23.vi.1985; RMNH.PISC.80507[5], ♂, 52.8 mm, 23.vi.1985; RMNH.PISC.80508[5], ♂, 62.9 mm, 23.vi.1985; RMNH.PISC.80512[5], ♂, 59.3 mm, 23.vi.1985; RMNH.PISC.80513[5], ♂, 63.6 mm, 23.vi.1985; RMNH.PISC.80514[5], ♂, 61.7 mm, 23.vi.1985; RMNH.PISC.83574[3], ♂, 62.6 mm, 23.vi.1985; RMNH.PISC.83575[4], ♂, 57.5 mm, 23.vi.1985; RMNH.PISC.83576, ♂, 58.2 mm, 23.vi.1985; RMNH.PISC.83577[3], ♂, 62.5 mm, 23.vi.1985; RMNH.PISC.83578[3], ♂, 69.2 mm, 23.vi.1985; RMNH.PISC.83579[3], ♂, 64.9 mm, 23.vi.1985; RMNH.PISC.83580[3], ♂, 62.9 mm, 23.vi.1985; RMNH.PISC.83581[3], ♂, 51.7 mm, 23.vi.1985; RMNH.PISC.83582[3], ♂, 52.4 mm, 23.vi.1985; RMNH.PISC.83583[3], ♂, 57.7 mm, 23.vi.1985; RMNH.PISC.83584[3], ♂, 55.4 mm, 23.vi.1985; RMNH.PISC.83585[3], ♂, 61.9 mm, 23.vi.1985; RMNH.PISC.83586[3], ♂, 65.4 mm, 23.vi.1985; RMNH.PISC.83664[3], ♂, 56.2 mm, 23.vi.1985; RMNH.PISC.83665[3], ♂, 63.2 mm, 23.vi.1985; RMNH.PISC.83666[3], ♂, 65.5 mm, 23.vi.1985; RMNH.PISC.83667[3], ♂, 60.7 mm, 23.vi.1985; RMNH.PISC.83668[3], ♂, 64.9 mm, 23.vi.1985; RMNH.PISC.83669[3], ♂, 65.8 mm, 23.vi.1985; RMNH.PISC.83670[3], ♂, 60.0 mm, 23.vi.1985; RMNH.PISC.83695[1, 2, 4], ♂, 56.2 mm, 23.vi.1985; RMNH.PISC.83696[1, 4], ♂, 58.0 mm, 23.vi.1985; RMNH.PISC.83699[1,

[5], ♂, 61.5 mm, 23.vi.1985; RMNH.PISC.83700[1, 5], ♂, 55.3 mm, 23.vi.1985; RMNH.PISC.83701[2, 5], ♂, 61.6 mm, 23.vi.1985; RMNH.PISC.83702[1, 2, 5], ♂, 61.1 mm, 23.vi.1985; AMNH 255036[5], ♂, 61.4 mm, 23.vi.1985; BMNH 2012.1.5.3[4], ♂, 61.6 mm, 22.vi.1985; NSMT-P 106960[4], ♂, 64.8 mm, 22.vi.1985.

[1] dissected to describe the oral jaws and contents of stomachs and intestines; [2] dissected to describe pharyngeal jaws and to count gill filaments; [3] proportional measurements taken; [4] colour picture available; [5] colour picture of anal fin available.

Diagnosis. Small sized (< 7 cm SL), slender (BD < 28% SL), micrognathic, zooplanktivorous *Hapolochromis* species (LJL < 45% HL in all but one specimens) with a slightly curved to straight dorsal head profile. Mainly bicuspid teeth in oral jaws. Generally premaxillary dentigerous arm edentulous over caudal $^1/_5$ - $^1/_4$. Males silvery with dusky flush on chest, flank, ventral side and ventral half of caudal peduncle.

Description. Proportional measurements of type material provided in Table 3.

Habitus. See Fig. 6. Body slender. Dorsal head profile straight to slightly curved. Premaxillary pedicel slightly prominent. Mouth oblique. Lips not thickened. Medial part of premaxilla slightly expanded to expanded. Caudal part of maxilla not bullate. Vertical through caudal tip of maxilla running through iris, just rostral to pupil. Lateral snout outline isognathous and obtuse, in large specimens sometimes slightly prognathous. Jaws equal anteriorly or lower jaw slightly protruding. Mental prominence slightly pronounced. Retro-articular processes of right and left mandible touching each other, interrupting ventral body outline. Eye approximately circular (occasionally slightly elongated) and medium to large in size. Distinct aphakic aperture present in pupil. Cephalic lateral line pores not enlarged.

Scales. Cheek, gill cover, and rostral part of the dorsal head surface with cycloid scales. Nape and rostral part of dorsum with a mixture of cycloid and weakly ctenoid scales. Chest mainly with ctenoid scales, occasionally weakly ctenoid or cycloid. Scales on remaining part of body mainly ctenoid. Scales on chest smaller than those on ventral and ventro-lateral part of body; size transition gradual. Small elongated scales on basal quarter to one third of caudal fin. Four to 5.5 (mode 5) scales between upper lateral line and dorsal-fin origin, four to seven (mode 6) between between pectoral- and pelvic-fin bases.

Fins. Pelvic fins just reaching or slightly surpassing rostral-most point of anal-fin origin. Pelvic fins with first soft rays slightly produced, occasionally filamentous. Caudal tip of anal fin not reaching caudal-fin origin. Caudal-fin outline truncate to slightly emarginate.

Gill apparatus. Description of gill apparatus based on lateral gill rakers and lateral hemibranch of first gill arch. Number of gill rakers on lower part of first gill arch 10–12 (one specimen with 13). Lower two to three rakers reduced (= very short), next one to two short, followed by two to seven slender and longer ones. Remaining rakers hooked, bifid, or trifid. Generally rakers closely set, viz. touching each other over major part of length. Number of gill filaments 87 to 93.

Viscera. Ratio between intestine length and SL: 1.0–1.2 (n = 5).

Oral jaws. (Fig. 7 A,B) Premaxillary ascending arm equal to or longer than dentigerous arm (asc./dent. arm ratio 1.0 to 1.1). Angle between arms 77° to 81°. Symphyseal articulation facet not present, lower jaw slightly more elongated than generalized

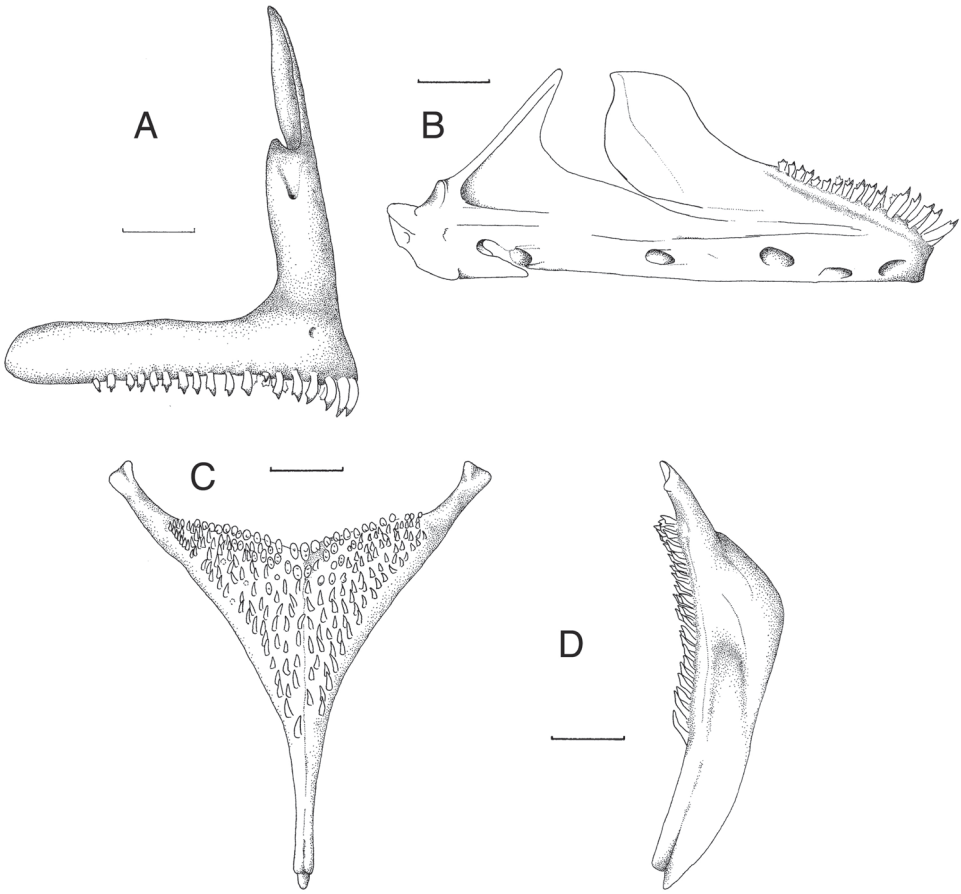


Figure 7. Skeletal elements of *Haplochromis goldschmidti* sp. n. **A** Right premaxilla, lateral view (RMNH.PISC.83695) **B** Right lower jaw, lateral view (RMNH.PISC.83695) **C** Lower pharyngeal element, dorsal view (RMNH.PISC.83701) **D** Lower pharyngeal element, lateral view (RMNH.PISC.83701). Scale bars equal 1 mm. Drawn by I. Westbroek.

type (length/height ratio 2.3 to 2.8). Upper half of dentary with distinct outwardly directed flare. Mental prominence slightly pronounced.

Oral teeth shape. (Fig. 7 A,B) Teeth of outer row in both jaws mainly bicuspid, with some unicuspid or tricuspid teeth interspersed. Major cusp of bicuspids isoscelene to subequilateral, protracted and acutely pointed. Flange occasionally present on major cusp. Minor cusp short compared to major cusp. Cusp gap rather narrow. In labial view neck moderately slender to normal, crown moderately expanded. In lateral view, crown compressed. Outer-row teeth in both premaxilla and lower jaw recurved. Inner rows in both jaws with mainly tricuspid or weakly tricuspid teeth.

Oral teeth size. Outer-row teeth relatively slender, gradually decreasing in size from rostral to caudal.

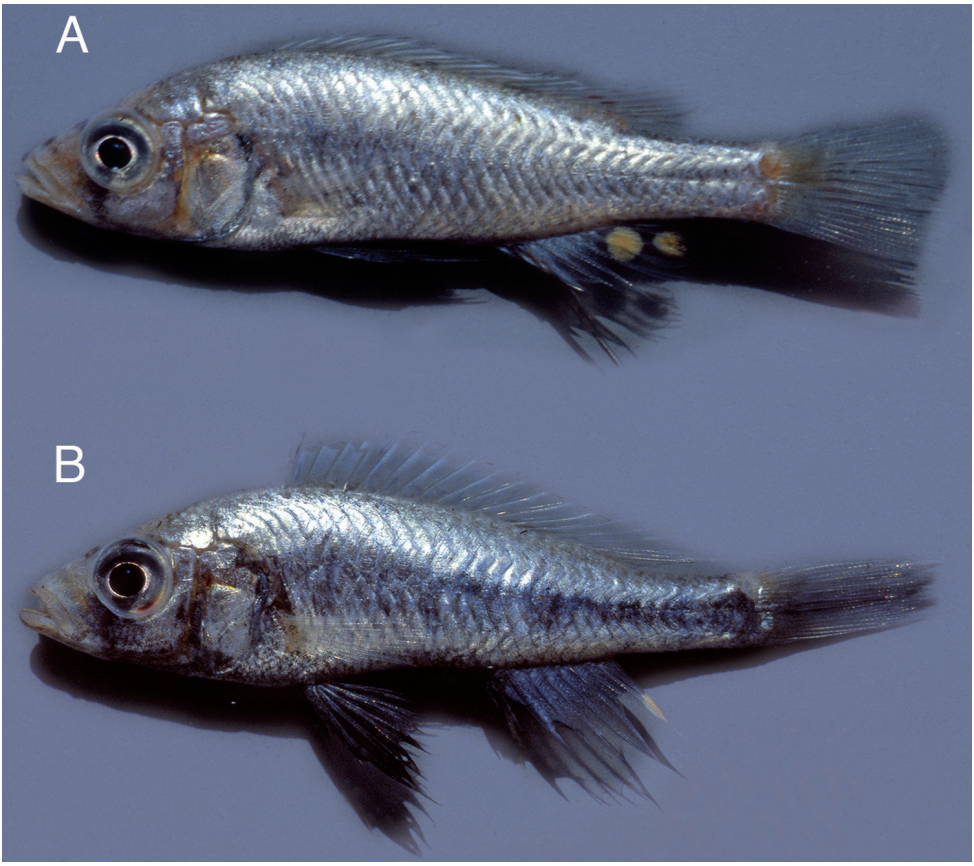


Figure 8. Live colours of *Haplochromis goldschmidti* sp. n. **A** sexually active ♂, 53.6 mm SL (paratype, RMNH.PISC.80480) **B** sexually active ♂, 57.5 mm SL (paratype, RMNH.PISC.83575).

Dental arcade and tooth band. Rostrally dental arcade rounded. Outer row occupying $^{3}/_{4}$ to $^{4}/_{5}$ of premaxillary dentigerous arm. One to two inner rows in both jaws.

Teeth counts and setting. Outer row of upper jaw (l+r premaxilla) with 33–47 teeth. In both jaws outer-row teeth regularly set. Teeth set wider rostrally than laterally.

Tooth implantation. Outer-row teeth of premaxilla rostrally erect. Inner-row teeth recumbent. Outer-row teeth of lower jaw slightly procumbent, inner-row teeth erect.

Lower pharyngeal element. (Fig. 7 C,D) Lower pharyngeal element relatively small and slender (length/width ratio 1.2–1.3). Dentigerous area slightly broader than long (length/width ratio 0.7–0.9). Suture straight.

Pharyngeal teeth counts. Caudal-most transverse row with 25–34 teeth, medial longitudinal rows with nine to 10 teeth.

Pharyngeal teeth shape. Teeth in caudal-most transverse row hooked, major cusp only slightly incurved, blunt to slightly acute. Other teeth bevelled or pronounced. All teeth relatively fine and slender, medial teeth not coarser than other teeth.

Figure 9. Preserved colours of *Haplochromis goldschmidti* sp. n. ♂ 60.3 mm SL (holotype, RMNH. PISC.83573). Scale bar equals 10 mm.

Vertebrae. Total number of vertebrae in 19 specimens: 30 (2), 31 (16) or 32 (1), comprising 13–14 abdominal and 16–18 caudal vertebrae.

Live colouration males. (Fig. 8 A,B) Sexually active males with grey-white snout, cheek and gill cover. Lips grey-white, generally with distinct black pigment spots. Eye with grey outer ring and silver inner ring. Dorsal head surface and dorsum silvery-grey. Chest, ventral side, flank and ventral part of caudal peduncle silvery-grey with dusky flush. Flush most distinct on flank and caudal peduncle and occasionally absent on ventral side, sometimes extending over suboperculum, interoperculum, branchiostegal membrane and lower jaw.

Pelvic fins black. Anal fin rostrally hyaline-grey with bluish sheen, remaining part hyaline. One to two pale-yellow to yellow egg dummies surrounded by hyaline ring on caudal part of anal fin. Caudal fin hyaline with bluish sheen; dusky flush on caudal peduncle may extend over rostral part of caudal fin. Dorsal fin hyaline with bluish sheen and faint dusky lappets.

Dark grey to blackish markings: Faint nostril-, interorbital- and supraorbital stripes sometimes present. Lachrymal stripe occasionally slightly longer than in *H. argens*, but often less distinct. Preopercular vertical stripe generally not clear. Opercular blotch present.

Preserved colouration of males. (Fig. 9) Body light brown. Chest, ventral side, flank and ventral part of caudal peduncle dusky to dark brown. Dark brown colour on caudal peduncle sometimes giving impression of broad mid-lateral band. Fins transparent to light grey-brown except for pelvics, which are black in adult males. Same markings present as in live specimens.

Distribution. *Haplochromis goldschmidti* is only known from the southern part of the Emin Pasha Gulf of Lake Victoria (Fig. 1).

Habitat. *Haplochromis goldschmidti* was caught over mud bottoms at depths of 4–10 m.

Food. Stomach and intestines of five examined specimens caught by day contained mainly zooplankton (mainly copepods, but also some cladocerans) and some insects (*Chaoborus* larvae and pupae).

Breeding. Based on the egg dummies on the anal fin of males, *H. goldschmidti* is probably a female mouth brooder.

Etymology. This species is named in honour of Dr Tijs Goldschmidt in appreciation for his work on haplochromine cichlids of Lake Victoria. As a member of the *Haplochromis* Ecology Survey Team, Tijs Goldschmidt worked in Tanzania (1981–1986) on the ecology and evolution of zooplanktivorous and detritivorous cichlids. *Haplochromis goldschmidti* is one of the species on which he based his theory on the possible role of egg-dummy divergence in speciation of haplochromines (Goldschmidt and de Visser 1990). With "Darwin's Dreampond" (Goldschmidt 1996) - originally published as "Darwins Hofvijver" (Godschmidt 1994) and translated in eight languages - Tijs Goldschmidt started his career as a writer and brought the human-induced extinction of the Lake Victoria cichlids to the attention of a worldwide public. The specific epithet, *goldschmidti*, is a Latinized version (genitive case) of the surname.

Comparisons. Sexually active males of *H. goldschmidti* and *H. argens* are very similar, but distinguishable by live colouration. *Haplochromis goldschmidti* has a dusky flush on its flank and *H. argens* a yellow to greenish sheen. In contrast to *H. argens*, red is generally absent on the fins of *H. goldschmidti*, only occasionally very faint traces of red are present on the caudal and dorsal fins. *Haplochromis goldschmidti* has plain yellow egg spots, while the egg spots of *H. argens* are orange yellow (Goldschmidt and de Visser 1990). Generally, *H. goldschmidti* has more pigment spots on its lips than *H. argens*. The body depth in *H. goldschmidti* is less deep than in *H. argens*. The snout width, lachrymal width and lower jaw width are generally larger in *H. goldschmidti* (Tables 1, 3, 4).

Sexually active males of *H. goldschmidti* are distinguished from *H. tanaos* and *H. thereuterion*, two other slender zooplanktivores, by colouration. A distinct mid- and dorsal-lateral band is absent in males of *H. goldschmidti*, whereas they are present in *H. tanaos* and *H. thereuterion* (sometimes difficult to distinguish in the latter). A nape band is lacking in *H. goldschmidti*, but present in *H. tanaos*.

Comparison of species and populations

The MANCOVA of the linear measurements of males of *H. goldschmidti* and both populations of *H. argens* shows that SL is a significant covariate ($P < 0.001$), explaining the largest part of the variance ($F = 81.406$). The two species differ significantly (species effect, $P < 0.001$), and the same holds for the populations from the Mwanza Gulf and the Emin Pasha Gulf (location effect, $P = 0.007$), with the effect of species explaining more of the variance ($F = 9.262$) than the effect of location ($F = 2.494$). There is also a significant interaction between SL and location, however it does not explain much of the variance ($F = 2.545$).

From the ANCOVAs of the individual measurements, the adjusted means and their differences were calculated (Table 4).

There is a significant species effect in eight (BD, CPL, CFL, SnW, POW, LaW, POD and LJW) of the 18 measurements, and in three of these measurements (CPL, POW, POD) this is the only significant effect. The other measurements (BD, CFL, SnW, LaW and LJW) also differ significantly between the two populations of *H. argens* (= effect of location). In addition, for BD, a significant interaction ($P = 0.031$) between the effects of location

Table 4. Adjusted means (rounded to the nearest 0.1 mm), their differences (in %) and significance levels of the ANCOVAs of linear measurements. Both populations of *Haplochromis argens* are compared to *H. goldschmidti*. The mean values represent antilogged adjusted means calculated from the ANCOVA analyses (sample mean adjusted for a common mean standard length and a common regression line for the three groups). Adjusted means and differences are not applicable (NA) when the slopes of the relationships differ (i.e., in case of a significant interaction between location and SL). Estimated differences were calculated from adjusted means. Parameter estimates were derived from the GLM (analysis of covariance) procedure. Significance levels (*P*) of the effect of species (Spec.), location (Loc.) and the interaction between SL and location (Loc. * SL) are given when below 0.05.

	H. argens	***H. argens***	***H. goldsch***	***H. argens***	***H. argens***	**Spec.**	**Loc.**	**Loc. * SL**
	Mwanza	**Emin P**	**Emin P**	**Mwanza**	**Emin P**			
	Mean	**Mean**	**Mean**	**% diff.**	**% diff.**	**P**	**P**	**P**
BD	NA	NA	NA	NA	NA	< 0.001	0.041	0.031
PFL	17.6	16.9	16.9	4.1	0.0	ns	< 0.001	ns
CPL	12.9	12.9	12.4	3.3	3.3	0.012	ns	ns
CPD	6.3	6.0	6.0	5.5	0.0	ns	< 0.001	ns
CFL	15.0	14.6	15.1	-0.6	-3.2	0.007	0.016	ns
HL	20.4	20.4	20.4	0.0	0.0	ns	ns	ns
SnL	5.4	5.4	5.4	0.0	0.0	ns	ns	ns
SnW	5.1	4.8	5.3	-2.7	-9.0	< 0.001	< 0.001	ns
HW	NA	NA	NA	NA	NA	ns	< 0.001	< 0.001
IOW	4.3	4.2	4.2	2.7	0.0	ns	0.011	ns
POW	4.7	4.7	4.9	-3.5	-3.5	0.004	ns	ns
LaW	4.2	4.0	4.5	-7.3	-10.4	< 0.001	0.046	ns
POD	3.1	3.1	2.9	5.4	5.4	0.030	ns	ns
EyL	NA	NA	NA	NA	NA	ns	< 0.001	< 0.001
EyD	6.5	6.5	6.5	0.0	0.0	ns	ns	ns
ChD	3.5	3.1	3.1	11.7	0.0	ns	< 0.001	ns
LJL	NA	NA	NA	NA	NA	ns	0.039	0.040
LJW	2.8	2.6	2.8	-2.1	-9.1	0.001	0.003	ns

and SL indicate an increasing relative difference in BD (with increasing standard length) between the estimations for the populations from the different locations (Table 4, Fig. 10).

In the measurements, except for BD, in which there is a significant effect of species and location, the population of *H. argens* from the Emin Pasha Gulf differs more from *H. goldschmidti* than does the population of *H. argens* from the Mwanza Gulf. Especially in width measurements from the oral and suspensorial compartment, SnW, LaW and LJW, this is apparent (Fig. 10). In BD, *H. argens* from the Mwanza Gulf differs more from *H. goldschmidti* than does *H. argens* from the Emin Pasha Gulf (Fig. 10).

The effect of location is significant in 12 of the 18 measurements, and for PFL, CPD, IOW and ChD, this is the only significant effect; these measurements are significantly larger in *H. argens* from the Mwanza Gulf than in *H. argens* from the Emin Pasha Gulf and *H. goldschmidti*. In four measurements in which there is a significant effect of location, the two-way interaction is significant as well. For BD, HW and LJL, the relative difference between *H. argens* from the Mwanza Gulf and both *H. argens*

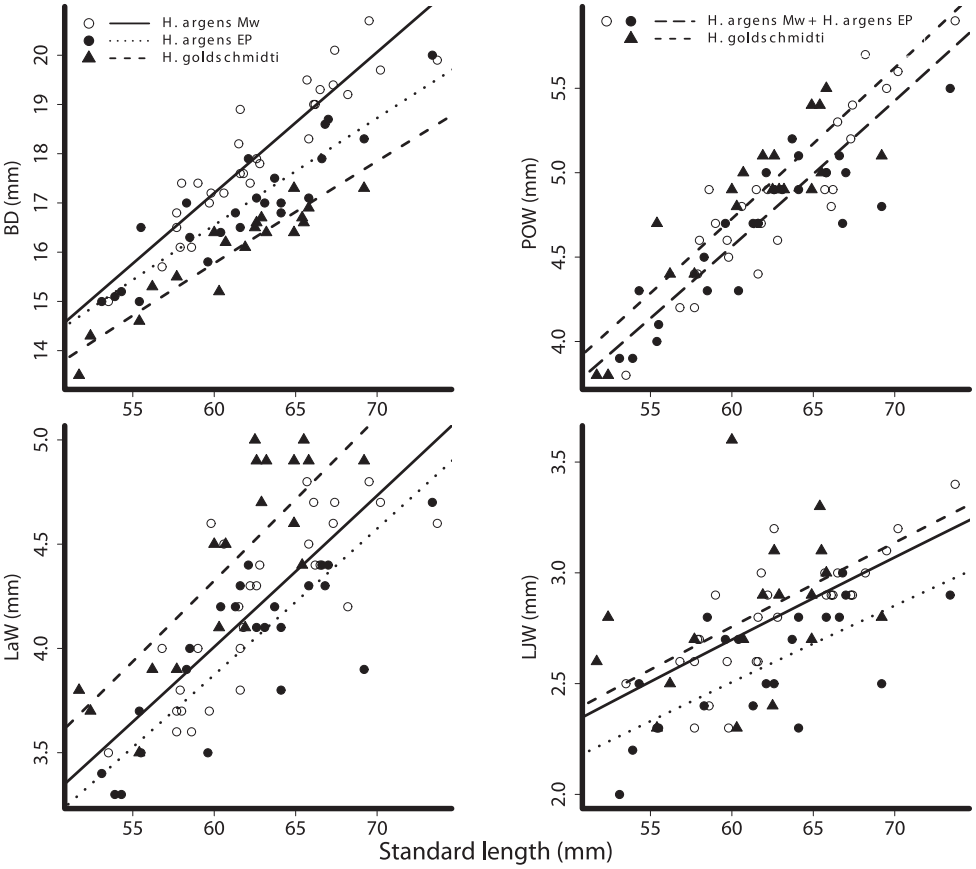


Figure 10. Plots of taxonomic measurements as a function of standard length. Body depth (BD), preorbital width (POW), lower jaw width (LJW) and lachrymal width (LaW). Open circles - *Haplochromis argens* from the Mwanza Gulf (Mw); closed circles - *H. argens* from the Emin Pasha Gulf (EP); triangles - *H. goldschmidti*. Power curves determined from GLM parameter estimates, solid line - *H. argens* from the Mwanza Gulf; dotted line - *H. argens* from the Emin Pasha Gulf; dashed line - *H. goldschmidti*, long dashed line (POW) - *H. argens* from both locations (MW + EP).

and *H. goldschmidti* from the Emin Pasha Gulf increases with SL. For EyL, however, the relative difference between *H. argens* from the Mwanza Gulf and both *H. argens* and *H. goldschmidti* from the Emin Pasha Gulf decreases with SL.

Discussion

Females of *H. goldschmidti*

In this paper, females of *H. goldschmidti* have not been described since it was difficult to distinguish the females from females of *H. argens* in the field. Samples of females,

which presumably contained both *H. argens* and *H. goldschmidti,* were collected during ecological surveys in the Emin Pasha Gulf, but unfortunately these samples were mislaid or may have been lost during the many moves of the material since its collection.

Specific status of *H. goldschmidti*

Since the field research of Greenwood (many papers bundled in 1981), male colouration has become a major character in species distinction of Lake Victoria cichlids. Indeed, experimental research has shown that male colouration plays a major role in female mate choice of Lake Victoria haplochromines (Seehausen and van Alphen 1998). However, Seehausen et al. (1998, 1999) also found some rock-dwelling species with a distinct polymorphism in breeding colours of sympatrically (and allopatrically) occurring males. These males did not differ in morphological characters, and mating experiments in tanks confirmed these colour polymorphisms (Seehausen and Bouton 1996; Seehausen et al. 1999). Nevertheless, we consider it unlikely that *H. argens* and *H. goldschmidti* represent an example of a species with male colour polymorphism, as apart from male body colouration there are at least four other presumably independent characters that differ in the two species (viz.: colour, position and number of egg spots (Goldschmidt and de Visser 1990); width measures of the head; body depth; differences in tooth shape). Based on the genotypic cluster species concept of Mallet (1995) it has been suggested that groups of haplochromine cichlids that differ in male nuptial colouration and one or more other characters that are likely to be genetically independent (e.g. dentition, body shape etc.) will be considered as different species (Seehausen et al. 1998). As will be clear from the comparison above, *H. argens* and *H. goldschmidti* fulfil these criteria.

Generic classification

Greenwood (1979, 1980) revised the Lake Victoria haplochromines and split them into more than 20 genera and subgenera. During the past decades there have been extensive debates on the validity of the genera defined by Greenwood (Hoogerhoud 1984; Meyer et al. 1990; Lippitsch 1993; Snoeks 1994; Seehausen 1996; van Oijen 1996; Seehausen et al. 1998). Because of the disagreements, and as a considerable number of the haplochromine species from Lake Victoria cannot be assigned to the "new" genera, we prefer to keep newly described species in the genus *Haplochromis* and add the generic names from Greenwood's revision of the Lake Victoria haplochromines (Greenwood 1979, 1980) between brackets in cases where the assignment is unequivocal.

In some studies *H. argens* has been assigned to *Yssichromis* (e.g. van Staaden et al. 1995; Chapman et al. 1995; Huber et al. 1997; Rosenberger and Chapman 2000; Melnychuk and Chapman 2002). However, even when adopting Greenwood's revision, for the following reasons we doubt whether this allocation to *Yssichromis* is correct.

According to Greenwood (1980: 24) "*Yssichromis* is an isolated lineage, defined by its autapomorphic features (shallow elongate body, and posteriorly edentulous premaxilla)". Though *H. argens* has a shallow, elongate body, it generally lacks a posteriorly edentulous premaxilla. Moreover, compared to the zooplanktivorous species assigned to *Yssichromis*, *H. argens* has a more piscivorous facies with some features that resemble those of *Prognathochromis*, e.g. a slightly prognathous lower jaw, a slightly pronounced mental prominence, the medial part of the premaxilla slightly expanded. Further, its oral teeth are longer and have a more protracted and acute major cusp than the teeth of the zooplanktivores that were assigned to *Yssichromis*. Greenwood (1980: 23) wrote concerning *Yssichromis*: "Superficially, members of this genus resemble the *Prognathochromis* lineage, especially members of the subgenus *Tridontochromis*. However, *Yssichromis* species retain several generalized features in the syncranium, and the lower jaw length is shorter, although some overlap does occur." The lower jaw of *H. argens* is indeed too short for the species to be recognized as *Prognathochromis* (viz. 37.6–44.3% of HL, mean 40.5% versus 41–62%, modal range 45–53%), and judging from the radiographs, the neurocranium is of the generalized type. Based on the information above, the position of *H. argens* seems to be between *Yssichromis* and *Prognathochromis.*

Haplochromis goldschmidti has the two autapomorphic characters of *Yssichromis* and can thus be referred to as *H. (Y.) goldschmidti*. However, in some characters it seems to bridge the gap between *H. argens* and the species of the *Yssichromis* group, as its teeth are longer than those of the latter, but shorter than those of *H. argens*, and it has the medial part of the premaxilla slightly expanded to expanded. Both *H. argens* and *H. goldschmidti* lack the typical arrangement of the inner rows in the lower jaw described for *H. (Y.) laparogramma*, *H. (Y.) pyrrhocephalus* and *H. (Y.) heusinkveldi* by Witte and Witte-Maas (1987). These species have a single inner row except for the rostro-lateral corner, where two inner rows are present.

Considering the resemblance between *H. argens* and *H. cassius*, the latter assigned to the genus *Psammochromis* by Greenwood (1980), we investigated whether *H. argens* could be assigned to this genus. The main apomorpic character for *Psammochromis*, a dentary with each ramus inflated anteriorly and antero-laterally (Greenwood 1980), has not been found in *H. argens* (and also not in *H. goldschmidti*). Other diagnostic characters for the genus, like thickened lips and a maximum adult size of 100–123 mm SL, have been found in neither *H. argens* nor in *H. goldschmidti*. So there are no arguments for assigning the species to *Psammochromis*.

Comparison of *H. goldschmidti* with the populations of *H. argens*

In some morphological characters (e.g. body depth), *Haplochromis goldschmidti* is more similar to the sympatric population of *H. argens* than to the allopatric population of the latter in the Mwanza Gulf, whereas for other characters (snout width, lower jaw width) the opposite is true. It has been found in earlier studies that local adaptations related to environmental conditions may cause similar morphological shifts in several

species of Lake Victoria haplochromines (Bouton et al. 1999, 2002). A recent study by van Rijssel and Witte (2012) revealed a decrease in body depth of two resurgent zooplanktivorous species in the Mwanza Gulf in the 1990s, which they associated with increased predation pressure by Nile perch in that period. Local environmental conditions may result in morphological similarity between sympatric populations of different species. On the other hand, competition for food might provide a tentative explanation for the greater difference in width of the snout area between *H. goldschmidti* and the sympatric population of *H. argens* in the Emin Pasha Gulf. However, to confirm this, information would be needed about their feeding habits in the areas where the two species coexist and where *H. argens* occurs alone.

Endangered species

Eight zooplanktivorous haplochromine species that were common on our research transect in the Mwanza Gulf (Goldschmidt et al. 1990) had virtually disappeared by 1987 (Witte et al. 1992b). However, since the early 1990s a gradual recovery has been observed for three of these species: *H. pyrrhocephalus*, *H. laparogramma* and *H. tanaos* (Seehausen et al. 1997b, Witte et al. 2000). Since 2005, these species are even more common than they used to be in the 1970s (Witte et al. 2007a, 2012a, Kishe-Machumu 2012). In contrast, the other five species, including *H. argens*, remain rare or are absent. In 2002, *H. argens* was observed for the first time since its disappearance in 1987, and since then it has been caught only occasionally in the Mwanza Gulf (Table 2) and in the Speke Gulf (Mizoiri et al. 2008) in spite of intensive sampling programmes. The catch per unit effort on the research transect has declined more than 50 times, and it is likely that the species is in danger of extinction. We are not sure of the conservation status of *H. goldschmidti*, as we did not sample the Emin Pasha Gulf, the only area from which the species is known, after 1986. This restricted distribution makes the species vulnerable in any case.

In the successfully recovering zooplanktivorous haplochromine species, morphological changes were observed, which may have been caused by adaptive responses to the environmental changes, both through natural selection and phenotypic plasticity (Wanink and Witte 2000, Witte et al. 2008, Chapman et al. 2008, van der Meer et al. 2012; van Rijssel and Witte 2012). In some cases (introgression through) hybridization may have also taken place among zooplanktivores (Mzighani et al. 2010). Van Rijssel and Witte (2012) found that several successfully resurgent haplochromine species had a smaller head-surface area/caudal-peduncle area than in the past, which aids in predator escape because it facilitates burst swimming (Langerhans 2010). In the not or poorly recovering zooplanktivorous species *H. heusinkveldi*, and *H. piceatus* Greenwood & Gee, 1969, the head-surface area/caudal-peduncle area changed in the opposite direction (van Rijssel and Witte 2012). A preliminary study of the few individuals that were collected in the Mwanza Gulf in the 2000s suggests that this also was the case in *H. argens*. These changes in the ratio between head surface

and caudal peduncle will be further studied when more material becomes available in the future. Obviously, the recovering zooplanktivores are of great interest for future research, and the species descriptions in this paper contribute to the taxonomic baseline for these studies.

Acknowledgements

We thank our colleagues from the *Haplochromis* Ecology Survey Team (HEST), the Tanzania Fisheries Research Institute (TAFIRI) and the Freshwater Fisheries Training Institute at Nyegezi, for support and co-operation during the fieldwork. We wish to thank Mhoja Kayeba, the late Aloys Peter, and the other crew members of the trawlers for their skilful labour, Abby Israëls for his help with the GLM, Mark van der Loo and Edwin de Jonge for their help with producing Fig. 10, and Erik-Jan Bosch, Bas Blankevoort and Niko Korenhof for making and/or digital processing of the other figures. We are indebted to Carole Baldwin, Jay Stauffer and Lodewijk van Duuren for carefully reviewing the manuscript. The fieldwork, during which the species and the ecological data described in this paper were collected, was financially supported by The Netherlands Foundation for the Advancement of Tropical Research (WOTRO; grants W87–129, W87–161, W87–189, W84–282, W84–488, WB84–587) and by the Section for Research and Technology of the Netherlands' Ministry of Development Co-operation.

References

Anker GCh, Dullemeijer P (1996) Transformation morphology on structures in the head of cichlid fishes. In: Datta Munsghi JS, Dutta HM (Eds) Fish Morphology – Horizon of New Research. Oxford & IBH Publishing, New Delhi, 1–20.

Balshine-Earn S (1995) The costs of parental care in Galilee St Peter's fish, *Sarotherodon galilaeus*. Animal Behaviour 50: 1–7. doi: 10.1006/anbe.1995.0214

Barel CDN (1983) Towards a constructional morphology of cichlid fishes (Teleostei, Perciformes). Netherlands Journal of Zoology 33: 357–424. doi: 10.1163/002829683X00183

Barel CDN (1985) A matter of space, constructional morphology of cichlid fishes. PhD Thesis, Leiden, the Netherlands: Leiden University.

Barel CDN (1993) Concepts of an architectonic approach to transformation morphology. Acta Biotheoretica 41: 345–381. doi: 10.1007/BF00709371

Barel CDN, Ligtvoet W, Goldschmidt T, Witte F, Goudswaard PC (1991) The haplochromine cichlids in Lake Victoria: an assessment of biological and fisheries interests. In: Keenleyside MHA (Ed) Cichlid Fishes, Behaviour, Ecology and Evolution. Chapman & Hall, London, 258–279.

Barel CDN, van Oijen MJP, Witte F, Witte-Maas ELM (1977) An introduction to the taxonomy and morphology of the haplochromine Cichlidae from Lake Victoria. Netherlands Journal of Zoology 27: 333–389.

Barel CDN, Witte F, van Oijen MJP (1976) The shape of the skeletal elements in the head of a generalized Haplochromis species: H. elegans Trewavas 1933 (Pisces, Cichlidae). Netherlands Journal of Zoology 26: 163–265. doi: 10.1163/002829676X00019

Bouton N, de Visser J, Barel CDN (2002) Correlating head shape with ecological variables in rock-dwelling haplochromines (Teleostei: Cichlidae) from Lake Victoria. Biological Journal of the Linnean Society 76: 39–48. doi: 10.1111/j.1095-8312.2002.tb01712.x

Bouton N, Witte F, van Alphen JJM, Schenk A, Seehausen O (1999) Local adaptations in populations of rock-dwelling haplochromines (Pisces: Cichlidae) from southern Lake Victoria. Proceedings of the Royal Society of London B 266: 355–360. doi: 10.1098/rspb.1999.0645

Carleton KL, Spady TC, Streelman JT, Kidd MR, McFarland WN, Loew ER (2008) Visual sensitivities tuned by heterochronic shifts in opsin gene expression. BioMed Central Biology 6: 22. doi: 10.1186/1741-7007-6-22

Chapman LJ, Chapman CA, Kaufman L, Witte F, Balirwa J (2008) Biodiversity conservation in African inland waters: lessons of the Lake Victoria region. Verhandlungen Internationale Vereinigung für theoretische und angewandte Limnologie 30: 16–34.

Chapman LJ, Kaufman LS, Chapman CA, McKenzie FE (1995) Hypoxia tolerance in twelve species of East African cichlids: potential for low oxygen refugia in Lake Victoria. Conservation Biology 9: 1274–1287. doi: 10.1046/j.1523-1739.1995.9051262.x-i1

Collin SP, Hart NS, Wallace KM, Shand J, Potter IC (2004) Vision in the southern hemisphere lamprey *Mordacia mordax*: Spatial distribution, spectral absorption characteristics, and optical sensitivity of a single class of retinal photoreceptor. Visual Neuroscience 21: 765–773. doi: 10.1017/S0952523804215103

de Visser J (2000) Tongue in cheek. A study in biological engineering of fish. PhD Thesis, Leiden, the Netherlands: Leiden University.

de Visser J, Barel CDN (1996) Architectonic constraints on the hyoid's optimal starting position for suction feeding of fish. Journal of Morphology 228: 1–18. doi: 10.1002/(SICI)1097-4687(199604)228:1<1::AID-JMOR1>3.0.CO;2-B

Goldschmidt T (1989a) An ecological and morphological field study on the haplochromine cichlid fishes (Pisces, Cichlidae) of Lake Victoria. PhD Thesis, Leiden, the Netherlands: Leiden University.

Goldschmidt T (1989b) Reproductive strategies, subtrophic niche differentiation and the role of competition for food in haplochromine cichlids (Pisces) from Lake Victoria, Tanzania. Annalen van het Koninklijk Museum voor Midden-Afrika, Zoologische Wetenschappen 257: 119–132.

Goldschmidt T (1991) Egg mimics in haplochromine cichlids (Pisces, Perciformes) from Lake Victoria. Ethology 88: 177–190. doi: 10.1111/j.1439-0310.1991.tb00273.x

Goldschmidt T (1994) Darwins Hofvijver. Uitgeverij Prometheus, Amsterdam, 286 pp.

Goldschmidt T (1996) Darwin's Dreampond. MIT Press, Cambridge, Massachusetts, 277 pp.

Goldschmidt T, de Visser J (1990) On the possible role of egg mimics in speciation. Acta Biotheoretica 38: 125–134. doi: 10.1007/BF00047549

Goldschmidt T, Witte F (1990) Reproductive strategies of zooplanktivorous haplochromine species (Pisces, Cichlidae) from Lake Victoria before the Nile perch boom. Oikos 58: 356–368. doi: 10.2307/3545227

Goldschmidt T, Witte F (1992) Explosive speciation and adaptive radiation of haplochromine cichlids from Lake Victoria: an illustration of the scientific value of a lost species flock. Mitteilungen Internationale Vereinigung für theoretische und angewandte Limnologie 23: 101–107.

Goldschmidt T, Witte F, de Visser J (1990) Ecological segregation of zooplanktivorous haplochromine species (Pisces, Cichlidae) from Lake Victoria. Oikos 58: 343–355. doi: 10.2307/3545226

Goldschmidt T, Witte F, Wanink JH (1993) Cascading effects of the introduced Nile perch on the detritivorous/phytoplanktivorous species in the sublittoral areas of Lake Victoria. Conservation Biology 7: 686–700. doi: 10.1046/j.1523-1739.1993.07030686.x

Gottfried MD (1986) Developmental transition in feeding morphology of the Midas cichlid. Copeia 1986: 1028–1030. doi: 10.2307/1445308

Goudswaard K (PC), Witte F, Katunzi EFB (2008) The invasion of an introduced predator, Nile perch (*Lates niloticus*, L.) in Lake Victoria (East Africa): chronology and causes. Environmental Biology of Fishes 81: 127–139. doi: 10.1007/s10641-006-9180-7

Greenwood PH (1979) Towards a phyletic classification of the 'genus' *Haplochromis* and related taxa. Part I. Bulletin British Museum of natural History (Zoology) 35: 265–322.

Greenwood PH (1980) Towards a phyletic classification of the 'genus' *Haplochromis* and related taxa. Part II. Bulletin British Museum of natural History (Zoology) 39: 1–101.

Greenwood PH (1981) The Haplochromine Fishes of the East African Lakes. Kraus International Publications, München, 839 pp.

Greenwood PH, Barel CDN (1978) A revision of the Lake Victoria *Haplochromis* species (Pisces, Cichlidae), Part VIII. Bulletin British Museum of natural History (Zoology), 33: 141–192.

Hecky RE (1993) The eutrophication of Lake Victoria. Verhandlungen Internationale Vereinigung für theoretische und angewandte Limnologie 25: 39–48.

Hecky RE, Bugenyi FWB, Ochumba P, Talling JF, Mugidde R, Gophen M, Kaufman L (1994) Deoxygenation of the deep water of Lake Victoria, East Africa. Limnology and Oceanography 39: 1476–1481. doi: 10.4319/lo.1994.39.6.1476

Hecky RE, Mugidde R, Ramlal PS, Talbot MR, Kling GW (2010) Multiple stressors cause rapid ecosystem change in Victoria. Freshwater Biology 55 (1): 19–42. doi: 10.1111/j.1365-2427.2009.02374.x

Hilder ML, Pankhurst NW (2003) Evidence that temperature change cues reproductive development in the spiny damselfish, *Acanthochromis polyacanthus*. Environmental Biology of Fishes 66: 187–196. doi: 10.1023/A:1023601729203

Hoogerhoud RJC (1984) A taxonomic reconsideration of the haplochromine genera *Gaurochromis* Greenwood, 1980 and *Labrochromis* Regan, 1920 (Pisces, Cichlidae). Netherlands Journal of Zoology 34: 539–565. doi: 10.1163/002829684X00281

Hoogerhoud RJC, Witte F (1981) Revision of species from the 'Haplochromis' empodisma group. Netherlands Journal of Zoology 31: 232–273. doi: 10.1163/002829680X00258

Huber R, van Staaden MJ, Kaufman LS, Liem KF (1997) Microhabitat use, trophic patterns, and the evolution of brain structure in African cichlids. Brain, Behaviour and Evolution 50: 167–182. doi: 10.1159/000113330

Kaufman L (1992) Catastrophic change in species-rich freshwater ecosystems. BioScience 42: 846–858. doi: 10.2307/1312084

Kaufman L, Seehausen O (1995) Cichliden von der ugandischen und der kenianischen Victoriaseeküste. In: Stawikowski R (Ed) Cichliden, Festschrift zum 25jährigen Jubiläum der DCG. Deutsche Cichliden-Gesellschaft, Frankfurt am Main, 147–151.

Katunzi EFB, Zoutendijk J, Goldtschmidt T, Wanink JH, Witte F (2003) Lost zooplanktivorous cichlid from Lake Victoria reappears with a new trade. Ecology of Freshwater Fish 12: 237–240. doi: 10.1046/j.1600-0633.2003.00023.x

Kishe-Machumu MA (2012) Inter-guild differences and possible causes of the recovery of cichlid species in Lake Victoria, Tanzania. PhD Thesis, Leiden, the Netherlands: Leiden University.

Kishe-Machumu M, Witte F, Wanink JH (2008) Dietary shift in benthivorous cichlids after the ecological changes in Lake Victoria. Animal Biology 58: 401–417. doi: 10.1163/157075608X383700

Langerhans RB (2010) Predicting evolution with generalized models of divergent selection: a case study with poeciliid fish. Integrative and Comparative Biology 50: 1167–1184. doi: 10.1093/icb/icq117

Lippitsch E (1993) A phyletic study on lacustrine haplochromine fishes (Perciformes, Cichlidae) of East Africa, based on scale and squamation characters. Journal of Fish Biology 42: 903–946. doi: 10.1111/j.1095-8649.1993.tb00399.x

Mallet J (1995) A species definition for the modern synthesis. Trends in Ecology & Evolution 10: 294–299. doi: 10.1016/0169-5347(95)90031-4

Melnychuk MC, Chapman LJ (2002) Hypoxia tolerance of two haplochromine cichlids: swamp leakage and potential for interlacustrine dispersal. Environmental Biology of Fishes 65: 99–110. doi: 10.1023/A:1019602403098

Meyer A, Kocher TD, Basasibwaki P, Wilson AC (1990) Monophyletic origin of Lake Victoria cichlid fishes suggested by mitochondrial DNA sequences. Nature 347: 550–553. doi: 10.1038/347550a0

Mizoiri S, Aibara M, Okada N (2008) Live Cichlids in the Southern Lake Victoria - Ongoing Speciation. (in Japanese) Report of Grant-in-Aid for Scientific Research on Priority Areas 2002–2007 from The Ministry of Education, Culture, Sports, Science and Technology (Japan). Kougakutosho Ltd., Tokyo, 278 pp.

Mzighani SI, Nikaido M, Takeda M, Seehausen O, Budeba YL, Ngatunga BP, Katunzi EFB, Aibara M, Mizoiri S, Sato T, Tachida H, Okada N (2010) Genetic variation and demographic history of the *Haplochromis laparogramma* group of Lake Victoria. An analysis based on SINEs and mitochondrial DNA. Gene 450: 39–47. doi: 10.1016/j.gene.2009.10.002

Niemantsverdriet P (2005) Victoriacichliden houden en kweken in het laboratorium. Cichlidae 31: 150–156.

Ogutu-Ohwayo R (1990) The decline of the native fishes of Lakes Victoria and Kyoga (East Africa) and the impact of introduced species, especially the Nile perch, *Lates niloticus* and the Nile tilapia, *Oreochromis niloticus*. Environmental Biology of Fishes 27: 81–96. doi: 10.1007/BF00001938

Rinkes M (1999) Conflicts in cichlid head morphology due to optimization of functional demands on suction feeding. PhD Thesis, Leiden, the Netherlands: Leiden University.

Rosenberger AE, Chapman LJ (2000) Respiratory characters of three species of haplochromine cichlids: Implications for use of wetland refugia. Journal of Fish Biology 57: 483–501. doi: 10.1111/j.1095-8649.2000.tb02187.x

Seehausen O (1995) Cichliden von der tansanischen Victoriasee-Küste. In: Stawikowski, R (Ed) Cichliden, Festschrift zum 25jährigen Jubiläum der DCG. Deutsche Cichliden-Gesellschaft, Frankfurt am Main, 143–146.

Seehausen O (1996) Lake Victoria Rock Cichlids: Taxonomy, Ecology and Distribution. Verduijn Cichlids, Zevenhuizen, 304 pp.

Seehausen O, Bouton N (1996) Polychromatism in rock dwelling Lake Victoria cichlids: types, distribution, and observations on their genetics. In: Konings A. (Ed) The Cichlids Yearbook, volume 6. Cichlid Press, 36–45.

Seehausen O, Lippitsch E, Bouton N, Zwennes H (1998) Mbipi, the rock-dwelling cichlids of Lake Victoria: description of three new genera and fifteen new species (Teleostei). Ichthyological Explorations of Freshwaters 9: 129–228.

Seehausen O, van Alphen JJM (1998) The effect of male colouration on female mate choice in closely related Lake Victoria cichlids (*Haplochromis nyererei* complex). Behavioural Ecology and Sociobiology 42: 1–8. doi: 10.1007/s002650050405

Seehausen O, van Alphen JJM, Lande R (1999) Color polymorphism and sex ratio distortion in a cichlid fish as an incipient stage in sympatric speciation by sexual selection. Ecology Letters 2: 367–378.

Seehausen O, van Alphen JJM, Witte F (1997a) Cichlid fish diversity threatened by eutrophication that curbs sexual selection. Science 277: 1808–1811. doi: 10.1126/science.277.5333.1808

Seehausen O, van Alphen JJM, Witte F (2003) Implications of eutrophication for fish vision, behavioral ecology and species coexistence: A theoretical framework. In: Crisman TL, Chapman LJ, Chapman CA, Kaufman LS (Eds) Conservation, Ecology, and Management of African Fresh Waters. University Press of Florida, Florida, 268–287.

Seehausen O, Witte F (1995) Extinction of many and survival of some: the current situation of the endemic cichlids in southern Lake Victoria. Tropical Fish Hobbyist 43 (7): 96–105.

Seehausen O, Witte F, Katunzi EF, Smits J, Bouton N (1997b) Patterns of the remnant cichlid fauna in southern Lake Victoria. Conservation Biology 11: 890–904. doi: 10.1046/j.1523-1739.1997.95346.x

Smit SA, Anker GCh (1997) Photopic sensitivity to red and blue light related to retinal differences in two zooplanktivorous haplochromine species (Teleostei, Cichlidae). Netherlands Journal of Zoology 47: 9–20. doi: 10.1163/156854297X00201

Smith C, Wootton RJ (1994) The cost of parental care in *Haplochromis* 'argens' (Cichlidae). Environmental Biology of Fishes 40: 99–104. doi: 10.1007/BF00002184

Smith C, Wootton RJ (1995) The costs of parental care in teleost fishes. Reviews in Fish Biology and Fisheries 5: 7–22. doi: 10.1007/BF01103363

Snoeks J (1994) The haplochromines (Teleostei, Cichlidae) of Lake Kivu (East Africa). A taxonomic revision with notes on their ecology. Annalen van het Koninklijk Museum voor Midden-Afrika, Zoologische Wetenschappen 270: 1–221.

Tacon P, Baroiller JF, Le Bail PY, Prunet P, Jalabert B (2000) Effect of egg deprivation on sex steroids, gonadotropin, prolactin, and growth hormone profiles during the reproductive cycle of the mouthbrooding cichlid fish *Oreochromis niloticus*. General and Comparative Endocrinology 117: 54–65. doi: 10.1006/gcen.1999.7388

van der Meer HJ (1989) Ecological significance of retinal receptor patterns in 4 sympatric haplochromine cichlids. Annalen van het Koninklijk Museum voor Midden-Afrika, Zoologische Wetenschappen 257: 51–56.

van der Meer HJ (1991a) Determination of photopic thresholds in two sympatric cichlids using optomotor response. Annalen van het Koninklijk Museum voor Midden-Afrika, Zoologische Wetenschappen 263: 91–96.

van der Meer HJ (1991b) Ecomorphology of photoreception in haplochromine cichlid fishes. PhD Thesis, Leiden, the Netherlands: Leiden University.

van der Meer HJ (1995) Visual resolution during growth in cichlid fish: A morphological and behavioural case study. Brain, Behaviour and Evolution 45: 25–33. doi: 10.1159/000113383

van der Meer HJ, Bowmaker JK (1995) Interspecific variation of photoreceptors in four coexisting haplochromine cichlid fishes. Brain, Behaviour and Evolution 45: 232–240. doi: 10.1159/000113552

van der Meer HJ, Anker GCh, Barel CDN (1995) Ecomorphology of retinal structures in zooplanktivorous haplochromine cichlids (Pisces) from Lake Victoria. Environmental Biology of Fishes 44: 115–132. doi: 10.1007/BF00005910

van der Meer HJ, van Rijssel JC, Wagenaar LC, Witte F (2012) Photopic adaptations to a changing environment in two Lake Victoria cichlids. Biological Journal of the Linnean Society 106: 328–341. doi: 10.1111/j.1095-8312.2012.01859.x

van Oijen MJP, Witte F (1996) Taxonomical and ecological description of a species complex of zooplanktivorous and insectivorous cichlids from Lake Victoria. Zoologische Verhandelingen Leiden 302: 1–56.

van Oijen MJP (1996) The generic classification of the haplochromine cichlids of Lake Victoria, East Africa. Zoologische Verhandelingen Leiden 302: 57–110. http://www.repository.naturalis.nl/document/148949

van Rijssel JC, Witte F (2012) Adaptive responses in resurgent Lake Victoria cichlids over the past 30 years. Evolutionary Ecology. doi: 10.1007/s10682-012-9596-9

van Staaden MJ, Huber R, Kaufman LS, Liem KF (1995) Brain evolution in cichlids of the African Great Lakes: brain and body size, general patterns, and evolutionary trends. Zoology 98: 165–178.

Verheijen E, van der Linden A-M, Decleir W (1989) The eye-lens proteins of haplochromine cichlids from Lake Victoria studied by isoelectric focusing. Annalen van het Koninklijk Museum voor Midden-Afrika, Zoologische Wetenschappen 257: 93–96.

Wanink JH (1998) The pelagic cyprinid *Rastrineobola argentea* as a crucial link in the disrupted ecosystem of Lake Victoria. PhD Thesis, Leiden, the Netherlands: Leiden University.

Wanink JH, Goldschmidt T, Witte F (1989) Recent changes in the zooplanktivorous-/insectivorous fish community from the Mwanza Gulf of Lake Victoria. In: Anonymous (Eds) WOTRO Report for the year 1988. Netherlands Foundation for the Advancement of Tropical Research, The Hague, the Netherlands: 22–28.

Wanink JH, Kashindye JJ, Goudswaard PC, Witte F (2001) Dwelling at the oxycline: does increased stratification provide a refugium for the Lake Victoria sardine *Rastrineobola argentea*? Freshwater Biology 46: 75–85. doi: 10.1111/j.1365-2427.2001.00644.x

Wanink JH, Witte F (1998) Niche shift in a zooplanktivorous cyprinid from Lake Victoria after reduction of its cichlid guild members by Nile perch. In: Wanink JH (1998) The pelagic cyprinid *Rastrineobola argentea* as a crucial link in the disrupted ecosystem of Lake Victoria. PhD Thesis, Leiden, the Netherlands: Leiden University, 157–167.

Wanink JH, Witte F (2000) The use of perturbation as a natural experiment: effects of predator introduction on the community structure of zooplanktivorous fish in Lake Victoria. Advances in Ecological Research 31: 553–570. doi: 10.1016/S0065-2504(00)31030-3

Witte F (1984a) Consistency and functional significance of morphological differences between wild-caught and domestic *Haplochromis squamipinnis* (Pisces, Ciclidae). Netherlands Journal of Zoology 34: 596–612. doi: 10.1163/002829684X00308

Witte F (1984b) Ecological differentiation in Lake Victoria haplochromines: comparison of cichlid species flocks in African Lakes. In: Echelle AA, Kornfield I (Eds), Evolution of Fish Species Flocks. Orono Press, University of Maine, Maine, 155–167.

Witte F (1987) From form to fishery. An ecological and taxonomical contribution to morphology and fishery of Lake Victoria cichlids. PhD Thesis, Leiden, the Netherlands: Leiden University.

Witte F, Barel CDN, van Oijen MJP (1997) Intraspecific variation of haplochromine cichlids from Lake Victoria and its taxonomic implications. South African Journal of Science 93: 585–594.

Witte F, Goldschmidt T, Goudswaard PC, Ligtvoet W, van Oijen MJP, Wanink JH (1992a) Species extinction and concomitant ecological changes in Lake Victoria. Netherlands Journal of Zoology 42: 214–232.

Witte F, Goldschmidt T, Wanink J, van Oijen M, Goudswaard K, Witte-Maas E, Bouton N (1992b) The destruction of an endemic species flock: quantitative data on the decline of the haplochromine cichlids of Lake Victoria. Environmental Biology of Fishes 34: 1–28. doi: 10.1007/BF00004782

Witte F, van der Meer H, Barel K (2003) Door cichlidenogen bezien: het belang van het gezichtsvermogen bij haplochromine cichliden voor het ontstaan en in stand houden van diversiteit. Cichlidae 29: 104–114.

Witte F, Msuku BS, Wanink JH, Seehausen O, Katunzi EFB, Goudswaard PC, Goldschmidt T (2000) Recovery of cichlid species in Lake Victoria: an examination of factors leading to differential extinction. Reviews in Fish Biology and Fisheries 10: 233–241. doi: 10.1023/A:1016677515930

Witte F, Seehausen O, Wanink JH, Kishe-Machumu M, Rensing M, Goldschmidt T (2012a) Cichlid species diversity in naturally and anthropogenically turbid habitats of Lake Victoria, East Africa. Aquatic Sciences 74. doi: 10.1007/s00027-012-0265-4

Witte F, Silsbe GM, Hecky RE, Goudswaard PC, Guildford SJ, Kishe-Machumu MA, Wanink JH (2012b) Did the loss of phytoplanktivorous fish contribute to algal blooms in the Mwanza Gulf of Lake Victoria? Hydrobiologia 679: 283–296. doi: 10.1007/s10750-011-0893-z

Witte F, Wanink JH (2000) De zoöplanktivore cichliden van het Victoriameer: ontdekking, verdwijning en terugkeer. Cichlidae 26: 77–84.

Witte F, Wanink JH, Kishe-Machumu M (2007a) Species distinction and the biodiversity crisis in Lake Victoria. Transactions of the American Fisheries Society 136: 1146–1159. doi: 10.1577/T05-179.1

Witte F, Wanink JH, Kishe-Machumu M, Mkumbo OC, Goudswaard PC, Seehausen O (2007b) Differential decline and recovery of haplochromine trophic groups in the Mwanza Gulf of Lake Victoria. Aquatic Ecosystem Health and Management 10: 416–433. doi: 10.1080/14634980701709410

Witte F, Wanink JH, Rutjes HA, van der Meer HJ, van den Thillart GEEJM (2005) Eutrophication and its influences on the fish fauna of Lake Victoria. In: Reddy VM (Ed) Restoration and Management of Tropical Eutrophic Lakes. Science publishers, Inc., Enfield (NH), 301–338.

Witte F, Welten M, Heemskerk M, van der Stap I, Ham L, Rutjes C, Wanink J (2008) Major morphological changes in a Lake Victoria fish within two decades. Biological Journal of the Linnean Society 94: 41–52. Doi: 10.1111/J.1095-8312.2008.00971.X

Witte F, Witte-Maas ELM (1981) Haplochromine cleaner fishes: a taxonomic and eco-morphological description of two new species. Netherlands Journal of Zoology 31: 203–231. doi: 10.1163/002829680X00249

Witte F, Witte-Maas ELM (1987) Implications for taxonomy and functional morphology of intraspecific variation in haplochromine cichlids of Lake Victoria. In: Witte F, From form to fishery, PhD Thesis, Leiden, the Netherlands: Leiden University. 1–83.

Zihler F (1982) Gross morphology and configuration of the digestive tract of Cichlidae (Teleostei, Perciformes): phylogenetic and functional significance. Netherlands Journal of Zoology 32: 544–571. doi: 10.1163/002829682X00210

ZooKeys 256: 35–79 (2013)
doi: 10.3897/zookeys.256.4272
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Revision of the *Agrilus occipitalis* species–group (Coleoptera, Buprestidae, Agrilini)

Eduard Jendek[1,†]

1 *Canadian Food Inspection Agency, K.W. Neatby Bldg., 960 Carling Avenue, Ottawa, Ontario, K1A 0C6, Canada*

† *urn:lsid:zoobank.org:author:963E83FF-C75C-41DC-AC42-22854A1D6C9A*

Corresponding author: *Eduard Jendek* (jendeke@gmail.com)

Academic editor: *L. Penev* | Received 8 November 2012 | Accepted 17 December 2012 | Published 3 January 2013

urn:lsid:zoobank.org:pub:DA644208-89A6-45CF-B488-7400B237F48D

Citation: Jendek E (2013) Revision of the *Agrilus occipitalis* species–group (Coleoptera, Buprestidae, Agrilini). ZooKeys 256: 35–79. doi: 10.3897/zookeys.256.4272

Abstract

The *Agrilus occipitalis* species–group is redefined and diagnosed. Two species from this group, *A. auriventris* Saunders, 1873 and *A. occipitalis* (Eschscholtz, 1822), are known as the serious pests of cultivated *Citrus* trees. Overall twenty-three taxa are included in the *A. occipitalis* species–group. A complete list of references, type material, species examined and distribution is given for each taxon. The host plants, adult occurrence and altitude range is cited for most taxa. Habitus of all taxa and aedeagi of available males are pictured. Images of primary type specimens are provided. A character state matrix table for diagnostic characters is given for all taxa to facilitate their determination.

The following new taxonomic and nomenclatural acts are proposed. **New species**: eight new species are described: *Agrilus mucidus* **sp. n.**, *A. nebulosus* **sp. n.**, *A. picturatus* **sp. n.**, *A. pluvius* **sp. n.**, *A. pseudoambiguus* **sp. n.**, *A. tesselatus* **sp. n.**, *A. trepanatus* **sp. n.** and *A. umrongso* **sp. n. Proposed synonyms**: eight synonyms are proposed: *celebicola* Obenberger, 1924, **syn. n.** (synonym of *occipitalis* Eschscholtz, 1822); *connexus* Kerremans, 1900, **syn. n.** (synonym of *occipitalis* Eschscholtz, 1822); *cupricauda* Saunders, 1867 **syn. n.** (synonym of *occipitalis* Eschscholtz, 1822); *evinadus* Gory & Laporte, 1839, **syn. n.** (synonym of *occipitalis* Eschscholtz, 1822); *nirius* Obenberger, 1924 syn. reconfirmed (synonym of *occipitalis* Eschscholtz, 1822); *oblatus* Kerremans, 1900, **syn. n.** (synonym of *occipitalis* Eschscholtz, 1822); *samoensis* Blair, 1928, **syn. n.** (synonym of *auriventris* Saunders, 1873); *tebinganus* Obenberger, 1924, **syn. n.** (synonym of *occipitalis* Eschscholtz, 1822). **New lectotype designations**: six lectotypes are designated: *Agrilus celebicola* Obenberger, 1924; *A. cupricauda* Saunders, 1867; *A. korenskyi* Obenberger, 1923; *A. kurandae* Obenberger, 1923; *A. nirius* Obenberger, 1924; *A. nitidus* Kerremans, 1898.

Keywords
Buprestidae, Agrilini, *Agrilus*, new species, synonymy, lectotype designation, *Citrus*, pest

Introduction

This publication presents the first comprehensive revision of the *Agrilus* taxa of the *occipitalis* species–group. The group was established and defined by Jendek and Grebennikov (2011) for seven species distributed in East Asia. With another sixteen taxa, including the eight new added in this work, the overall number of species of this group reaches twenty-three.

The state of species taxonomy has remained unrevised despite the fact that the two most serious pests in the citrus orchards *A. occipitalis* (Eschscholtz, 1822) and *A. auriventris* Saunders, 1873 belong to this group. Most of the species from the *A. occipitalis* species–group are distributed in South and Eastern Asia but some spread well beyond this area: *Agrilus diversornatus* Jendek, 2011 to Russian Far East; *A. occipitalis* and *A. biakanus* Curletti, 2006 to Australasia. The occurrence of the chronic *Citrus* pest *A. auriventris* in Polynesia and *A. occipitalis* in Micronesia is most likely an introduction.

Material and methods

The format of the taxonomic part, style of the new species descriptions and morphological terms follow those used in Jendek and Grebennikov (2011). Type data, type images and examined material published in Jendek and Grebennikov (2011) are omitted.

According to Article 74.7.3 of the ICZN (1999), lectotype designations after 1999 "*must contain an express statement of the taxonomic purpose of the designation*". Lectotype designations herein are provided in order to preserve the stability of nomenclature by fixing the status of the specimen as the sole name-bearing type of a particular nominal taxon. Lectotype designations were made with careful attention to previously accepted usage of a name.

Abbreviations for collections

BMNH The Natural History Museum, London, United Kingdom
EJCB Collection of E. Jendek, Bratislava, Slovak Republic [currently in Ottawa, Canada]
IZAS Institute of Zoology, Academia Sinica, Beijing, China
MNHN Muséum national d'Histoire Naturelle, Paris, France
NHMB Naturhistorisches Museum, Basel, Switzerland
NMPC National Museum (Natural History), Prague, Czech Republic
NSMT National Science Museum (Natural History), Tokyo, Japan
USNM National Museum of Natural History, Washington D.C., USA
ZIN Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia

Taxonomy

Agrilus occipitalis species–group

Diagnosis. Medium (>5 mm) or large species (>10 mm), body shape cuneiform or parallel. Head usually impressed medially with curved sculpture at both sides; eyes small or moderate. Pronotum with anteromedial, posteromedial and lateral impressions; rarely without apparent impressions. Prehumerus carinal or filamentary; rarely tubercular or obsolete. Elytra monochromatic or with elytral apices carmine; apices separately arcuate, rarely separately subtruncate; elytral pubescence fasciate or ornamental, rarely absent. Prosternal process flat, sides subparallel or dilated, rarely narrowed. Sexual dimorphism not obvious except for the longer ventral pubescence in male.

Distribution. East, South and Southeast Asia, Indonesia, Australasia, Oceania.

Host plants. Adoxaceae (*Sambucus*), Rutaceae (*Citrus*, *Euodia*, *Fagara*, *Zanthoxylum*), Rosacae (*Sorbaria*).

Within the *A. occipitalis* species–group seven subgroups can be recognized (Appendix):

A: elytral apices separately subtruncate

A. tesselatus-subgroup
Species: *A. tesselatus* sp. n.
Diagnostic characters: antennae very short, serrate from antennomere 5; pronotum obviously convex, without apparent impressions, maximum width of pronotum at posterior margin; groove on apex of last ventrite deeply sinuate; ovipositor square.

B: elytral apices separately subarcuate

B1: species with elytral apex pubescent and prosternal lobe predominantly emarginate.

A. perroti-subgroup
Species: *A. perroti* Descarpentries & Villiers, 1963, *A. umrongso* sp. n. and *A. zanthoxylumi* Li Meng Lou, 1989.
Diagnostic characters: body large or medium sized; head with deep medial longitudinal impressions; maximum width of pronotum at posterior margin, rarely at middle; elytral pubescence at least partly fasciate; apex of elytra pubescent and concolor with elytral disk; ovipositor prolonged.

A. auroapicalis-subgroup
Species: *A. auroapicalis* Kurosawa, 1957, *A. diversornatus* Jendek, 2011, *A. ishigakianus* Tôyama, 1985.

Diagnostic characters: body medium sized; head with deep medial longitudinal impressions; anterior pronotal lobe obvious; pronotum widest at posterior margin or at middle; prehumerus long, reaching to anterior pronotal angles, often joined with pronotal marginal carina; elytral pubescence at least partly fasciate; apex of elytra with strikingly different color than disk; prosternal lobe emarginate; apex of pygidium arcuate; groove on apex of last ventrite arcuate; ovipositor prolonged.

B2: species with prosternal lobe subtruncate or arcuate, elytral apex glabrous (except for *A. yamawakii*) and prosternal process often dilated.

***A. inamoenus*-subgroup**
Species: *A. inamoenus* Kerremans, 1892, *A. mucidus* sp. n., *A. pluvius* sp. n., *A. tonkineus* Kerremans, 1895
Diagnostic characters: body medium or large, robust; head with deep medial longitudinal impressions; pronotum widest at posterior margin or at middle; elytral pubescence mosaic or at least partly mosaic; apex of pygidium angulate or with short protrusion, rarely arcuate; apex of last ventrite smooth, without medial carinula; ovipositor square.

***A. ambiguus*-subgroup**
Species: *A. ambiguus* Kerremans, 1895, *A. picturatus* sp. n., *A. pseudoambiguus* sp. n.
Diagnostic characters: body medium sized, slender; head with medium or deep medial impressions; antennae long; pronotum widest in middle, rarely at anterior margin; elytral pubescence mosaic or at least partly mosaic; pygidium angulate, with protrusion or long spine; ovipositor prolonged.

***A. auriventris*-subgroup**
Species: *A. alesi* Obenberger, 1935, *A. auriventris* Saunders, 1873, *A. nebulosus* sp. n., *A. trepanatus* sp. n., *A. yamawakii* Kurosawa, 1957.
Diagnostic characters: body medium or large, robust; head with or without medial impression; pronotum widest at anterior margin or in middle, rarely at posterior margin; elytral pubescence fasciate or ornamental, rarely missing; elytral apex concolor with elytral disk, rarely indistinctly carmine; ovipositor prolonged.

***A. occipitalis*-subgroup**
Species: *A. biakanus* Curletti, 2006, *A. horniellus* Obenberger, 1935, *A. occipitalis* (Eschscholtz, 1822), *A. sordidulus* Obenberger, 1916.
Diagnostic characters: body medium, robust; head rarely without medial impression; pronotum widest in middle; elytral pubescence fasciate or ornamental, rarely missing; pygidium arcuate or with short protrusion, never with long spine; ovipositor prolonged.

Alphabetical list of species

Agrilus alesi Obenberger, 1935

http://species-id.net/wiki/Agrilus_alesi
Fig. 11 (habitus); Fig. 31 (aedeagus); Fig. 41 (pygidium)

alesi Obenberger, 1935 (*Agrilus*)
Obenberger 1935b: 164 (description) – Miwa and Chûjô 1936: 15 (catalog; Japan) – Obenberger 1936a: 940 (world catalog) – Kurosawa 1963: 152 (subspecies of *auriventris*; characters; Japan) – Chûjô 1970: 20 (subspecies of *auriventris*; checklist; faunal records; Japan (Loo-Choo Archipelago)) – Kurosawa 1974: 2-3 (characters; notes) – Tôyama 1985a: 24 (iconography; Japan) – Hirashima 1989: 322 (checklist; Japan) – Morimoto and Tadauchi 1995: 231 (checklist; Japan) – Akiyama and Ohmomo 1997: 28-29 (checklist; Japan: Ryukyus (Okinawa)) – Jendek 2006: 396 (Palaearctic catalog) – Bellamy 2008: 1960 (world catalog) – Jendek and Grebennikov 2011: 38-39 (lectotype designation; synonymy; references; faunal records; distributional summary; East Asia).
= *sacchari* Obenberger, 1940 (*Agrilus*)
Obenberger 1940: 175-176 (description) – Miwa and Chûjô 1940: 74 (cited as *sacchari*; faunal records; Okinawa: Loo-Choo) – Kurosawa 1974: 3 (subspecies of *alesi*; characters; notes) – Hirashima 1989: 322 (subspecies of *alesi*; checklist; Japan) – Peng Zhongliang 1994: 19 (faunal records; China) – Morimoto and Tadauchi 1995: 231 (subspecies of *alesi*; checklist; Japan) – Akiyama and Ohmomo 1997: 29 (subspecies of *alesi*; checklist; Japan) – Hua Li Zhong 2002: 90 (checklist; China: Sichuan) – Jendek 2006: 396 (subspecies of *alesi*; Palaearctic catalog) – Bellamy 2008: 1960 (subspecies of *alesi*; world catalog) – Jendek and Grebennikov 2011: 39 (synonym of *alesi*; lectotype designation).
= *aritai* Tôyama, 1985 (*Agrilus*)
Tôyama 1985b: 42-44 (description) – Tôyama 1985a: 25 (iconography; Japan) – Hirashima 1989: 322 (checklist; Japan) – Morimoto and Tadauchi 1995: 231 (checklist; Japan) – Akiyama and Ohmomo 1997: 29 (checklist; Japan: Ryukyus (Ishigaki-jima I.)) – Jendek 2006: 396 (Palaearctic catalog) – Bellamy 2008: 1976 (world catalog) – Jendek and Grebennikov 2011: 39 (synonym of *alesi*).

Type material. *Agrilus alesi* Obenberger, 1935. Type locality. Loo-choo: Okinawa. Lectotype designated by Jendek and Grebennikov (2011).

Agrilus sacchari Obenberger, 1940. Type locality. Insulae Loo-Choo; Okinawa. Lectotype designated by Jendek and Grebennikov (2011).

Agrilus aritai Tôyama, 1985. Type locality. Hirano, Ishigakijima Is. Holotype examined by Jendek and Grebennikov (2011).

Diagnosis. Size 7.2–8.5 mm. *Agrilus alesi* can be distinguished from closely related *A. auriventris* by the smaller size; by the more transverse pronotum with the maximum

Figures 1–12. Habitus of *Agrilus*: **1** *A. tesselatus* sp. n – Holotype **2** *A. perroti* Descarpentries & Villiers, 1963 **3** *A. umrongso* sp. n – Holotype **4** *A. zanthoxylumi* Li Meng Lou, 1989 **5** *A. auroapicalis* Kurosawa, 1957 **6** *A. auroapicalis ishigakianus* Tôyama, 1985 **7** *A. diversornatus* Jendek, 2011 – Holotype **8** *A. ambiguus* Kerremans, 1895 **9** *A. picturatus* sp. n – Holotype **10** *A. pseudoambiguus* sp. n – Holotype **11** *A. alesi* Obenberger, 1935 **12** *A. auriventris* Saunders, 1873.

width in the middle; by the obvious anterior pronotal lobe and by the pygidium with the long spine on apical margin (Fig. 41). See also Appendix.

Additional material. CHINA: 2 ♂, 1 ♀ (USNM): "CB [citrus borer?] adults, Chengtu, China, v.28.-vi.5. '[19]39, Kovlieu [Note: Chengtu may refer to many populated places in several provinces of China". JAPAN: Kyushu: 23 (USNM): "Kagoshima, Kyushu, 5-v-1940, F. Yano"; 2 ♂, 1 ♀ (USNM): "Kagoshima: Kyushu, Japan, 5-v-1940 (F. Yano)". For further records see Jendek and Grebennikov (2011).

Adult occurrence: 5–6–7–9.

Host plant. *Citrus*: Akiyama and Ohmomo (1997)**.**

Distribution. CHINA [provincial level unknown]. JAPAN: Kyushu; Ryukyu islands (Okinawa incl.).

***Agrilus ambiguus* Kerremans, 1895**

http://species-id.net/wiki/Agrilus_ambiguus

Fig. 8 (habitus); Fig. 28 (aedeagus)

ambiguus Kerremans, 1895 (*Agrilus*)

Kerremans 1895: 220-221 (description) – Kerremans 1903: 282 (catalog) – Jakobson 1913: 798 (synonym of *ambiguellus*; catalog) – Obenberger 1936a: 1072 (world catalog) – Jendek 2000: 502 (valid species; notes) – Jendek 2006: 396 (Palaearctic catalog) – Bellamy 2008: 1962 (world catalog) – Jendek 2012: 3 (lectotype designation).

= *ambiguellus* Kerremans, 1903 (*Agrilus*; unnecessary replacement name)

Kerremans 1903: 282 (unnecessary replacement name proposal) – Jakobson 1913: 798 (catalog; Russia and Europe) – Obenberger 1936a: 1072 (world catalog) – Kurosawa 1974: 3 (characters; notes) – Jendek 2000: 502 (synonym of *ambiguus*) – Jendek 2006: 396 (synonym of *ambiguus*; Palaearctic catalog) – Bellamy 2008: 1962 (synonym of *ambiguus*; world catalog).

Type material. *Agrilus ambiguus* Kerremans, 1895. Type locality. Sikkim: Kurseong. Lectotype designated by Jendek (2012).

Diagnosis. Size 6.7–10 mm. *Agrilus ambiguus* differs from the closely related *A. picturatus* sp. n. and *A. pseudoambiguus* sp. n. by having the head only feebly impressed medially; by the black vertex and by having elytral apices concolor with elytral disk (See also Appendix).

Additional material. INDIA: Assam: 1 ♀ (EJCB): "NE India, Assam, 1999, 5 km N of Umrongso, 700m, 25°27'N, 92°43'E, 17.-25.v., Dembický & Pacholátko leg.". Meghalaya: 7 (EJCB): "NE India, Meghalaya state, West Garo Hills, Nokrek Nat.Park, 9–17.V.1996 alt.1100+150m, GPS N25°29.6', E90°19.5' (WGS 84), E. Jendek & O. Šauša leg."; 7 (EJCB): "NE India, Meghalaya, 1400 m, Nokrek N.P., 3 km S Daribokgiri, 25°27'N, 90°19'E, 26.iv.1999, Dembický & Pacholátko leg.". 1 ♂ (EJCB): "NE India, Meghalaya, 1400 m, Nokrek N.P., 3 km S Daribokgiri, 25°27'N, 90°19'E, 26.iv.1999, J. Rolčík leg.". West Bengal: 2 (NMPC): "Darjeeling [labeled as

pescheti Obnb.; nomen nudum]". LAOS: Louang Namtha: 1 ♂, 2 ♀ (EJCB): "Laos, Louang Namtha pr., 21°09'N, 101°19'E, Namtha–Muang Sing, 5-31.v.1997, 900-1200 m, Vit Kubáň leg.". Phongsali: 1 ♂ (EJCB): "Lao-N, Phongsaly prov., 21°41'-2'N, 102°06'–08'E, 28.v.-20.vi.2003 Phongsaly env., ~1500m, Vít Kubáň leg."; 1 ♂ (EJCB): "Lao, Phongsaly prov. 21°41'N, 102°06'E Phongsaly env. 6–17.v.2004, 1500 m, P. Pacholátko leg.".

Adult occurrence: 4–5–6. **Altitude range**: 700–1500 m.

Host plant. Unknown.

Distribution. INDIA: Assam; Meghalaya; Sikkim; West Bengal. LAOS: Louang Namtha; Phongsali.

Agrilus auriventris Saunders, 1873

http://species-id.net/wiki/Agrilus_auriventris

Fig. 12 (habitus); Fig. 32 (aedeagus); Fig. 42 (pygidium)

auriventris Saunders, 1873 (*Agrilus*)

Saunders 1873: 517 (description) – Samouelle 1819: 9-17 [not seen] (biology; biocontrol; Japan) – Lewis 1879: 15 (catalog; Japan) – Kerremans 1885: 152 (catalog) – Schönfeldt 1887: 113 (*Anambus*; catalog; Japan) – Kerremans 1892: 248 (catalog) – Kerremans 1903: 282 (catalog) – Jakobson 1913: 798 (catalog; Russia and Europe) – Obenberger 1926: 659 (Palaearctic catalog) – Tanaka 1928: 1437-1444 [not seen] (pest; Japan) – Miwa 1931: 126 (catalog; Formosa) – Ogloblin and Reichardt 1932: 277 (pest) – Yuasa 1932: 653 (characters; Japan) – Yuasa 1933: 281 (larva) – Miwa and Chûjô 1936: 15 (catalog; Japan) – Obenberger 1936a: 958 (world catalog) – Chûjô and Matuda 1940: 65 (checklist; faunal records; Japan (Kyushu)) – Miwa 1940: 72 (checklist; Japan) – Yuasa 1949: 128 (characters; Japan) – Kurosawa 1950: 1115 – Mühlmann 1954: 83 (pest in Asia; biology) – Iga 1955: 78 (iconography; Japan) – Ter Minasyan 1955: 450 (notes) – Kurosawa 1956: 1115 (characters; Japan) – Shimizu et al. 1961: 57-59 (biology) – Yamamoto et al. 1961: 1-8 [not seen] (biology; pest) – Balachowsky et al. 1962: 286 (economic importance) – Iga 1962: 78 (iconography; Japan) – Isrigaya 1963: 351-355 (biology; larva; economic importance; treatment; Japan (Wakayama)) – Ohgushi 1963: 92-96 (pest; ovary and pre-oviposition period; Japan) – Woo Sheh Ming 1964: 61-71 (larval biology; protection; China: Chekiang) – Ohgushi 1966b: 361-366 [not seen] (biology; ecology; Japan) – Ohgushi 1966a: 55-63 (biology) – Yoshikawa et al. 1969: 178 (notes) – Guryeva 1974: 98 (pest of agriculture cultures; references) – Kurosawa 1974: 2, 3 (characters; notes) – Ohgushi 1978: 62-73 (population ecology; Japan: Nagasaki prefecture) – Tôyama 1985a: 24 (iconography; Japan) – Peng Zhongliang 1987: 354 (checklist; China) – Hirashima 1989: 322 (checklist; Japan) – Peng Zhongliang 1992: 398-399 (characters; notes; Hunan) – Morimoto and Tadauchi 1995: 231 (checklist; Japan) – Akiyama and Akiyama 1996: 184 (faunal records; Japan: Honshu) – Naka and

Ohashi 1996: 43-44 (occurrence; chemical control; Japan: Honshu) – Akiyama and Ohmomo 1997: 29-30 (checklist; Japan) – Hua Li Zhong 2002: 89 (checklist) – Lin Gui Rui 2002: 233 (checklist; pest) – Peng Zhongliang 2002: 268 (characters; Fujian) – Jendek 2006: 396 (Palaearctic catalog) – Shi Fu Ming et al. 2006: 724 (notes) – Wei et al. 2006: 302-308 (larval instars and characters; China: Zheijang) – Zheng et al. 2006: 806 (spatial distribution pattern; attacking strategy; China) – Huangfu et al. 2007: 682-688 (ovarian development; ovariole; oviposition duration; fecundity) – Wei et al. 2007: 79-84 (immature stages; chorion; hatching; pupation) – Bellamy 2008: 1985 (world catalog) – Hill 2008: 279, 539 (pest; control; life history) – Jendek and Grebennikov 2011: 46-47 (lectotype designation; synonymy; references; types; diagnosis; faunal records; host plants; distributional summary; East Asia).

= *graptelytrus* Obenberger, 1914 (*Agrilus*)

Obenberger 1914: 43 (in Czech), 48-49 (in German) (description) – Obenberger 1926: 654 (Palaearctic catalog) – Obenberger 1936a: 1084 (world catalog) – Descarpentries and Villiers 1963: 104, 118 (species incertae sedis) – Bellamy 2008: 2116 (world catalog) – Jendek and Grebennikov 2011: 46 (synonym of *auriventris*; lectotype designation).

= *fleutiauxi* Bourgoin, 1922 (*Agrilus*)

Bourgoin 1922: 23 (description) – Théry 1935a: 132 (faunal record; China) – Obenberger 1936a: 1083 (world catalog) – Descarpentries and Villiers 1963: 108, 118 (characters; faunal records; Tonkin; Formose; Chine: Hong-Kong, Kiangsi; Birmanie) – Jendek 2006: 398 (Palaearctic catalog) – Bellamy 2008: 2096 (world catalog) – Jendek and Grebennikov 2011: 46, 47 (synonym of *auriventris*; lectotype designation).

= *pidjinus* Obenberger, 1924 (*Agrilus*; cited as *podjinus* on page 53 and as *pidjinus* on page 58)

Obenberger 1924b: 53-54, 58 (description; [Note: Multiple original spelling: Precedence of the name *pidjinus* has been fixed by the original author (Obenberger 1926) as the first reviser (Article 24.2.4)]) – Obenberger 1926: 654 (Palaearctic catalog) – Obenberger 1936a: 1022 (world catalog) – Peng Zhongliang 1987: 357 (checklist; China) – Hua Li Zhong 2002: 90 (checklist; China: Hongkong) – Jendek 2006: 400 (Palaearctic catalog) – Bellamy 2008: 2235 (world catalog) – Jendek and Grebennikov 2011: 46, 47 (synonym of *auriventris*; lectotype designation).

= *samoensis* Blair, 1928 (*Agrilus*), **syn. n.**

Blair 1928: 108-109 (description) – Théry 1934: 148 – Obenberger 1936a: 1101 (world catalog) – Bellamy 2008: 2278 (world catalog).

Unavailable names

= *citri* Matsumura

Quayle 1938: 314 (biology; Formosa; [Note: Quayle attributed this name to Matsumara [= Matsumura] but his use of the name was not found and Quayle presented

no characters]) – Fang Zhigang and Wu Hong 2001: 80 (checklist; China: Zhejiang) – Hua Li Zhong 2002: 89 (synonym of *auriventris*) – Lin Gui Rui 2002: 233 (checklist; pest) – Jendek and Grebennikov 2011: 236 (unavailable name).

Type material. *Agrilus auriventris* Saunders, 1873. Type locality. Japan. Lectotype designated by Jendek and Grebennikov (2011).

Agrilus graptelytrus Obenberger, 1914. Type locality. China, Tonkin: Phu-long-thuan. Lectotype designated by Jendek and Grebennikov (2011).

Agrilus fleutiauxi Bourgoin, 1922. Type locality. not given [Note: Indo-Chine française is cited in the title of the publication]. Lectotype designated by Jendek and Grebennikov (2011).

Agrilus pidjinus Obenberger, 1924. Type locality. China: Hong-Kong. Lectotype designated by Jendek and Grebennikov (2011).

Agrilus samoensis Blair, 1928. Type locality. Upolu: Apia; Malololelei. Holotype (Fig. 61), ♀, (BMNH): "Type H. T. [p] [round label with red border] \ Samoan Is. [p] Upolu Malololelei 2000 ft, 28.xi.1924 [h] P. A. Buxton and G. H. Hopkins [p] \ Agrilus Samoensis Type Blr. [h] frt. K. G. Blair [p]". Paratypes: 1 paratype (MNHN); 1 paratype (BPBM). Described from 4 specimens (holotype, paratypes).

Diagnosis. Size: 5.0–8.8 mm. *Agrilus auriventris* can be distinguished from the most close *A. nebulosus* sp. n. by the pygidium which is angulate or armed with a short protrusion (Fig. 42). See also Appendix.

Additional material. CHINA: Guangxi: 1 (IZAS): "Guangxi, Longzhou, 140m, 1.v.1963, Y. Wang leg.". VIETNAM: 1 (IZAS): "Tonkin, Hoa Binh, vii.1931, A. De Cooman leg.". For further records see Jendek and Grebennikov (2011).

Adult occurrence: 4–5–6–7–8–10. **Altitude range:** 140–700 m.

Host plant. *Citrus* sp. For the detailed bibliography see Jendek and Grebennikov (2011).

Distribution. CHINA: Fujian; Guangdong; Guangxi; Hong Kong; Hubei; Hunan; Jiangxi; Sichuan; Taiwan; Zhejiang. JAPAN: Honshu; Kyushu. LAOS. MYANMAR. SAMOA. VIETNAM.

Agrilus auroapicalis Kurosawa, 1957

http://species-id.net/wiki/Agrilus_auroapicalis

Fig. 5 (habitus); Fig. 46 (Holotype)

auroapicalis Kurosawa, 1957 (*Agrilus*)

Kurosawa 1957: 190–191 (description) – Kurosawa 1974: 3-4 (characters; notes) – Tôyama 1985a: 24 (iconography; Japan) – Akiyama and Ohmomo 1997: 30 (checklist; Japan: Ryukyus; Taiwan) – Hua Li Zhong 2002: 89 (Kerremans is cited as the author; checklist; China: Taiwan) – Mühle 2003: 46 (checklist; Taiwan) – Jendek 2006: 396 (Palaearctic catalog) – Bellamy 2008: 1985 (world catalog) – Jendek 2012: 6 (synonymy).

= *laurenconi* Descarpentries & Villiers, 1963 (*Agrilus*)

Descarpentries and Villiers 1963: 104, 109 (description) – Bellamy 2008: 2161 (world catalog) – Jendek 2012: 6 (synonym of *laurenconi*).

Type material. *Agrilus auroapicalis* Kurosawa, 1957. Type locality. Mt. Nanjin-zan, Formosa. Holotype (Fig. 46) examined by Jendek (2012).

Agrilus laurenconi Descarpentries & Villiers, 1963. Type locality. Tonkin: Hoa-Binh. Holotype (Fig. 55) examined by Jendek (2012).

Diagnosis. Size 5.8–8.1 mm. *Agrilus auroapicalis* differs from the similar *A. diversornatus* mainly by the larger eyes, by pronotum widest in the middle and by pronotal lobe obviously arcuate. See also Appendix.

Additional material. CHINA: Guizhou: 1 ♀ (MNHN): "Kouy-Tchéou, R.P.J.R. Chaffanjon 1903". Taiwan: 1 (EJCB): "Meiyuan, Nantou Hsien, Taiwan, 5.v.1993, Luo Chinchi leg.". LAOS: Louangphrabang: 1 ♀ (EJCB): "Laos-N, 23.iv.1999, Louangphrabang prov. 20°42'N 102°54'E, 25 km E Muang Ngoy, 1000 m, Vít Kubáň leg.". VIETNAM: Gia Lai: 1 (EJCB): "S Vietnam, Gia Lai-Kon Tum pr., 5 km N Ankhé, 19.x.1979"; 1 (EJCB): "Vietnam, Gialai, Contum Tram Cap, 20.4.1995, Gorochov".

Adult occurrence: 4–5–10. **Altitude range:** 1000 m.

Host plant. Unknown.

Distribution. CHINA: Guizhou; Taiwan. LAOS: Louangphrabang. VIETNAM: Gia Lai; Hoa Binh.

Agrilus auroapicalis ishigakianus Tôyama, 1985

http://species-id.net/wiki/Agrilus_auroapicalis_ishigakianus

Fig. 6 (habitus); Fig. 27 (aedeagus)

ishigakianus Tôyama, 1985 (*Agrilus*; subspecies of *auroapicalis*)

Tôyama 1985a: 33-34 (description) – Hirashima 1989: 322 (subspecies of *auroapicalis*; checklist; Japan) – Morimoto and Tadauchi 1995: 231 (subspecies of *auroapicalis*; checklist; Japan) – Akiyama and Ohmomo 1997: 30 (subspecies of *auroapicalis*; checklist; Japan: Ryukyus (Ishigaki-jima I.)) – Jendek 2006: 396 (subspecies of *auroapicalis*; Palaearctic catalog) – Bellamy 2008: 1985 (subspecies of *auroapicalis*; world catalog) – Fukutomi and Kurihara 2011: 27 (subspecies of *auroapicalis*; faunal record; biology; Ryukyu islands).

Type material. *Agrilus auroapicalis ishigakianus* Tôyama, 1985. Type locality. Mt. Omotodake, Ishigaki-jima Isl. Types not examined. See Remarks. Described from 3 specimens (holotype, alotype, paratype).

Diagnosis. Size 6.1 mm; it can be distinguished from *A. auroapicalis auroapicalis* by having the body smaller, less produced apically; by the golden-brown dorsal color; by the ornamental elytral pubescence more extensive mostly along the suture and by having the color of elytral apices less contrasting to that of the nominal subspecies. See also Appendix.

Additional material. JAPAN: Ryukyu islands: 1 ♂ (EJCB): "1996.4.19, Ishigaki Is., Okinawa, Ryukyu, K. Takahashi leg.".

Host plant. *Euodia meliifolia*: Fukutomi and Kurihara (2011).

Distribution. JAPAN: Ryukyu islands (Okinawa incl.).

Remarks. The type specimens of this taxon were not studied; they should be preserved in NSMT as stated by Tôyama (1985a). The taxonomic concept was judged from the specimen determined by S. Ohmomo.

Agrilus biakanus Curletti, 2006

http://species-id.net/wiki/Agrilus_biakanus
Fig. 47 (habitus of holotype)

biakanus Curletti, 2006 (*Agrilus*; subgenus *Agrilus*)
Curletti 2006: 178–179, 220 (description) – Bellamy 2008: 1996 (subgenus *Agrilus*; world catalog).

Type material. *Agrilus biakanus* Curletti, 2006. Type locality. Mokmer, Biak Isl., N. G. Type specimens were not examined. Image of the holotype (Fig. 47) was adopted from Curletti (2006). See also Remarks. Described from 10 specimens (holotype, paratypes).

Diagnosis. Size: 6.9–9.2 mm. This species is distinctive by the glabrous elytra (Curletti 2006). See also Appendix.

Host plant. Unknown.

Distribution. INDONESIA: Irian Jaya.

Remarks. No specimens of this species were available for this study. The assignment of this taxon to *A. occipitalis* species–group is based on the original description and on the image of aedeagus which is very similar to that of *A. occipitalis*.

Agrilus diversornatus Jendek, 2011

http://species-id.net/wiki/Agrilus_diversornatus
Fig. 7 (habitus of holotype)

diversornatus Jendek, 2011 (*Agrilus*)
Jendek In: Jendek and Grebennikov 2011: 89–90, 267 (description).

Type material. *Agrilus diversornatus* Jendek, 2011. Type locality. Eastern Russia, south Primorskiy kray, Lazovskii zapovednik, kordon Korpad', 43°15'17"N, 134°07'59"E. Holotype (Fig. 7) examined by Jendek and Grebennikov (2011).

Diagnosis. Size 6.8–7.1 mm. From the similar *A. auroapicalis* it differs mostly by the smaller eyes; by pronotum widest at the posterior margin and by the pronotal lobe being obviously angulate. See also Appendix.

Additional material. Known only from type specimens.

Adult occurrence: 7–8.
Host plant. *Sorbaria*: Jendek and Grebennikov (2011).
Distribution. RUSSIA: Primorskiy kray.

Agrilus horniellus Obenberger, 1935

http://species-id.net/wiki/Agrilus_horniellus
Fig. 16 (habitus); Fig. 35 (aedeagus)

horniellus Obenberger, 1935 (*Agrilus*; replacement name for *horni* Théry not Kerremans)
Obenberger 1935a: 121 (replacement name proposal) – Obenberger 1936b: 92 (erronoeusly cited as new replacement name) – Obenberger 1936a: 1085 (world catalog) – Bellamy 2008: 2127 (world catalog) – Jendek 2012: 9 (synonymy).
= *horni* Théry, 1904 (*Agrilus*; [preoccupied])
Théry 1904: 161-162 (description) – Obenberger 1935a: 121 (synonym of *horniellus*) – Obenberger 1936b: 92 (synonym of *horniellus*) – Obenberger 1936a: 1085 (synonym of *horniellus*) – Bellamy 2008: 2127 (synonym of *horniellus*; world catalog) – Jendek 2012: 9 (synonym of *horniellus*; lectotype designation).

Type material. *Agrilus horniellus* Obenberger, 1935. Type locality. See: *Agrilus horni* Théry, 1904. See: *Agrilus horni* Théry, 1904.

Agrilus horni Théry, 1904. Type locality. Nalanda. Lectotype designated by Jendek (2012).

Diagnosis. Size: 6.5–7.3 mm. *Agrilus horniellus* differs from the very similar *A. occipitalis* by having the apex of pygidium arcuate and the apex of elytra concolor with the elytral disk. See also Appendix.

Additional material. SRI LANKA: 1 ♂ (EJCB): "Sri Lanka: Anu Distr., 6 miles south of Tantirimalai, 2000ft, 31 Oct 1976"; 1 ♀ (EJCB): "Ceylon, E. Prov., Pottuvil, 1-12/vii.-1983 Ole Mehl. leg."; 1 ♀ (EJCB): "Ceylon, N. C. Prov., Anuradhapura, 22-26/vi.-1985, Ole Mehl. leg.".

Adult occurrence: 6–7–10. **Altitude range:** 610 m.
Host plant. Unknown.
Distribution. SRI LANKA.

Remarks. *Agrilus horniellus* may be conspecific with *A. occipitalis*, but its original taxonomic concept was tentatively retained due to limited specimens available for examination.

Agrilus inamoenus Kerremans, 1892

http://species-id.net/wiki/Agrilus_inamoenus
Fig. 21 (habitus); Fig. 38 (aedeagus)

inamoenus Kerremans, 1892 (*Agrilus*)

Figures 13–24. Habitus of *Agrilus*: **13** *A. nebulosus* sp. n – Holotype **14** *A. trepanatus* sp. n – Holotype **15** *A. yamawakii* Kurosawa, 1957 **16** *A. horniellus* Obenberger, 1935 **17** *A. occipitalis* (Eschscholtz, 1822) – Laos, Vientiane, Ban Phabat **18** *A. occipitalis* (Eschscholtz, 1822) – Papua New Guinea, Sideia island **19** *A. occipitalis* (Eschscholtz, 1822) – Philippines, Palawan **20** *A. sordidulus* Obenberger, 1916 **21** *A. inamoenus* Kerremans, 1892 **22** *A. mucidus* sp. n – Holotype **23** *A. pluvius* sp. n – Holotype **24** *A. sordidulus* Obenberger, 1916.

Kerremans 1892a: 824-825 (description) – Kerremans 1903: 286 (catalog) – Obenberger 1936a: 1086 (world catalog) – Baudon 1961: 74 (faunal records; Laos) – Descarpentries and Villiers 1963: 104, 109 (lectotype designation; characters; faunal data; Birmanie; Laos; Tonkin; Annam) – Baudon 1968: 131, 143 (characters in key; faunal records; Laos) – Peng Zhongliang and Huang Bangkan 1995: 98-101 (characters; biology; China: Fujian) – Hua Li Zhong 2002: 89 (checklist; China: Fujian [Note: Misidentification]) – Peng Zhongliang 2002: 270 (characters; Fujian) – Jendek 2003: 181–182 (remark on lectotype designation) – Bellamy 2008: 2136 (world catalog) – Jendek and Grebennikov 2011: 109–110 (references; types; diagnosis; faunal records; host plants; distributional summary; East Asia).

Type material. *Agrilus inamoenus* Kerremans, 1892. Type locality. Carin Cheba, 900–1100 m. Lectotype designated by Descarpentries and Villiers (1963).

Diagnosis. Size 7.8–9.8 mm. Within the subgroup, *A. inamoenus* is distinctive by the short antennae, by the prosternal lobe absent or vague and by the tubercular prehumerus. See also Appendix.

Additional material. CHINA: 1 (IZAS): "[China] Shuangjiang, vi.1953 [in Chinese]". Yunnan: 1 (IZAS): "Yunnan Xishuangbanna Xiaomengyang, 850m, 9.vii.1957, S. Y. Wang leg. [in Chinese]"; 3 (IZAS): "Yunnan Xishuangbanna Menghun, 750m, 2–7.vi.1958, S. Y. Wang leg. [in Chinese]"; 1 (IZAS): "Yunnan Xishuangbanna Damenglong, 650m, 5.v.1958, X. W. Meng leg. [in Chinese]". THAILAND: Chaiyaphum: 1 (EJCB): "Thailand, Chaiyaphum Tat Tone NP, near stream, 15°58.771'N, 102°02.397'E, Malaise trap, 5–12.vii.2006, T. Jaruphan and O. Budsawong leg.". Chiang Rai: 1 ♂ (USNM): "Khun Tan Mts, N Siam 3000 ft, HM. Smith May [19]33". VIETNAM: Lam Dong: 1 (MNHN): "Djiring, Annam, H. Perrot". For further records see also Jendek and Grebennikov (2011).

Adult occurrence: 4–5–6–7. **Altitude range:** 420–1600 m.

Host plant. *Citrus*: Hua Li Zhong (2002); *Sambucus javanica*: Baudon (1968).

Distribution. CHINA: Fujian; Yunnan. LAOS: Borikhamxai; Khammouan; Louang Namtha; Louangphrabang; Savannakhet; Xaignabouri; Xiangkhoang. MYANMAR: Karen State. THAILAND: Chaiyaphum; Chiang Mai, Chiang Rai. VIETNAM: Binh Dinh; Gia Lai; Hoa Binh; Lam Dong; Son La.

***Agrilus mucidus* sp. n.**

urn:lsid:zoobank.org:act:1C67DFF8-5BF1-416C-9F7F-CD0F18B685C5
http://species-id.net/wiki/Agrilus_mucidus
Fig. 22 (habitus of holotype); Fig. 39 (aedeagus)

Description. BODY. Size: 9.6–10.7 mm (Holotype 10 mm). Shape: subparallel, Build: robust, Posterior tapering part: short with broad apex, Color (dorsally): unicolored, Sexual modifications in male: not apparent. HEAD. Size: very large, Me-

dial impression: deep, Epistoma: raised above frons. *Vertex*: Shape: markedly convex, Sculpture elements: rugae, Sculpture shape: semispherical, Sculpture density: dense, Sculpture intensity: rough. *Eyes*: Size: small, Shape: markedly protruding head outline, Lower margin: in line or below with antennal socket, Medial orbit: converging ventrally or subparallel. *Antennae*: Length: long, Width: slender, Serration: from antennomere 4, Antennomere 7–10 (shape): with obvious collum. PRONOTUM. Shape: transverse, Sides: markedly arcuate or slightly arcuate, Maximal width: at middle, Anterior margin: subequal to posterior. *Anterior lobe*: Size: moderate, Shape: arcuate or subangulate, Position: at level with anterior angles. *Posterior angles*: Shape: acute or obtuse or rectangular, Apex: blunt or sharp. *Disk*: Convexity: flat, Impressions: medial and lateral, Medial impression: anteromedial and posteromedial, Lateral impressions (intensity): shallow, Lateral impression (size): wide. *Prehumerus*: Development: filamentary, rarely carinal, Shape: bisinuate, Extent: to 1/3 of pronotal length, rarely to 1/2 of pronotal length, Anterior end: distant from lateral carina, Posterior end: joined with posterior angle or margin, Arc: moderate or obvious. *Lateral carinae*: Convergence: moderately convergent, Junction: present, Narrowest point: at posterior 1/5-1/4 of marginal carina. ELYTRA. Color: monochromatic, Humeral carina: absent. *Apices*: Arrangement: separate, Shape: arcuate. *Pubescence*: Color: monochromatic, Character: homogenous or with patches or spots of denser pubescence, Extent: entire ornamental with indication of fasciae or entire ornamental. Tomentum: Spots (pattern): postmedial only. STERNUM. *Prosternal lobe*: Size: large, Distal margin: arcuate. *Prosternal process*: Shape: subparallel, Sides: arcuate, Angles: obtuse, Angles (tips): blunt, Disc: flat. ABDOMEN. Tomentum: absent or present. *Pygidium*: Apical margin: angulate. *Sternal groove*: Extent: on three apical ventrites, Shape on the apex of last ventrite: arcuate. LEGS. *Metatarsus*: Size to metatibia: distinctly shorter than metatibia. *Tarsomere 1*: Size to following tarsomeres: longer than 2-3 but shorter than 2-4. GENITALIA. *Aedeagus* (Fig. 39): Symmetry: symmetric, Shape: widest in basal part, rarely subparallel, Modifications: apex of medial lobe sharply pointed. *Ovipositor*: Shape: square (uritiform).

Diagnosis. From the very close *A. tonkineus*, it can be distinguished by the flat pronotum; by the bi-sinuate prehumerus and by the presence of transverse tomentose strip at apical third of elytra. See also Appendix.

Type locality. China, Hainan, Baihualing, 19.018, 109.836, altitude 300 m.

Type material. Holotype (Fig. 22), ♂, (EJCB): "China, Hainan, Baihualing, 19.018, 109.836, alt. 300 m, vi. 2008 [p]". Paratypes: 1 paratype (EJCB), 3 paratypes (IZAS) from the same locality as holotype; 1 paratype (EJCB): "[China] Hainan Qiongzhong Baihuashan Mt, 27.v.1997, P. Y. Yu leg. [transcription from Chinese]". 1 paratype (USNM), 1 paratype (EJCB): "Taichow, China, 1933".

Adult occurrence: 5–6 . **Altitude range:** 300 m.

Host plant. Unknown.

Distribution. CHINA: Hainan; Zhejiang.

Etymology. The specific name is Latin adjective *mucidus* (moldy). It refers to the elytral tomentum of the species.

***Agrilus nebulosus* sp. n.**
urn:lsid:zoobank.org:act:2DF8A3BE-19D6-40D4-B183-D3EE333BF5F5
http://species-id.net/wiki/Agrilus_nebulosus
Fig. 13 (habitus of holotype); Fig. 33 (aedeagus)

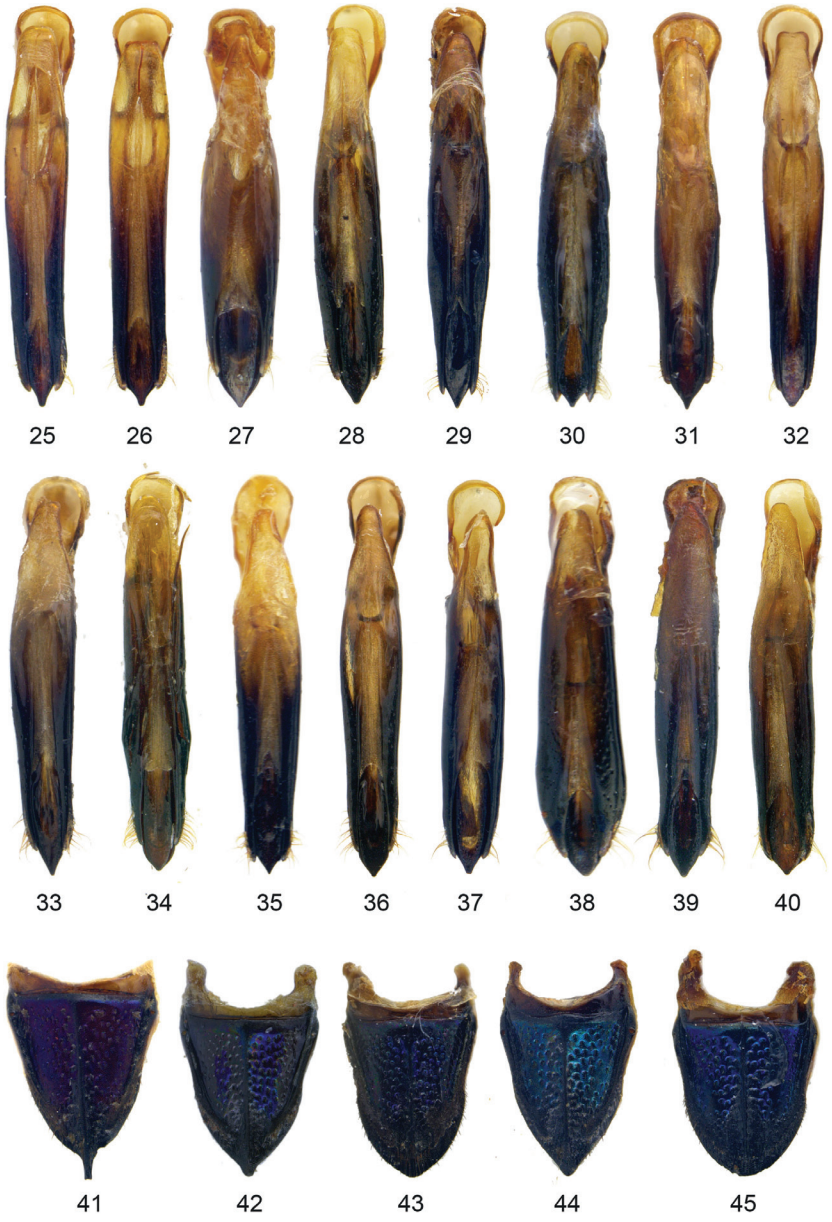
Description. BODY. Size: 6.4–7.5 mm (Holotype 6.5 mm). Shape: cuneiform, Posterior tapering part: long with narrow apex, Color (dorsally): unicolored, Sexual modifications in male: not apparent. HEAD. Medial impression: deep, rarely shallow, Epistoma: raised above frons, *Vertex*: Sculpture elements: rugae, Sculpture density: dense, *Eyes*: Size: moderate, Lower margin: in line or below with antennal socket, Medial orbit: converging ventrally, *Antennae*: Length: long, Width: slender, Serration: from antennomere 4. PRONOTUM. Shape: transverse, Sides: slightly arcuate, Maximal width: at anterior margin, Anterior margin: wider than posterior, *Anterior lobe*: Size: moderate, Shape: arcuate, Position: at level with anterior angles, *Posterior angles*: Shape: obtuse or rectangular, Apex: sharp, *Disk*: Impressions: medial and lateral, Medial impression: anteromedial and posteromedial, *Prehumerus*: Development: carinal, Shape: arcuate, Extent: to 1/3 of pronotal length, Anterior end: distant from lateral carina, Posterior end: joined with posterior angle or margin, Arc: moderate or weak, *Lateral carinae*: Convergence: moderately convergent, Junction: present, Narrowest point: at posterior 1/5-1/4 of marginal carina. ELYTRA. Color: monochromatic, Humeral carina: absent, *Apices*: Arrangement: separate, Shape: arcuate, *Pubescence*: Color: monochromatic, Extent: entire ornamental, rarely entire ornamental with indication of stripes. STERNUM. *Prosternal lobe*: Size: large, Distal margin: arcuate, *Prosternal process*: Size: wide, Shape: dilated, rarely subparallel, Sides: straight, Angles: acute, Angles (tips): blunt, Disc: flat, Projection (extend): distinctly beyond angles, *Mesosternum*: Mesosternal projection: flat. ABDOMEN. Tomentum: absent, *Pygidium*: Apical margin: arcuate, rarely angulate, *Sternal groove*: Extent: on all ventrites or on three apical ventrites, Shape on the apex of last ventrite: arcuate, rarely arcuately sinuate, Emargination (deepness): very shallow. LEGS. *Metatarsus*: Size to metatibia: distinctly shorter than metatibia, *Tarsomere 1*: Size to following tarsomeres: longer than 2-3 but shorter than 2-4 or subequal or longer than 2-4. GENITALIA. *Aedeagus* (Fig. 33): Symmetry: symmetric, Shape: widest in basal part, rarely subparallel, Modifications: apex of medial lobe sharply pointed, *Ovipositor*: Shape: markedly elongate.

Diagnosis. From the close *A. auriventris*, it can be distinguished by the generally smaller size and slender body; by the pygidium arcuate apically and by the the groove on the apex of last ventrite arcuate (rarely sinuate). See also Appendix.

Type locality. North Vietnam, 21°35N, 106°30E, 52 km southwest of Lang Son, altitude 370 m.

Type material. Holotype (Fig. 13), ♂, (EJCB): "N Vietnam, 21°35N, 106°30E, 52 km SW of Lang Son, 27.iv.-6.v.1996, 370 m, Dembický and Pacholátko leg.". Paratypes: 1 ♂ paratype, 7 ♀ paratypes (EJCB) from the same locality as holotype.

Adult occurrence: 5–6 . **Altitude range**: 300 m.



Figures 25–45. Aedeagus of *Agrilus*: **25** *A. perroti* Descarpentries & Villiers, 1963 **26** *A. zanthoxylumi* Li Meng Lou, 1989 **27** *A. auroapicalis ishigakianus* Tôyama, 1985 **28** *A. ambiguus* Kerremans, 1895 **29** *A. picturatus* sp. n – Holotype **30** *A. pseudoambiguus* sp. n – Holotype **31** *A. alesi* Obenberger, 1935 **32** *A. auriventris* Saunders, 1873 **33** *A. nebulosus* sp. n – Holotype **34** *A. yamawakii* Kurosawa, 1957 **35** *A. horniellus* Obenberger, 1935 **36** *A. occipitalis* (Eschscholtz, 1822) – Philippines, Palawan **37** *A. sordidulus* Obenberger, 1916 **38** *A. inamoenus* Kerremans, 1892 **39** *A. mucidus* sp. n – Holotype **40** *A. tonkineus* Kerremans, 1895. Pygidium of *Agrilus* **41** *A. alesi* Obenberger, 1935 **42** *A. auriventris* Saunders, 1873 **43** *A. occipitalis* (Eschscholtz, 1822) – Laos, Vientiane, Ban Phabat **44** *A. occipitalis* (Eschscholtz, 1822) – Papua New Guinea, Sideia island **45** *A. occipitalis* (Eschscholtz, 1822) – Thailand, Mae Hong Son, Pai.

Host plant. Unknown.

Distribution. VIETNAM: Lang Son.

Etymology. The specific name is Latin adjective *nebulosus* (misty, hazy, indefinite, obscure). It refers to the faint ornamental elytral pubescence of the species.

***Agrilus occipitalis* (Eschscholtz, 1822)**

http://species-id.net/wiki/Agrilus_occipitalis

Figs 17–19 (habitus); Fig. 36 (Aedeagus); Figs 43–45 (pygidium); Fig. 60 (Lectotype)

occipitalis (Eschscholtz, 1822) (*Buprestis*)

Eschscholtz 1822: 79-80 (description) – Eschscholtz 1823: 135-136 (*Buprestis*) – Dejean 1833: 83 (catalog) – Dejean 1836: 93 (catalog) – Mannerheim 1837: 110 (notes) – Gemminger and Harold 1869: 1443 (catalog) – Saunders 1870: 23 (catalog) – Saunders 1871: 121 (catalog) – Saunders 1874: 323 (faunal records; Philippines) – Baer 1886: 126 (catalog; Philippines) – Kerremans 1892: 265 (catalog) – Kerremans 1903: 278 (catalog) – Schultze 1916: 57 (checklist; faunal records; Luzon) – Fisher 1921: 349, 356, 369 (checklist; Philippines) – Obenberger 1924c: 562 – Tan 1925: 583-584 [not seen] (pest; Philippines) – Fisher 1926: 242 – Clausen 1933: 29, 30 (pest) – Obenberger 1936a: 1094-1095 (world catalog) – Quayle 1938: 197-198, 314 (ecology; pest; control; Philippines) – Miwa and Chûjô 1940: 74 (faunal record; Formosa) – Mühlmann 1954: 84 (notes) – Balachowsky et al. 1962: 287 (pest on *Citrus*) – Macabasco 1964: 133-135 (biology; pest; control measures; Philippines: Luzon) – Anonymous 1969: 60 (pest; Papua New Guinea) – Yoshikawa et al. 1969: 178 (biological observation; Malaysia: Perak; Cambodia: Phnom-Penh) – Anonymous 1971: 189 (pest; Papua New Guinea) – Kurosawa 1974: 3 (characters; notes) – Jackman 1987: 28 (faunal records; Phillipines (Luzon)) – Hawkeswood and Turner 1994: 14-18 (biology; behaviour; Papua New Guinea) – Jendek 1998: 326 (lectotype designation) – Curletti 2006: 173-174, 222 (subgenus *Agrilus*; characters; faunal records; remarks; distributional summary; Indonesia: Maluku; New Guinea) – Jendek 2006: 400 (Palaearctic catalog) – Bellamy 2008: 2211-2212 (subgenus *Agrilus*; world catalog) – Hill 2008: 279, 539 (pest; control; life history).

= *evinadus* Gory & Laporte, 1839 (*Agrilus*) **syn. n.**

Gory and Laporte 1839: 30 (description) – Gray 1848: 36 (Buquet is cited as the author; checklist of taxa in the collection of the British museum) – Gemminger and Harold 1869: 1439 (cited as *evanidus*; catalog) – Saunders 1871: 121 (cited as *evanidaus*; catalog) – Kerremans 1892: 256 (cited as *evanidus*; catalog) – Kerremans 1903: 277 (cited as *evanidaus*; catalog) – Obenberger 1936a: 1082 (world catalog) – Descarpentries and Villiers 1963: 104, 110 (lectotype designation; characters; faunal records; remark; Cochinchine; Java) – Descarpentries and Chûjô 1968: 15 (faunal record; Vietnam) – Nelson and Bellamy 1993: 304 (authorship and publication

date) – Jendek 1998: 321 (lectotype data) – Bellamy 1999: 3 (authorship assigned to Buquet) – Bellamy 2008: 2087 (world catalog).

= *occipitalis* Gory, 1841 (*Agrilus*)

Gory 1841: 222-223 (description; [Note: Gory's name is based on the type specimen of Eschscholtz. The name *occipitalis* Gory is a junior objective synonym and a secondary homonym of *occipitalis* Eschscholtz]) – Nelson and Bellamy 1993: 304 (authorship and publication date) – Jendek 1998: 326 (synonym of *occipitalis* Eschscholtz; lectotype designation) – Curletti 2006: 173 (synonym of *occipitalis* Eschscholtz) – Jendek 2006: 400 (synonym of *occipitalis* Eschscholtz; Palaearctic catalog) – Bellamy 2008: 2212 (synonym of *occipitalis* Eschscholtz; world catalog).

= *marmoreus* Deyrolle, 1864 (*Agrilus*)

Deyrolle 1864: 146, 201–202 (description) – Gemminger and Harold 1869: 1442 (catalog) – Saunders 1871: 124 (catalog) – Kerremans 1892: 263 (catalog) – Kerremans 1903: 287 (catalog) – Obenberger 1936a: 1091 (world catalog) – Mühlmann 1954: 83 (notes) – Balachowsky et al. 1962: 287 (pest on *Citrus*) – Jendek 1998: 325 (lectotype designation) – Curletti 2001: 6, 21-22, 39 (subgenus *Agrilus*) – Bellamy 2002: 352 (subgenus *Agrilus*; catalog; Australia) – Williams 2002: 88 (faunal records; Australia) – Curletti 2006: 173 (synonym of *occipitalis* Eschscholtz) – Bellamy 2008: 2212 (synonym of *occipitalis* Eschscholtz; world catalog).

= *cupricauda* Saunders, 1867 (*Agrilus*), **syn. n.**

Saunders 1867: 520 (description) – Gemminger and Harold 1869: 1438 (catalog) – Saunders 1871: 124 (catalog) – Kerremans 1892: 253 (catalog) – Kerremans 1903: 284 (catalog) – Obenberger 1936a: 1079 (world catalog) – Bellamy 2008: 2049 (world catalog).

= *nitidus* Kerremans, 1898 (*Agrilus*)

Kerremans 1898: 179–180 (description) – Kerremans 1903: 277 (catalog) – Carter 1924a: 29 – Carter 1929: 276 – Obenberger 1936a: 1095 (presumed synonym of *occipitalis*; world catalog) – Théry 1936: 61 (synonym of *occipitalis*) – Carter 1940: 389 (synonym of *korenskyi*) – Curletti 2001: 21, 39 (synonym of *marmoreus*) – Bellamy 2002: 352 (synonym of *marmoreus*) – Curletti 2006: 173 (synonym of *occipitalis* Eschscholtz) – Bellamy 2008: 2212 (synonym of *occipitalis* Eschscholtz; world catalog).

= *connexus* Kerremans, 1900 (*Agrilus*), **syn. n.**

Kerremans 1900b: 5, 22, 28 (description) – Kerremans 1903: 278 (catalog) – Obenberger 1936a: 1078 (world catalog) – Bellamy 2008: 2035 (world catalog).

= *oblatus* Kerremans, 1900 (*Agrilus*), **syn. n.**

Kerremans 1900a: 340 (description) – Kerremans 1903: 278 (catalog) – Obenberger 1936a: 1094 (world catalog) – Jendek 2005: 14 (lectotype designation) – Bellamy 2008: 2206 (world catalog).

= *korenskyi* Obenberger, 1923 (*Agrilus*)

Obenberger 1923: 80-81 (description) – Carter 1924b: 536 (presumably conspecific with *semiviridis*) – Carter 1929: 276 (variety of *nitidus*) – Obenberger 1936a: 1089 (world catalog) – Carter 1940: 389 (synonymy) – Curletti 2001: 21, 39

(synonym of *marmoreus*; notes) – Bellamy 2002: 352 (synonym of *marmoreus*) – Curletti 2006: 173 (synonym of *occipitalis* Eschscholtz) – Bellamy 2008: 2212 (synonym of *occipitalis* Eschscholtz; world catalog).

= *kurandae* Obenberger, 1923 (*Agrilus*)

Obenberger 1923: 80 (description) – Carter 1924b: 536 (presumably near to *nitidus*) – Carter 1929: 276 (synonym of *nitidus*) – Obenberger 1936a: 1089 (world catalog) – Carter 1940: 389 (synonym of *korenskyi*) – Curletti 2001: 21, 39 (synonym of *marmoreus*) – Bellamy 2002: 352 (synonym of *marmoreus*) – Curletti 2006: 173 (synonym of *occipitalis* Eschscholtz) – Bellamy 2008: 2212 (synonym of *occipitalis* Eschscholtz; world catalog).

= *celebicola* Obenberger, 1924 (*Agrilus*), **syn**. **n.**

Obenberger 1924a: 123 (description) – Obenberger 1936a: 1077 (world catalog) – Bellamy 2008: 2019 (world catalog).

= *nirius* Obenberger, 1924 (*Agrilus*), **syn**. **reconfirmed**

Obenberger 1924a: 123-124 (description) – Théry 1927: 34 (synonym of *occipitalis*) – Obenberger 1931: 36 (subspecies of *occipitalis*) – Théry 1935c: 256 (synonym of *occipitalis*) – Obenberger 1936a: 1095 (subspecies of *occipitalis*; world catalog) – Kalshoven 1951: 697-699 (variety of *occipitalis*; larva; larval galleries; biology; Philippines; Java) – Mühlmann 1954: 84 (variety of *occipitalis*; notes on biology) – Bellamy 2008: 2212 (subspecies of *occipitalis* Eschscholtz; world catalog).

= *tebinganus* Obenberger, 1924 (*Agrilus*), **syn**. **n.**

Obenberger 1924a: 120 (description) – Obenberger 1936a: 1105 (world catalog) – Bellamy 2008: 2324 (world catalog).

Unavailable names

= *evanidus* Buquet

Dejean 1836: 93 (catalog; [Note: Dejean attributed this name to Buquet but his use of the name was not found and Dejean presented no characters]) – Bellamy 2008: 2087 (unavailable synonym of *evinadus*; world catalog).

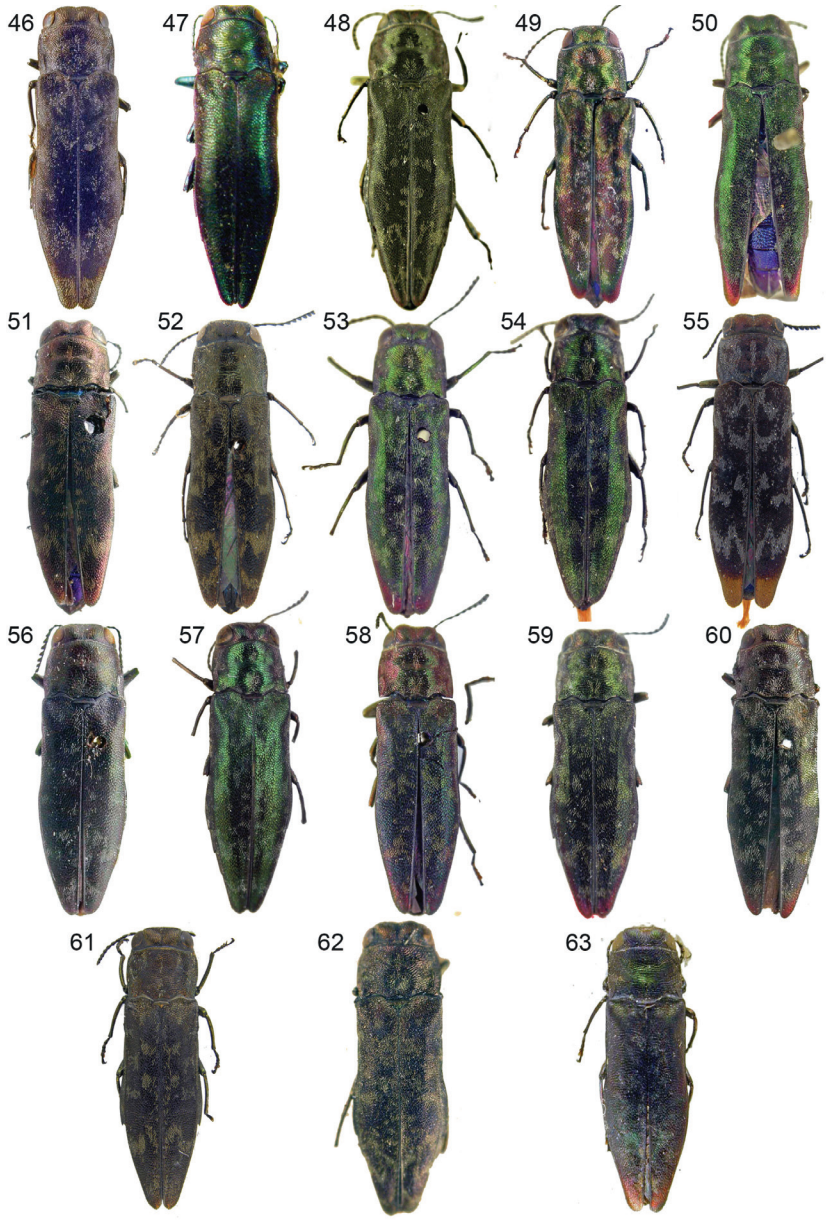
= *evanidus* Gemminger & Harold

Gemminger and Harold 1869: 1439 (Gory and Laporte are cited as authors; [Note: Incorrect subsequent spelling; Gemminger and Harold did not propose the name as new, they misspelled *evinadus* Gory & Laporte]) – Obenberger 1936a: 1082 (synonym of *evinadus*) – Descarpentries and Villiers 1963: 110 (synonym of *evinadus*) – Bellamy 2008: 2087 (unavailable synonym of *evinadus*; world catalog).

Type material. *Buprestis occipitalis* Eschscholtz, 1822. Type locality. Auf der Inßel [= Insel] Luzon, bei Manilla. Lectotype (Fig. 60) designated by Jendek (1998).

Agrilus evinadus Gory & Laporte, 1839. Type locality. Java. Lectotype (Fig. 51) designated by Descarpentries and Villiers (1963).

Agrilus occipitalis Gory, 1841. Type locality. Iles Philippines. Lectotype designated by Jendek (1998).



Figures 46–63. Types of *Agrilus*: **46** *A. auroapicalis* Kurosawa, 1957 – Holotype **47** *A. biakanus* Curletti, 2006 – Holotype (source: Curletti, 2006) **48** *A. celebicola* Obenberger, 1924 – Lectotype **49** *A. connexus* Kerremans, 1900 – Holotype by monotypy **50** *A. cupricauda* Saunders, 1867 – Lectotype **51** *A. evinadus* Gory & Laporte, 1839 – Lectotype **52** *A. horni* Théry, 1904 – Lectotype **53** *A. korenskyi* Obenberger, 1923 – Lectotype **54** *A. kurandae* Obenberger, 1923 – Lectotype **55** *A. laurenconi* Descarpentries & Villiers, 1963 – Holotype **56** *A. marmoreus* Deyrolle, 1864 – Lectotype **57** *A. nitidus* Kerremans, 1898 – Lectotype **58** *A. nirius* Obenberger, 1924 – Lectotype **59** *A. oblatus* Kerremans, 1900 – Lectotype **60** *A. occipitalis* (Eschscholtz, 1822) – Lectotype **61** *A. samoensis* Blair, 1928 – Holotype **62** *A. sordidulus* Obenberger, 1916 – Holotype by monotypy **63** *A. tebinganus* Obenberger, 1924 – Lectotype.

Agrilus marmoreus Deyrolle, 1864. Type locality. I. Mysole et Batchian. Lectotype (Fig. 56) designated by Jendek (1998).

Agrilus cupricauda Saunders, 1867. Type locality. Penang. **Lectotype by present designation** (Fig. 50), ♀, (BMNH): "Type H. T. [p] [round label with red border] \ Penang [h] [oval blue label] \ Penang (Lamb.) Pascoe Coll. [p] \ Agrilus cupricauda Typ ES [h]". Described from unknown number of syntypes.

Agrilus nitidus Kerremans, 1898. Type locality. Australie: Cocktown. **Lectotype by present designation** (Fig. 57), ♀, (BMNH): "Syn-Type [p] [round label with blue border] \ Cocktown Stauding [h] \ nitidus Kerr. Type [h] \ A. nitidus Kerrem. Australie [h] \ Kerremans 1903-59 [p]". **Secondary**: 1 paralectotype (BMNH). Described from unknown number of syntypes.

Agrilus connexus Kerremans, 1900. Type locality. not given [Sumatra, Hindrapoera is cited in the title and introductory text]. Holotype by monotypy (Fig. 49), ♂, (BMNH): "Type [p] [round label with red border] \ Sumatra Weyers [h] \ connexus Kerr. Type [h] \ Kerremans 1903-59 [p] \ A. connexus Kerrem. Sumatra [h]". Described from 1 specimen.

Agrilus oblatus Kerremans, 1900. Type locality. Sumatra. Lectotype (Fig. 59) designated by Jendek (2005).

Agrilus korenskyi Obenberger, 1923. Type locality. Australia. **Lectotype by present designation** (Fig. 53), ♂, (NMPC): "Australia [h] \ Typus [p] [red label] \ A. Kořenskyi m. Type [h] Det. Dr. Obenberger [p]". Described from unknown number of syntypes.

Agrilus kurandae Obenberger, 1923. Type locality. Kuranda (Quensland). **Lectotype by present designation** (Fig. 54), ♀, (NMPC): "Kuranda Queensland [h] \ Typus [p] [red label] \ Agrilus kurandae m. Type [h] Det. Dr. Obenberger [p]". Described from unknown number of syntypes.

Agrilus celebicola Obenberger, 1924. Type locality. Celebes. **Lectotype by present designation** (Fig. 48), ♀, (NMPC): "Drs. Sarasin S.O. Celebes Kolaka [p] [yellow label] \ TYPUS [p] [red label] \ Agrilus celebicola m. Type [h] Det. Dr. Obenberger [p]". Described from unknown number of syntypes.

Agrilus nirius Obenberger, 1924 Type locality. Java; Ins. Batoe; Tanah Masa. **Lectotype by present designation** (Fig. 58), ♀, (NMPC): "Java Buitenzorg [h] \ Typus [p] [red label] \ Agrilus Nirius m. Type [h] Det. Dr. Obenberger [p]". Secondary: 6 paralectotypes (NMPC); 1 paralectotype (RMNH). Described from unknown number of syntypes.

Agrilus tebinganus Obenberger, 1924. Type locality. Ostsumatra. **Lectotype by present designation** (Fig. 63), ♀, (NMPC): "Sumatra [h] \ Typus [p] [red label] \ tebinganus Kerr. n. sp. type \ Agrilus tebinganus m. Type [h] [Obenberger's MS] Det. Dr. Obenberger [p]". Secondary: 1 paralectotype (MNHN). Described from unknown number of syntypes.

Diagnosis. Size: 5.5–9.3 mm. *Agrilus occipitalis* is very variable in the size, color and the shape of body parts. The pygidium varies from arcuate to subangulate (Figs 43-45). From the close *A. horniellus* and *A. sordidulus*, it differs by the characters cited in diagnosis at *A. horniellus* and *A. sordidulus*. See also characters in Appendix.

Additional material. INDONESIA: Java: 1 ♂ (EJCB): "F.H. Doesburg, Java, Samarang"; 1 ♂ (EJCB): "Java Samarang"; 1 ♂ (EJCB): "Java Malang"; 1 (USNM): "L. G. E. Kalshoven, Java 250m, Buitenzorg, ix.1924, NS 176"; 1 (USNM): "Dr. L. J. Toxopeus, Preanger, Java, Bandoeng, 27.xi.31, Djeroek"; 1 (USNM): "Dr. L. J. Toxopeus, Preanger, Java, Bandoeng, xi.1932"; 1 ♂ (EJCB): "Indonesia, Java, Bandung, iv.1993 on Citrus trees"; 8 (EJCB): "Indonesia, Java isl, East Java prov., 6 km SE of Lasem, Celering Mt., 23.I.1998, St. Jákl leg."; 1 ♂, 1 ♀ (EJCB): "Indonesia, Java cent., Lasem env. - 4 km E of, Gunung Celering 140 m, 23–24.I.1998, R. Červenka lgt.". Kalimantan: 3 (EJCB): "Borneo occ. Pontianak 1901". Lesser Sunda: 2 ♂, 2 ♀ (EJCB): "Sumbawa Colffs."; 3 ♂ (EJCB): "W Timor, 350 m, Buraen, 50 km S Kupang, 26.i.-9. ii.2006, S. Jákl leg.". Sulawesi: 1 (EJCB): "Celebes"; 2 ♂, 1 ♀ (USNM): "Celebes NEJ, Watampone vi 1935, leg. L.E.C. Veen".Sumatra: 1 ♂ (EJCB): "W Sumatra, 1991"; 1 ♀ (EJCB): "W Sumatra, Solok, Jul 1995"; 1 ♂ (EJCB): "Sumatra, Harau valley, April 1996"; 1 ♂, 4 ♀ (EJCB): "W Sumatra, Harau Valley, 700 m, iv.2004, S. Jákl leg."; 1 ♂ (EJCB): "Indonesia, W Sumatra, Harau Valley, 500-800 m, ca 20 km N of Payakumbuh, iv-v.2006, S. Jákl leg."; 3 ♂ (EJCB): "Indonesia, W Sumatra, Harau Valley, 500–800 m, ca 20 km N of Payakumbuh, 5-28.ii.2006, S. Jákl leg."; 1 ♀ (EJCB): "Indonesia, W Sumatra, Harau Valley, 500-800 m, N of Payakumbuh, iv-v.2006"; 1 ♂ (EJCB): "Indonesia, W Sumatra, Harau Valley, 500-800 m, ca 20 km N of Payakumbuh, iv-v.2006, S. Jákl leg."; 1 ♂ (EJCB): "Indonesia, W Sumatra, Harau Valley, 500–800 m, ca 20 km N of Payakumbuh, ii.2006, S. Jákl leg."; 8 (EJCB): "Indonesia, W Sumatra, Mt. Tandikat, 400-600m, ca 25 km N Pariaman, i. 2007 S. Jákl leg."; 1 ♂ (EJCB): "Indonesia, W Sumatra, Harau Valley, 500–800 m, ca 20 km N of Payakumbuh, v-vi.2007, S. Jákl leg."; 8 (EJCB): "Indonesia, W Sumatra, Harau Valley, 500-800 m, ca 20 km N of Payakumbuh, v-vi.2007, S. Jákl leg."; 2 ♂, 2 ♀ (EJCB): "Indonesia, W Sumatra, Harau Valley, 500-800 m, ca 20 km N of Payakumbuh, viii.2009, S. Jákl leg.". LAOS: Vientiane: cca 55 (EJCB): "Laos centr., 27.IV.-1.V.1997, 70 km NE Vientiane, Ban Phabat env., 150 m, N 18°16.1, E 103°10.9, E. Jendek & O. Šauša leg."; 1 ♂ (EJCB): "C Laos, Viang Chan prov. Lao Pako resort, 100 m, 50km NE Vientiane, 2002, M. Štrba leg. 28–30.V."; 1 ♂, 1 ♀ (EJCB): "LAOS, Vientiane prov., Lao Pako env. 200 m, 55 km NE Vientiane, 1–4.v.2004, F. & L. Kantner leg."; 1 ♀ (EJCB): "Laos centr., Viang Chan pr., Ban PA Kho resort, ca.50 km, NE of Vientiane, ~90 m, 18°10'N, 102°52'E, 9.–14.vi.2007, M. Štrba leg.". MALAYSIA: Johor: 1 (EJCB): "Malaysia: Pahang, Tioman island, 2 km N Ayer Batang, 18.7.1993, leg. Schuh". Pahang: 1 ♀ (EJCB): "Malaysia-W, Pahang pr., 30km E Ipoh, 1500m, Cameron Highlands, Tanah Rata, 20.ii.-3.iii.1998, P. Čechovský leg."; 1 ♀ (EJCB): "Malaysia-W, Pahang pr., 30km E Ipoh, 1500m, Cameron Highlands, Tanah Rata, 21-24.vi.2001, P. Čechovský leg."; Perak: 1 ♀ (EJCB): "Malaysia-W, Perak 900m, 40km SE Ipoh, 4°25'N, 101°23'E, Cameron Highlands, Ringlet, M.Říha leg. 25.iv.–5.v.2001". NORTHERN MARIANA ISLANDS: 13 (USNM): "Mariana Isls.: Saipan Island, Aug. 20, 1944, David G. Hall"; 38 (USNM): "Lake Hagoya, Tinian Is., VI-10-46 \ Oakley 526 on Citrus leaves"; 2 (USNM): "Chalon [?]avlav, Saipan, vi-19-46, Oakley 734, on orange leaves"; 1 (USNM): "Rota Rota, vi-23-46, Townes"; 1 (USNM): "Vlig Bay, Guam, 22-i-48,

Mechler \ with Annona recticulata 48-2448"; 5 (USNM): "Chalon Lavlau, Saipan, vi-19-46, Oakley 734, on orange leaves"; 6 (USNM): "Marpo Valley, Tinian Isl., vi-9-46, Oakley 520, on sour orange leaves". PAPUA NEW GUINEA: 1 ♂ (CBCS): "New Guinea, Sideia island, Sideia Mission, 28 Dec. 1988, Leg. G. Hangay". PHILIPPINES: Luzon isl. group: 22 (USNM): "Manilla PI, in citrus branches, CollnRC McGregor"; 3 (USNM): "Malinao, Tayabas, Baker"; 1 (USNM): "Manila, PI, CollnRC McGregor"; 1 (USNM): "Mt. Makiling, Luzon, Baker,"; 1 ♂ (EJCB): "Mindoro"; 6 (USNM): "Santo Tomas, Batangas, Luzon"; 8 (USNM): "Manile, Philippines"; 1 (USNM): "Luzon, P.I., Montalban"; 1 (USNM): "Los Banos, Philippine Is., vi-vii-17"; 3 (USNM): "Manila P.I., VI-24, R.C.Mc. Gregor"; 5 (USNM): "Manila P.I., April 24, R.C.Mc. Gregor"; 1 (USNM): "Manila P.I., V-24, R.C.Mc. Gregor"; 22 (USNM): "in Citrus wood, Manila, P.I., 8.17.25, FC Brosius"; 1 (USNM): "Los Banos, Luzon PI, X.1945, Bmalkin"; 1 ♀ (EJCB): "Mt. Maquiling Philippines, elev. 50m, 28-II-48, R. Afenir"; 2 ♂, 1 ♀ (EJCB): "Lipa, Batangas, elev. 100m, 10-VIII-1948, Bigornia, A.";Mindanao isl. group: 2 (USNM): "Zamboanga, Mindanao, Baker"; 1 (USNM): "Zamboanga, Mindanao, Baker"; 3 (USNM): "Iligan, Mindanao"; 2 (USNM): "Surigao, Mindanao, Baker"; 3 (USNM): "Dapitan, Mindanao, Baker"; 1 ♂, 1 ♀ (NMPC): "Dapitan Mindanao Baker"; 6 (USNM): "Davao, Mindanao, Baker"; 1 (USNM): "Diklom, Bukidnon, Mindanao"; 2 ♀ (EJCB): "Philippinen Mindanao"; 15 (USNM): "Butuan, Mindanao, Baker"; 1 ♀ (EJCB): "Mindanao Phillippines 28.vii.1977 M. Sato leg."; 3 (CBCS): "Philippines, S. E. Mindanao, ix.2009, local collector". Palawan isl. group: 11 (EJCB): "Philippines, Palawan, 1–21.II.2000, 800 m, 9°42'N, 118°31E, Salakot waterfalls, E. Jendek leg.". Visayas islands: 1 (USNM): "Isl. Biliran, Philippines, Baker"; 4 (USNM): "Victoria, occ. Negros, in gardin"; 5 (USNM): "Island Samar, Baker"; 1 ♀ (EJCB): "Victorias, Occ. Negros, 10/26/[19]29"; 6 (USNM): "Calicoan isl., P.I., x-15-45 FF Bibby 601"; 1 (EJCB): "Masbate P.I. VIII.28 1952 Henry Townes"; 1 ♂ (EJCB): "Malubog, Toledo City, Cebu Is., 12.vi.1986, Hawkeswood T.J., on steam of Citrus"; 1 (CBCS): "Philippines, Leyte Isl., Mt. Balocaue, vi.2009, local collector". THAILAND: 1 ♂ (EJCB): "S Thailand Covaz 2.6.1995", Chiang Mai: 1 ♂ (EJCB): "Thailand 1.VI.1990 Sansai, Chiang Mai, S. Steinke leg.". Mae Hong Son: 2 ♂ (EJCB): "Thailand bor., prov. Mae Hong Son, Pai, 24–30.IV.1997, R. Šigut leg.". Nakhon Ratchasima: 1 ♂ (MHCB): "Thailand Corat 12.vii.1995, leg. Lehman & Steinke"; 1 ♂, 1 ♀ (EJCB): "Thailand Corat VI.1997".Yala: 1 ♀ (EJCB): "S Thailand 7-8.V.1992 Betong, L. Dembický leg."; 1 ♀ (EJCB): "S Thailand Betong, Gunung Cang dun vill., Yala dist. 25.3.–22.4.93, J. Horák leg.".VIETNAM: 2 ♀ (EJCB): "Cochinchine".

Adult occurrence: 1–2–3–4–5–6–7–8–9–10–11–12. **Altitude range**: 50–1500 m.

Host plant. *Citrus* sp.: Tan (1925); Clausen (1933); Quayle (1938); Kalshoven (1951 (as *nirius*)); Mühlmann (1954); Balachowsky et al. (1962); Macabasco (1964); Anonymous (1969); Yoshikawa et al. (1969); Hill (2008); *C. aurantifolia*: Anonymous (1971); Hawkeswood and Turner (1994 – *C. grandis*: Hawkeswood and Turner (1994) – *C. microcarpa*: Jackman (1987) – *C. sinensis*: Hawkeswood and Turner (1994).

Distribution. AUSTRALIA: Queensland. CAMBODIA: Phnum Penh. CHINA: Taiwan. INDONESIA: Irian Jaya; Java; Kalimantan; Lesser Sunda (incl. West Timor);

Maluku; Sulawesi; Sumatra. LAOS: Vientiane. MALAYSIA: Johor; Malaysia Peninsular; Pahang; Perak. NORTHERN MARIANA ISLANDS. PAPUA NEW GUINEA. PHILIPPINES: Luzon isl. group; Mindanao isl. group; Palawan isl. group; Visayas islands. THAILAND: Chiang Mai; Mae Hong Son; Nakhon Ratchasima; Yala. VIETNAM: Ba Ria-Vung Tau.

Remarks. Obenberger (1936a) cited this species without supportive data also from "Turkestan". This record needs verification.

Agrilus perroti Descarpentries & Villiers, 1963

http://species-id.net/wiki/Agrilus_perroti
Fig. 2 (habitus); Fig. 25 (aedeagus)

perroti Descarpentries & Villiers, 1963 (*Agrilus*)
Descarpentries and Villiers 1963: 108, 118 (description) – Peng Zhongliang 2002: 269, 281 (characters; new record for China; Fujian) – Jendek 2006: 400 (Palaearctic catalog) – Bellamy 2008: 2233 (world catalog) – Jendek and Grebennikov 2011: 151 (references; types; diagnosis; faunal records; distributional summary; East Asia).

Type material. *Agrilus perroti* Descarpentries & Villiers, 1963. Type locality. Tonkin: Thanh-Moï. Holotype examined by Jendek and Grebennikov (2011).

Diagnosis. See Jendek and Grebennikov (2011) and Appendix.

Additional material. INDIA: West Bengal: 1 ♂, 1 ♀ (MNHN): "British Bootang, Maria Basti, Durel [leg.]". For further records see: Jendek and Grebennikov (2011).

Adult occurrence: 4. **Altitude range**: 400 m.

Host plant. Unknown.

Distribution. CHINA: Fujian; Guangxi; Yunnan. INDIA: West Bengal. VIETNAM.

Agrilus picturatus sp. n.

urn:lsid:zoobank.org:act:03996C31-A484-4599-8E00-36FB8A1B98C7
http://species-id.net/wiki/Agrilus_picturatus
Fig. 9 (habitus of holotype); Fig. 29 (aedeagus)

Description. BODY. Size: 8.4 mm (Holotype). Shape: cuneiform, Build: slender, Color (dorsally): bicolored. HEAD. Medial impression: deep, *Frons*: Shape: flat, *Vertex*: Sculpture elements: rugae, Sculpture shape: semispherical or subparallel, Sculpture density: dense, Sculpture intensity: rough, *Eyes*: Size: moderate, Lower margin: in line or below with antennal socket, Medial orbit: converging ventrally, *Antennae*: Length: long, Width: slender, Serration: from antennomere 4, Antennomere 7-10 (shape): with obvious collum. PRONOTUM. Shape: visually square, Sides: slightly arcuate or straight, Maximal width: at

middle, Anterior margin: subequal to posterior, *Anterior lobe*: Size: obvious, Shape: arcuate, Position: projecting beyond anterior angles, *Posterior angles*: Shape: rectangular, Apex: sharp, *Disk*: Impressions: medial and lateral, Medial impression: anteromedial and posteromedial, Lateral impressions (intensity): deep, *Prehumerus*: Development: carinal, Shape: arcuate, Extent: to 1/3 of pronotal length, Anterior end: distant from lateral carina, Posterior end: joined with posterior angle or margin, Arc: moderate, *Lateral carinae*: Interspace: narrow, Convergence: moderately convergent, Junction: absent or present, Narrowest point: at posterior angles. ELYTRA. Color: dichromatic, Alternative color: apical portion, Humeral carina: absent, *Apices*: Arrangement: separate, Shape: arcuate, Modifications: margin obviously denticulate, *Pubescence*: Color: monochromatic, Extent: entire ornamental, rarely entire ornamental with indication of stripes. STERNUM. *Prosternal lobe*: Distal margin: arcuate, *Prosternal process*: Shape: dilated, rarely subparallel, Sides: straight, Angles: obtuse, Angles (tips): blunt, Disc: flat, Projection (extend): distinctly beyond angles, *Mesosternum*: Mesosternal projection: flat. ABDOMEN. *Pygidium*: Apical margin: with shortly projecting carina, *Last ventrite*: Disk: with medial carinula, *Sternal groove*: Extent: on all ventrites or on three apical ventrites, Shape on the apex of last ventrite: arcuate. LEGS. *Metatarsus*: Size to metatibia: about as long or longer than metatibia, *Tarsomere 1*: Size to following tarsomeres: subequal or longer than 2-4. GENITALIA. *Aedeagus* (Fig. 29): Symmetry: symmetric, Shape: widest in basal part, Modifications: apex of medial lobe sharply pointed.

Diagnosis. From the very similar *A. pseudoambiguus* sp. n., it differs by having the pronotum more elongate with sides almost straight; by having an obvious pronotal lobe and by the elytral apices being distinctly denticulate. See also Appendix.

Type locality. Thailand, Sakon Nakhon province, Phu Phane National Park, 17°07'30"N, 104°01'E, altitude 350 m.

Type material. Holotype (Fig. 9), ♂, (EJCB): "Thai, Sakon Nakhon, Phu Phane Nat.Park, 17°07'30"N, 104°01'E, 350m, ix.2000, local collector".

Adult occurrence: 9. **Altitude range**: 350 m.

Host plant. Unknown.

Distribution. THAILAND: Sakhon Nakhon.

Etymology. The specific name is the Latin adjective *picturatus* (painted). It refers to the elytral pubescence of the species.

***Agrilus pluvius* sp. n.**

urn:lsid:zoobank.org:act:4C107D00-2832-487F-B508-2899F45C55AA
http://species-id.net/wiki/Agrilus_pluvius
Fig. 23 (habitus of holotype)

Description. BODY. Size: 12.6 mm (Holotype). Shape: cuneiform, Build: robust, Color (dorsally): unicolored. HEAD. Medial impression: deep, Epistoma: raised above frons, *Vertex*: Sculpture elements: rugae, Sculpture shape: semispherical, Sculpture density: dense, *Eyes*: Size: small, Lower margin: in line or below with antennal socket, Medial orbit: subparallel, *Antennae*: Serration: from antennomere 4. PRONOTUM.

Shape: transverse, Sides: slightly arcuate, Maximal width: at middle, Anterior margin: subequal to posterior, *Anterior lobe*: Size: moderate, Shape: arcuate, Width: wide, Position: at level with anterior angles or not reaching level of anterior angles, *Posterior angles*: Shape: obtuse, Apex: sharp, *Disk*: Impressions: medial and lateral, Medial impression: anteromedial and posteromedial, Lateral impressions (intensity): deep, *Prehumerus*: Development: carinal, Shape: bisinuate, Extent: to 1/3 of pronotal length, Anterior end: distant from lateral carina, Posterior end: joined with posterior angle or margin, Arc: moderate, *Lateral carinae*: Interspace: narrow, Convergence: moderately convergent, Junction: present, Narrowest point: at posterior angles. ELYTRA. Color: monochromatic, Humeral carina: absent, *Apices*: Arrangement: separate, Shape: arcuate, *Pubescence*: Color: monochromatic, Density: dense, Extent: entire ornamental. STERNUM. *Prosternal lobe*: Size: large, Distal margin: arcuate or subtruncate, *Prosternal process*: Shape: subparallel, Sides: straight, Angles: obtuse, Angles (tips): blunt, Disc: flat, Projection (extend): distinctly beyond angles, *Mesosternum*: Mesosternal projection: flat. ABDOMEN. Tomentum: present, *Pygidium*: Apical margin: arcuate, *Sternal groove*: Extent: on three apical ventrites, Shape on the apex of last ventrite: arcuately sinuate, Emargination (deepness): very shallow. LEGS. *Metatarsus*: Size to metatibia: about as long or longer than metatibia, *Tarsomere 1*: Size to following tarsomeres: subequal or longer than 2-4. GENITALIA. *Ovipositor*: Shape: square (uritiform).

Diagnosis. *Agrilus pluvius* sp. n. is very distinctive by the large size and it differs from all members of the subgroup by having the apical half of elytra more elongate; by the arcuate apical margin of pygidium and by the distinctly sinuate sternal groove on the apex of last ventrite. See also Appendix.

Type locality. Northeastern India, Meghalaya, southwest of Cherrapunjee, 25°13'–14'N 91°40'E, altitude 900 m.

Type material. Holotype (Fig. 23), ♀, (EJCB): "NE India, Meghalaya, SW of Cherrapunjee, 25°13'–14'N 91°40'E, 900m, 5.–24.v.2005, P. Pacholátko leg.".

Adult occurrence: 5. **Altitude range**: 900 m.

Host plant. Unknown.

Distribution. INDIA: Meghalaya.

Etymology. The specific name is Latin adjective *pluvius* (rainy). It refers to the type locality which is known for the highest precipitation in the world.

Agrilus pseudoambiguus sp. n.

urn:lsid:zoobank.org:act:9A413050-3A7B-480A-9990-AE8CBA32019D
http://species-id.net/wiki/Agrilus_pseudoambiguus
Fig. 10 (habitus of holotype); Fig. 30 (aedeagus)

Description. BODY. Size: 5.9–8.1 mm (Holotype 8.1 mm). Shape: cuneiform, Color (dorsally): bicolored, rarely unicolored, Sexual modifications in male: not apparent. HEAD. Medial impression: deep, Epistoma: raised above frons, *Vertex*: Shape: mark-

edly convex, Sculpture elements: rugae, Sculpture shape: semispherical or subparallel, Sculpture density: dense, *Eyes*: Size: small, Lower margin: in line or below with antennal socket, Medial orbit: converging ventrally, *Antennae*: Length: long, Width: slender, Serration: from antennomere 4, Antennomere 7-10 (shape): with obvious collum. PRONOTUM. Shape: visually square, Sides: slightly arcuate, rarely subangulate, Maximal width: at middle, Anterior margin: subequal to posterior or wider than posterior, *Anterior lobe*: Size: absent or vague, rarely moderate, Shape: arcuate, Position: at level with anterior angles, *Posterior angles*: Shape: rectangular, rarely acute, rarely obtuse, Apex: sharp, *Disk*: Impressions: medial and lateral, Medial impression: anteromedial and posteromedial, Lateral impressions (intensity): deep, Lateral impression (size): narrow, *Prehumerus*: Development: carinal, Shape: arcuate, Extent: to 1/3 of pronotal length, Anterior end: distant from lateral carina, Posterior end: joined with posterior angle or margin, Arc: moderate or weak, *Lateral carinae*: Convergence: moderately convergent, Junction: absent or present, Narrowest point: at posterior angles. ELYTRA. Color: dichromatic, Alternative color: apical portion, *Apices*: Arrangement: separate, Shape: arcuate, *Pubescence*: Color: monochromatic, Extent: entire ornamental, rarely entire ornamental with indication of stripes. STERNUM. *Prosternal lobe*: Distal margin: arcuate, *Prosternal process*: Shape: dilated or subparallel, Sides: straight, Angles: obtuse, Disc: flat, Projection (extend): distinctly beyond angles, *Mesosternum*: Mesosternal projection: flat. ABDOMEN. *Pygidium*: Apical margin: angulate, *Sternal groove*: Extent: on all ventrites or on three apical ventrites, Shape on the apex of last ventrite: arcuate, rarely arcuately sinuate, Emargination (deepness): very shallow. LEGS. *Metatarsus*: Size to metatibia: somewhat shorter as metatibia, *Tarsomere 1*: Size to following tarsomeres: subequal or longer than 2-4. GENITALIA. *Aedeagus* (Fig. 30): Symmetry: symmetric, Shape: subparallel, Modifications: apex of medial lobe sharply pointed, *Ovipositor*: Shape: markedly elongate.

Diagnosis. From very similar *A. picturatus* sp. n., this new species differs by having the pronotum more transverse with sides slightly arcuate; by absent or vague pronotal lobe and by the smooth or very finely denticulate elytral apices. See also Appendix.

Type locality. Laos, Louang Namtha pr., 21°09'N, 101°19'E, Namtha - Muang Sing, 900–1200 m.

Type material. Holotype (Fig. 10), ♂, (EJCB): "Laos, Louang Namtha pr., 21°09'N, 101°19'E, Namtha - Muang Sing, 5–31.v.1997, 900–1200 m, Vit Kubáň leg.". Paratypes: 2 paratypes (EJCB) with the same data as holotype. 1 paratype (EJCB): "Laos NE, Hua Phan prov., 20°19'N, 104°25'E, 25 km SE Vieng Xai (by road), Ban Kangpabong env., 14–18.v.2001, D. Hauck leg."

Adult occurrence: 5. **Altitude range**: 900–1200 m.

Host plant. Unknown.

Distribution. LAOS: Houaphan; Louang Namtha.

Etymology. The specific name is derived from Greek prefix *pseudo-* (having the appearance of) and the specific name *ambiguus*; it refers to the similarity of the species to *A. ambiguus.*

***Agrilus sordidulus* Obenberger, 1916**
http://species-id.net/wiki/Agrilus_sordidulus
Fig. 20 (habitus); Fig. 37 (aedeagus); Fig. 62 (Holotype by monotypy)

sordidulus Obenberger, 1916 (*Agrilus*)
Obenberger 1916: 34-35 (description) – Obenberger 1936a: 1102 (world catalog) – Bellamy 2008: 2300 (world catalog).

Type material. *Agrilus sordidulus* Obenberger, 1916. Type locality. Ostindien: Trichinopoli. Holotype by monotypy (Fig. 62), (NHMB): "Typus [p] [red label with black border] \ 1220 [h] [blue label] \ Koll. Dr. A. Frh. v. Hoschek [p] Trichinopolis Ind. or. [h] \ Agrilus sordidulus Typ! [h] Det. Obenberger [p]". Described from 1 specimen.

Diagnosis. Size: 6.1–8.4 mm. *Agrilus sordidulus* can distinguished from the similar *A. occipitalis* and *A. horniellus* by the more robust body with the narrowing apical part of elytra shorter; by the head deeply, medially impressed and by the very deep medial pronotal impressions. See also Appendix.

Additional material. INDIA: Karnataka: 1 (CBCS): "S. Coorg, S. India, Ammatti, 3100 ft, II.1952". Kerala: 2 ♂ (EJCB): "S India, Kerala, Thekkady Periyar Lake, 9.34 N, 77.10 E, 900–1000 m, 19-27.IV.1997, Dembický & Pacholátko leg.". Tamil Nadu: 1 ♂, 8 ♀ (EJCB): "S India, Tamil Nadu, Nilgiri Hills, 15 km SE Kotagiri, near Kunchappanai, alt. 900 m, 13-20.V.1994, 11°22'N, 76°56'E, Z. Kejval lgt."; 1 ♂, 3 ♀ (EJCB): "India S, Tamil Nadu, Nilgiris, 15 km SE of Kotagiri, Kunchappanai, 900 m, 11.22 N 76.56 E, 7–22.v.2000, leg. P. Pacholátko"; 1 ♂, 1 ♀ (EJCB): "India S, Tamil Nadu, Nilgiri Hills, 11 km SE of Kotagiri, 1100±100 m, 11.24 N 76.56 E, Kunchappanai, leg. L. Dembický, 3-15.v.2002".

Adult occurrence: 2–4–5. **Altitude range**: 900–1200 m.

Host plant. Unknown.

Distribution. INDIA: Karnataka; Kerala; Tamil Nadu.

***Agrilus tesselatus* sp. n.**
urn:lsid:zoobank.org:act:4298A27E-4E89-42F4-A989-AF7CC76DB545
http://species-id.net/wiki/Agrilus_tesselatus
Fig. 1 (habitus of holotype)

Description. BODY. Size: 9.9 mm (Holotype). Shape: subparallel, Build: robust, Posterior tapering part: short with broad apex, Color (dorsally): unicolored. HEAD. Medial impression: deep, Epistoma: raised above frons, *Frons*: Shape: markedly convex, *Vertex*: Shape: markedly convex, Sculpture elements: rugae, Sculpture shape: semispherical, *Eyes*: Size: small, Shape: markedly protruding head outline, Lower margin: in line or below with antennal socket, Medial orbit: converging ventrally, *Antennae*: Length: short, Width: solid, Serration: from antennomere 5, Antennomere 7-10 (shape): without collum, Antennomere 7-10 (length): markedly wider than long. PRONOTUM. Shape: transverse, Sides: straight, Maximal width: at posterior margin, Anterior mar-

gin: narrower than posterior or subequal to posterior, *Anterior lobe*: Size: obvious, Position: projecting beyond anterior angles, *Posterior angles*: Shape: obtuse, Apex: blunt, *Disk*: Convexity: strongly convex, Impressions: absent or medial and lateral, Medial impression: anteromedial and posteromedial, Lateral impressions (intensity): shallow, Lateral impression (size): narrow, *Prehumerus*: Development: carinal, Shape: straight, Anterior end: distant from lateral carina, Posterior end: distant from angles and margin, *Lateral carinae*: Convergence: moderately convergent, Junction: present, Narrowest point: at posterior angles, *Scutellum*: Disc: impressed, Scutellar carina: obsolete or absent. ELYTRA. Color: monochromatic, Humeral carina: absent, *Apices*: Arrangement: separate, Shape: subtruncate, Truncation: transverse, *Pubescence*: Color: monochromatic, Extent: entire ornamental. STERNUM. *Prosternal lobe*: Distal margin: angulately emarginate, Delimitation: angulate, Emargination (width): wide, *Prosternal process*: Shape: subparallel, Sides: straight, Angles: rectangular, Angles (tips): blunt, Disc: flat, Projection (extend): distinctly beyond angles, *Mesosternum*: Mesosternal projection: flat. ABDOMEN. Tomentum: absent, *Pygidium*: Apical margin: arcuate, *Sternal groove*: Extent: on apical ventrite, Shape on the apex of last ventrite: angulately sinuate, Emargination (width): markedly wide. LEGS. *Metatarsus*: Size to metatibia: distinctly shorter than metatibia, *Tarsomere 1*: Size to following tarsomeres: longer than 2-3 but shorter than 2-4. GENITALIA. *Ovipositor*: Shape: square (uritiform).

Diagnosis. The very distinctive species which differs from all other members of *A. occipitalis* species-group mainly by characters given for the subgroup definition. See also Appendix.

Type locality. North Vietnam, Tonkin, Ninh Binh province, Cuc-Phuong national park, 20°18'N, 105°39'00"E.

Type material. Holotype (Fig. 1), ♀, (EJCB): "Vietnam N, Tonkin, Cuc-Phuong nat. park, 2–12.V.1991, E. Jendek leg.".

Adult occurrence: 5.

Host plant. Unknown.

Distribution. VIETNAM: Ninh Binh.

Etymology. The specific name is the Latin adjective *tesselatus* (checkered). It refers to the elytral pubescence of the species.

Agrilus tonkineus Kerremans, 1895

http://species-id.net/wiki/Agrilus_tonkineus

Fig. 24 (habitus); Fig. 40 (aedeagus)

tonkineus Kerremans, 1895 (*Agrilus*)

Kerremans 1895: 222-223 (description) – Kerremans 1903: 277 (catalog) – Obenberger 1936a: 1105 (world catalog) – Baudon 1963: 53 (faunal record; Laos) – Descarpentries and Villiers 1963: 105, 109 (lectotype designation; characters; faunal records; Tonkin; Laos) – Baudon 1968: 130, 143 (characters in key; faunal records; Laos) – Kurosawa 1974: 3 (characters; notes) – Bellamy 2008: 2330 (world catalog) –

Jendek and Grebennikov 2011: 206 (synonymy; references; types; diagnosis; faunal records; host plants; distributional summary; East Asia).

= *blatteiceps* Bourgoin, 1925 (*Agrilus*)

Bourgoin 1925: 131 (description) – Théry 1935b: 15 (synonym of *tonkineus*) – Obenberger 1936a: 1105 (synonym of *tonkineus*) – Baudon 1962: 69 (faunal record; Laos) – Descarpentries and Villiers 1963: 109 (synonym of *tonkineus*) – Bellamy 2008: 2321 (synonym of *tonkineus*; world catalog) – Jendek and Grebennikov 2011: 206 (synonym of *tonkineus*).

Type material. *Agrilus tonkineus* Kerremans, 1895. Type locality. Hanoï. Lectotype designated by Descarpentries and Villiers (1963).

Agrilus blatteiceps Bourgoin, 1925. Type locality. Laos: Vien Poukha. Holotype by monotypy examined by Jendek and Grebennikov (2011).

Diagnosis. Size: 7.5–9.5 mm. Very close to *A. mucidus* sp. n. from which it can be distinguished by the pronotum more convex; by the arcuate prehumerus and by the absence of transverse tomentose strip at apical third of elytra. See also Appendix.

Additional material. CHINA: Fujian: 1 ♂ (EJCB): "Shunchang Fujian, 27.iv.1979, Shicheng Ji leg". Hainan: 1 ♀ (USNM): "Hainan Is, Woh Hau Chuen, E of Nodoa, Jul 3, 1929"; 1 ♀ (MNHN): "Hainan, Hu...[illegible], G. Ros leg. 23.v.[19]36". Yunnan: 1 (IZAS): "Yunnan Xishuangbanna Menghun, 1200-1400m, 28.iv.1958, C. P. Hong leg. [in Chinese]"; 1 (IZAS): "Yunnan Xishuangbanna Mengsong, 1600m, 28.iv.1958, S. Y. Wang leg. [in Chinese]"; 1 (IZAS): "Yunnan Xishuangbanna Damenglong, 650m, 11.iv.1958, L. Y. Zheng leg. [in Chinese]". For further records see Jendek and Grebennikov (2011).

Adult occurrence: 4–5–6–7. **Altitude range**: 420–1600 m.

Host plant. Unknown.

Distribution. CHINA: Fujian; Hainan; Yunnan. LAOS: Borikhamxai; Louang Namtha; Vientiane; Xaignabouri; Xiangkhoang. VIETNAM: Ha Noi; Ha Tay; Hoa Binh.

***Agrilus trepanatus* sp. n.**

urn:lsid:zoobank.org:act:46090B44-156C-4387-BADF-35E4F03F81E4

http://species-id.net/wiki/Agrilus_trepanatus

Fig. 14 (habitus of holotype)

Description. BODY. Size: 10.2–12.7 mm (Holotype 12.7 mm). Shape: subparallel, Build: robust, Posterior tapering part: short with broad apex, Color (dorsally): bicolored. HEAD. Medial impression: deep, Epistoma: raised above frons, *Vertex*: Sculpture elements: rugae, Sculpture shape: semispherical, Sculpture density: dense, *Eyes*: Size: small, Lower margin: in line or below with antennal socket, Medial orbit: subparallel, *Antennae*: Length: long, Width: slender, Serration: from antennomere 4, Antennomere 7-10 (shape): with obvious collum. PRONOTUM. Shape: visually square, Sides: slightly arcuate, Maximal width: at middle, Anterior margin: subequal to posterior, *Anterior lobe*: Size: moderate or obvious,

Shape: arcuate, Position: at level with anterior angles, *Posterior angles*: Shape: obtuse or rectangular, Apex: sharp, *Disk*: Convexity: strongly convex, Impressions: medial and lateral, Medial impression: anteromedial and posteromedial, *Prehumerus*: Development: carinal, Shape: arcuate or bisinuate, Extent: to 1/2 of pronotal length or to 1/3 of pronotal length, Modifications: with rudiment at anterior angle, Anterior end: distant from lateral carina, Posterior end: joined with posterior angle or margin, Arc: moderate, *Lateral carinae*: Interspace: narrow, Convergence: moderately convergent, Junction: absent, rarely present, Narrowest point: at posterior 1/5-1/4 of marginal carina, Modifications: submarginal carina posteriorly obliterate. ELYTRA. Color: monochromatic, Humeral carina: absent, *Apices*: Arrangement: separate, Shape: arcuate, *Pubescence*: Color: monochromatic, Extent: entire ornamental with indication of stripes. STERNUM. *Prosternal lobe*: Size: large, Distal margin: arcuate, *Prosternal process*: Shape: dilated or subparallel, Sides: straight, Angles: obtuse, Angles (tips): blunt, Disc: flat, Projection (extend): distinctly beyond angles, *Mesosternum*: Mesosternal projection: flat. ABDOMEN. *Pygidium*: Apical margin: arcuate, *Sternal groove*: Extent: on three apical ventrites, Shape on the apex of last ventrite: arcuate or arcuately sinuate, Emargination (deepness): very shallow. LEGS. *Metatarsus*: Size to metatibia: distinctly shorter than metatibia, *Tarsomere 1*: Size to following tarsomeres: subequal or longer than 2–4. GENITALIA. *Ovipositor*: Shape: markedly elongate.

Diagnosis. *Agrilus trepanatus* sp. n. can be distinguished from all species of the group by the large body; by the strikingly bicolor dorsal side and by the head obviously deeply impressed medially. See also Appendix.

Type locality. South India, Karnataka state, Coorg district, northeastern Virajpet, 75°50'E, 12°13'N, altitude 500 m.

Type material. Holotype (Fig. 14), ♀, (EJCB): "S-India, Karnataka state, Coorg distr., NE Virajpet, 75°50'E, 12°13'N, ca 500m, 4–8.vi.1999, Z. Kejval & M. Trýzna leg.". Paratypes: 1 paratype, ♀ (EJCB): "India, Karnataka, 12 km SW Yellapur, 7.vii-14.viii.84, B. Gill FIT 500 m".

Adult occurrence: 6–7–8. **Altitude range**: 500 m.

Host plant. Unknown.

Distribution. INDIA: Karnataka.

Etymology. The specific name is an adjective derived from the Greek verb *trepao* (drill, bore) in Latinized form *trepano*. It refers to the conspicuously impressed head of this species.

***Agrilus umrongso* sp. n.**

urn:lsid:zoobank.org:act:A12BB28B-30FB-4AC7-8D0A-99F504EA8221
http://species-id.net/wiki/Agrilus_umrongso
Fig. 3 (habitus of holotype)

Description. BODY. Size: 12 mm (Holotype). Shape: cuneiform, Posterior tapering part: long with narrow apex, Color (dorsally): unicolored. HEAD. Medial impression: deep, Epistoma: raised above frons, *Vertex*: Shape: markedly convex, Sculpture elements: rugae,

Sculpture shape: semispherical, Sculpture density: dense, *Eyes*: Size: small, Lower margin: in line or below with antennal socket, Medial orbit: converging ventrally, *Antennae*: Serration: from antennomere 4. PRONOTUM. Shape: transverse, Sides: slightly arcuate, Maximal width: at middle or at posterior margin, Anterior margin: subequal to posterior, *Anterior lobe*: Size: moderate, Shape: arcuate, Position: at level with anterior angles or projecting beyond anterior angles, *Posterior angles*: Shape: obtuse, Apex: sharp, *Disk*: Impressions: medial and lateral, Medial impression: anteromedial and posteromedial, *Prehumerus*: Development: carinal, Shape: bisinuate, Extent: to 1/3 of pronotal length, Anterior end: distant from lateral carina, Posterior end: distant from angles and margin, Arc: weak, *Lateral carinae*: Convergence: moderately convergent, Junction: present, Narrowest point: at posterior angles. ELYTRA. Color: monochromatic, Humeral carina: absent, *Apices*: Arrangement: separate, Shape: arcuate, *Pubescence*: Color: monochromatic, Density: dense, Extent: entire ornamental with indication of stripes. STERNUM. *Prosternal lobe*: Size: large, Distal margin: arcuately emarginate, Emargination (width): narrow, *Prosternal process*: Shape: subparallel, Sides: straight, Angles: obtuse, Angles (tips): blunt, Disc: flat, Projection (extend): distinctly beyond angles, *Mesosternum*: Mesosternal projection: flat. ABDOMEN. Tomentum: present, *Pygidium*: Apical margin: arcuate, *Sternal groove*: Extent: on three apical ventrites, Shape on the apex of last ventrite: arcuate. LEGS. *Metatarsus*: Size to metatibia: distinctly shorter than metatibia, *Tarsomere 1*: Size to following tarsomeres: longer than 2-3 but shorter than 2-4. GENITALIA. *Ovipositor*: Shape: markedly elongate.

Diagnosis. *Agrilus umrongso* sp. n. can be distinguished from the very close *A. perroti* by the head much more deeply impressed medially; by the apically arcuate pygidium and by the distinctly emarginate prosternal lobe. See also Appendix.

Type locality. Northeastern India, Assam, 5 km north of Umrongso, altitude 700 m, 25°27'N, 92°43'E.

Type material. Holotype (Fig. 3), ♀, (EJCB): "NE India, Assam, 1999, 5 km N of Umrongso, 700m, 25°27'N, 92°43'E, 17.–25.v., Dembický & Pacholátko leg.".

Adult occurrence: 5. **Altitude range**: 700 m.

Host plant. Unknown.

Distribution. INDIA: Assam.

Etymology. The specific name is a noun in apposition. It refers to the Umrongso, the type locality of the species.

Agrilus yamawakii Kurosawa, 1957

http://species-id.net/wiki/Agrilus_yamawakii

Fig. 15 (habitus); Fig. 34 (aedeagus)

yamawakii Kurosawa, 1957 (*Agrilus*)

Kurosawa 1957: 192 (description) – Kurosawa 1963: 152 (characters; Japan) – Akiyama 1975: 10 (faunal records; Izu Islands) – Kurosawa 1975: 3 – Akiyama 1980: 85, 87 (faunal record; Japan: Kanagawa) – Tôyama 1985b: 33 (faunal record; Ryukyu Islands) – Tôyama 1985a: 24 (iconography; Japan) – Hirashima 1989: 324 (checklist; Japan) –

Li Jingke 1992: 92 (checklist; China: Liaoning) – Morimoto and Tadauchi 1995: 232 (checklist; Japan) – Akiyama and Akiyama 1996: 187 (faunal records; Japan: Honshu) – Akiyama and Ohmomo 1997: 43 (checklist; Japan) – Nonnaizab et al. 1999: 113 (checklist; China: Inner Mongolia) – Hua Li Zhong 2002: 91 (checklist; China: Taiwan) – Mühle 2003: 47 (checklist; Taiwan) – Jendek 2006: 403 (Palaearctic catalog) – Bellamy 2008: 2366 (world catalog) – Jendek and Grebennikov 2011: 232 (references; types; diagnosis; faunal records; host plants; distributional summary; East Asia).

Type material. *Agrilus yamawakii* Kurosawa, 1957. Type locality. Mt. Fukuchiyama, Fukuoka Pref., Kyűshű, Japan. Holotype examined by Jendek and Grebennikov (2011).

Diagnosis. Size: 6.9–11.7 mm. *Agrilus yamawakii* differs from other member of the group by the following combination of characters: the antennae moderately long; the elytral pubescence obsolete at least in proximal part; apical-most part of elytral apices pubescent. See also Appendix.

Additional material. KOREA SOUTH: 1 ♂ (MNHN): "Corée, Mirinai, Chass. indigènes". For further records see Jendek and Grebennikov (2011).

Adult occurrence: 5–6–7.

Host plant. *Fagara* (=*Zanthoxylum*) *ailanthoides*; *Fagara mantchurica*: Akiyama and Ohmomo (1997).

Distribution. CHINA: Liaoning; Nei Mongol; Taiwan. JAPAN: Honshu; Kyushu; Ryukyu isl. (Okinawa incl.); Shikoku; Tsushima. KOREA NORTH. KOREA SOUTH.

Agrilus zanthoxylumi Li Meng Lou, 1989

http://species-id.net/wiki/Agrilus_zanthoxylumi

Fig. 4 (habitus); Fig. 26 (aedeagus)

zanthoxylumi Li Meng Lou, 1989 (*Agrilus*)

Li Meng Lou 1989: 60–63 (description) – Zhang Runzi 1988: 16-17 ([Note: no scientific name is cited]; biology) – Li Meng Lou et al. 1990: 34–38 (Hou and Feng are cited as the authors; biology; damage character; spatial distribution; China: Shaanxi) – Zhang Rung Ke and Wang Tong Mu 1992: 402–403 (Hou is cited as the author; characters; biology) – Jendek 2006: 403 (Zhang and Wang are cited as the authors; Palaearctic catalog) – Wu Hai 2006: 236–239 (Hou and Feng are cited as the authors; biology; control methods; China: Shandong) – Löbl and Smetana 2007: 29 (authorship of species corrected to Zhang R. & Wang) – Bellamy 2008: 2367 (Zhang and Wang are cited as the authors; world catalog) – Jendek and Grebennikov 2011: 233 (references; types; diagnosis; faunal records; host plants; distributional summary; East Asia).

Type material. *Agrilus zanthoxylumi* Li Meng Lou, 1989. Type locality. Shaanxi (Baoji, Weinan). Type specimens not found. Described from unknown number of specimens. See also Remarks.

Diagnosis. See Jendek and Grebennikov (2011) and Appendix.

Additional material. See Jendek and Grebennikov (2011).

Adult occurrence: 5–6.

Host plant. *Zanthoxylum*: Li Meng Lou (1989); *Zanthoxylum bungeanum*: Wu Hai (2006).

Distribution. CHINA: Gansu; Hubei; Shaanxi; Shandong; Yunnan; Zhejiang.

Remarks. The authorship of the name *zanthoxylumi* had changed several times. Li Meng Lou (1989) attributed the authorship to Hou and Feng, but by presenting characters he unintentionally made this name available. The primary type of *A. zanthoxylumi* has probably not been fixed.

Acknowledgements

All collection curators are sincerely acknowledged for their help in accessing the specimens. For consultation and comments to the early version of the manuscript I thank Aleš Smetana & Vasily Grebennikov (both Ottawa, Canada).

References

Akiyama K (1975) [The buprestids fauna of Izu Islands (Coleoptera, Buprestidae)]. Coleopterists' News, Tokyo 25/26: 10. [in Japanese]

Akiyama K (1980) [Four new records of Buprestids–beetles from Kanagawa Prefecture, with notes on the genus Nipponobuprestis and its allied genera (Coleoptera, Buprestidae)]. Natural History Report of Kanagawa 1: 85–87. [in Japanese]

Akiyama Y, Akiyama K (1996) The Buprestid beetles (Coleoptera: Buprestidae) from Hiroshima Prefecture, southwestern Japan. Miscellaneous Reports of the Hiwa Museum for Natural History 34: 181–192. [in Japanese with English subtitle and summary]

Akiyama K, Ohmomo S (1997) A check list of the Japanese Buprestidae. Gekkan–Mushi (Supplement 1), 67 pp.

Anonymous (1969) Insect pest survey for the year ending 30th june, 1967. Papua New Guinea agricultural jurnal 21 (2): 49–75.

Anonymous (1971) Insect pest survey for the year ending 30th june, 1968. Papua New Guinea agricultural jurnal 22 (3): 179–201.

Baer GA (1886) Catalogue des Coléoptères des Iles Philippines. Annales de la Société Entomologique de France (6) 6: 97–200.

Balachowsky AS, Davatchi A, Descarpentries A (1962) Famille des Buprestidae, p. 235–300. In: Balachowsky AS (Ed) Entomologie appliquée à l'Agriculture, Traité. Tome I, Coléoptères, Premier Volume, Caraboidea, Staphylinoidea, Hydrophiloidea, Scarabaeoidea, Dascilloidea, Cantharoidea, Bostrychoidea, Cucujoidea, Phytophaga (Cerambycidae et Bruchidae), Paris, Masson et cie éditeurs, XXVII + 564 pp.

Baudon A (1961) Contribution à l'étude des Buprestides du Laos. Bulletin de la Société Royale des Sciences Naturelles du Laos No. 1: 57–89.

Baudon A (1962) Contribution à l'étude des Buprestides du Laos. Bulletin de la Société Royale des Sciences Naturelles du Laos No. 4: 65–97.

Baudon A (1963) Addenda à la liste des Buprestidae du Laos. Bulletin de la Société Royale des Sciences Naturelles du Laos No. 9: 49–74.

Baudon A (1968) Catalogue commenté des Buprestidae récoltés au Laos. Deuxième Partie. Vientiane, Ministère de l'Information, 190 pp.

Bellamy CL (1999) Nomenclatural notes in Buprestidae (Coleoptera). Folia Heyrovskyana 7 (1): 1–11.

Bellamy CL (2002) Coleoptera: Buprestoidea. XII + 492 pp, 4 col. pls. In: Houston WWK (Ed), 2002: Zoological Catalogue of Australia. Vol. 29.5. Melbourne, CSIRO Publishing, Australia, 492 pp.

Bellamy CL (2008) A world catalogue and bibliography of the jewel beetles (Coleoptera: Buprestoidea). Volume 4, Agrilinae: Agrilina through Trachyini. Sofia, Pensoft, 79, 1932–2684.

Blair KG (1928) Heteromera, Bostrychoidea, Malacodermata and Buprestidae. In: Insects of Samoa and other Samoan terrestrial arthropoda, Part IV. Coleoptera, Fasc. 2., London, 67–174.

Bourgoin A (1922) Diagnoses préliminaires de Buprestides (Col.) de l'Indo–Chine française. Bulletin de la Société Entomologique de France 1922: 20–24.

Bourgoin A (1925) Diagnoses préliminaires de Buprestides nouveaux de l'Indochine française. Bulletin de la Société Entomologique de France 1925: 130–131.

Carter HJ (1924a) Australian Coleoptera–notes and new species No. iii. Proceedings of the Linnean Society of New South Wales 49: 19–45.

Carter HJ (1924b) Australian Coleoptera: notes and new species. No. iv. Proceedings of the Linnean Society of New South Wales 49: 521–536.

Carter HJ (1929) Preface and species list, In: Carter HJ & Théry A: A check list of the Australian Buprestidae. With tables and keys to sub–families, tribes, and genera by Andre Thery, correspondant de muséum de Paris; and figures (plates xxxi. to xxxiii.) drawn by Cedric Deane, A. M. I. E. (Aust.). Australian Zoologists 5: 265–304.

Carter HJ (1940) Australian Buprestidae and the Junk Catalogue. Annals and Magazine of Natural History (11) 6: 380–389. doi: 10.1080/03745481.1940.9723693

Chûjô M (1970) Coleoptera of the Loo–Choo Archipelago (II). Memoirs of the Faculty of Education Kagawa University Part 2, No 192: 17–21.

Chûjô M, Matuda R (1940) A list of the buprestid–beetles from Kagosima–Districts, southern end of Kyusyu, Japan. Mushi Fukuoka 13: 62–66.

Clausen CP (1933) The citrus insects of tropical Asia. United States Department of Agriculture, Washington Circular No. 266: 1–35.

Curletti G (2001) The genus *Agrilus* in Australia (Coleoptera, Buprestidae). Jewel Beetles No. 9: 1–45, figs, maps.

Curletti G (2006) The genus *Agrilus* Curtis, 1825 in New Guinea and nearest islands (Coleoptera, Buprestidae). Annali del Museo Civico di Storia Naturale Giacomo Doria XCVIII: 157–257.

Dejean PFMA (1833) Catalogue des Coléoptères de la collection de M. le comte Dejean. Livraison 1, (section 1–12), Paris, Chez Méquignon–Marvis père et fils, p. 1–96.

Dejean PFMA (1836) Catalogue des Coléoptères de la collection de M. le comte Dejean. Troisième édition, revue, corrigée et augmentée. Livraisons 1–4, Paris, Chez Méquignon–Marvis père et fils, 384 pp.

Descarpentries A, Chûjô M (1968) Coleoptera from Southeast Asia (VI). 2. Family Buprestidae. Memoirs of the Faculty of Education Kagawa University 2 (161): 8–15.

Descarpentries A, Villiers A (1963) Catalogue raisonné des Buprestidae d'Indochine. II. Agrilini, genre *Agrilus* (2e partie). Revue française d'Entomologie 30 (2): 104–119.

Deyrolle H (1864) Description des Buprestides de la Malaisie recueillis par M. Wallace. Annales de la Société Entomologique de Belgique 8: 1–272, 305–312.

Eschscholtz JF (1822) Entomographien. Erste Lieferung. Berlin, G. Reimer, 128 + 3 pp, 2 col. pls.

Eschscholtz JF (1823) II. Entomographien. Erste Lieferung. Mit zwei illuminirten Kupfertafeln. Berlin, Reimer, 186 pp, 2 col. pl.

Fang Zhigang, Wu Hong (2001) A Checklist of Insects from Zhejiang. China Forestry Publishing House, 452 pp. [in Chinese with Latin name index]

Fisher WS (1921) New Coleoptera from the Philippine Islands. Family Buprestidae, tribe Agrilini. Philippine Journal of Science, Manila 18 (4): 349–447.

Fisher WS (1926) Fauna Samarensis: Coleoptera, Buprestidae. Philippine Journal of Science, Manila 31 (2): 235–244.

Fukutomi H, Kurihara T (2011) [Host plant record for *Agrilus auroapicalis ishigakianus* Toyama from Iriomotejima, Japan]. Sayabane 1: 27. [in Japanese]

Gemminger M, Harold E von (1869) Catalogus coleopterorum hucusque descriptorum synonymicus et systematicus. Tom. V, Buprestidae, Trixagidae, Monommidae, Eucnemidae, Elateridae, Cebrionidae. Monachii, Sumptu E. H. Gummi, 1347–1608.

Gory HL (1841) Histoire naturelle et iconographie des insectes coléoptères, Supplément aux buprestides. Tome IV, Livraisons 43–52, P. Duménil, Paris.

Gory HL, Laporte de Castelnau FL (1839) Histoire naturelle et iconographie des insectes coléoptères, publiée par monographies séparées. Suite aux buprestides. Tome II, Paris, P. Duménil, genera paged separately.

Gray JE (1848) Nomenclature of coleopterous insects in the collection of the British museum. Part III.–Buprestidae. London, E. Newman, 52 pp.

Guryeva EL (1974) Buprestidae–Zlatki. In: Kryzhanovskii OL (Ed): Nasekomye i kleshchi–vrediteli sel'skokhozyaistvennykh kul'tur. Tom II, zhestkokrylye. Leningrad, Nauka, 96–112.

Hawkeswood TJ, Turner JR (1994) A note on the biology and behaviour of *Agrilus occipitalis* Eschscholtz (Coleoptera: Buprestidae) in Papua New Guinea. Jewel Beetles 3: 14–18.

Hill DS (2008) Pests of crops in warmer climates and their control. Springer Netherlands, 704 pp. doi: 10.1007/978-1-4020-6738-9

Hirashima Y (1989) Buprestidae, p. 320–327. In: Morimoto & Tadauchi (Eds). A check list of Japanese insects. I, Fukoka, Entomological laboratory, Kyushu University Express, XI + 540 pp.

Hua Li Zhong (2002) List of Chinese Insects. Vol. II. Guangzhou, Zhongshan (Sun Yat–sen) University Press, 612 pp.

Huangfu Wei Guo, Wei Shu Jun, Zheng Hong Hai, Liu Peng Cheng, Huang Wei, Shi Zu Hua, Chen Xue Xin (2007) Ovarian development of *Agrilus auriventris* Saunders (Coleoptera: Buprestidae). Acta Entomologica Sinica 50 (7): 682–688. [in Chinese with English subtitle]

Iga M (1955) Buprestidae, p. 73–82. In: Nakane T (Ed) Coloured illustrations of the insects of Japan. Coleoptera. Enlarged and revised edition. Osaka, Hoikusha, 274 pp. [in Japanese with English subtitle]

Iga M (1962) Buprestidae, p. 73–82. In: Nakane T (Ed) Coloured illustration of the insects of Japan (Coleoptera). Osaka, Hoikusha, 274 pp. [in Japanese with English subtitle]

ICZN (International Commission on Zoological Nomenclature) (1999) International Code of Zoological Nomenclature. Fourth Edition, adopted by the International Union of Biological Sciences. London, International Trust for Zoological Nomenclature, XXIX + 306 pp.

Isrigaya T (1963) [On the occurrence and control of citrus flat–headed borer [*Agrilus auriventris*] in Wakayama Prefecture]. Plant Protection 17 (9): 351–355. [in Japanese]

Jackman JA (1987) A new species of Sambus from Luzon Island, Philippines, with notes on other species in other genera (Buprestidae: Coleoptera). Coleopterists Bulletin 41 (1): 27–33.

Jakobson GG (1913) Zhuki Rossii i zapadnoi Evropy. Rukovodstvo k'' opredeleniyu zhukov. Vypusk'' X–yi. A. F. Devrien'', S.–Peterburg'', (2) + p. 721–864, pls 76–83 [Buprestidae: 770–800]. [in Russian]

Jendek E (1998) Lectotype designations in the Palaearctic and Oriental *Agrilus* species (Coleoptera: Buprestidae) of the Oberthür's collection in the Muséum national d'Histoire naturelle, Paris. Acta Societatis Zoologicae Bohemicae 62: 315–333.

Jendek E (2000) Studies in the Palaearctic and Oriental *Agrilus* (Coleoptera, Buprestidae). I. Biológia, Bratislava 55 (5): 501–508.

Jendek E (2003) Studies in the Palaearctic and Oriental *Agrilus* (Coleoptera, Buprestidae). III. Biológia, Bratislava 58 (2): 179–190.

Jendek E (2005) Taxonomic and nomenclatural notes on the genus *Agrilus* Curtis (Coleoptera: Buprestidae: Agrilini). Zootaxa 1073: 1–29.

Jendek E (2006) New nomeclatorial and taxonomic acts and comments. Buprestidae: *Agrilus* p. 60. Catalog: genus *Agrilus* Curtis, 1825, p. 388–403. In: Löbl I, Smetana A (Eds) Catalogue of the Palaearctic Coleoptera, Vol. 3, Stenstrup, Apollo Books, 690 pp.

Jendek E (2012) Studies in the Palaearctic and Oriental *Agrilus* (Coleoptera, Buprestidae) IV. Zootaxa 3300: 1–19.

Jendek E, Grebennikov V (2011) *Agrilus* (Coleoptera, Buprestidae) of East Asia. Prague, Jan Farkač, 362 pp.

Kalshoven LGE (1951) De plagen van de cultuurgewassen in Indonesië. Deel. II, Van Hoeve's Bandoeng, 1 p + 513–1065 pp +8 col. pls, 281 Figs [in Dutch with English translation of the text for illustrations]

Kerremans C (1885) Énumération des Buprestides décrits postérieurement au Catalogue de MM. Gemminger & de Harold. 1870–1883. Annales de la Société Entomologique de Belgique 29: 119–157.

Kerremans C (1892a) Viaggio di Leonardo Fea in Birmania e regioni vicine. XLIX. Buprestides. Annali del Museo Civico di Storia Naturale di Genova Serie 2, 12 (32): 809–832.

Kerremans C (1892b) Catalogue synonymique des Buprestides decrits de 1758 à 1890. Séance du 5 septembre 1891. Mémoires de la Société Entomologique de Belgique 1: 1–304.

Kerremans C (1895) Buprestides Indo–Malais. Deuxième partie. Annales de la Société Entomologique de Belgique 39: 192–224.

Kerremans C (1898) Buprestides nouveaux de l'Australie et des régions voisines. Annales de la Société Entomologique de Belgique 42: 113–182.

Kerremans C (1900a) Buprestides nouveaux et remarques synonymiques. Annales de la Société Entomologique de Belgique 44: 282–351.

Kerremans C (1900b) Contribution a l'Etude de la faune entomologique de Sumatra (Côte ouest–Vice–résidence de Païnan). Chasses de M. J. –L. Weyers VI. Buprestides. Mémoires de la Société Entomologique de Belgique 7: 1–60.

Kerremans C (1903) Coleoptera Serricornia. Fam. Buprestidae, Fasc. 12b, 12c, 12d. In: Wytsman (Ed) Genera Insectorum. Tome II, Fascicules XII–XIV. Verteneuil & Desmet, Bruxelles, 49–338.

Kurosawa Y (1950) Iconographia Insectorum Japonicorum. [pars Buprestidae p. 3183–3216]. 1031–1186. [in Japanese]

Kurosawa Y (1956) Buprestidae. In: Esaki T, Ishii T, Kawamura T, Kinoshita S (Eds) Iconographia insectorum Japonicorum, Editio secunda, reformata, Tokyo, Hokuryukan, 1111–1122.

Kurosawa Y (1957) Buprestid–fauna of Eastern Asia (4). (Coleoptera). Bulletin of the National Science Museum, Tokyo Vol. 3, No. 3 (No. 40): 183–194.

Kurosawa Y (1963) Buprestidae. 147–156 [Buprestidae], 167–168, 187–188. In: Nakane T, Ohbayashi K, Nomura S, Kurosawa Y (Eds) Iconographia Insectorum Japonicorum. Colore naturali edita. Volumen II (Coleoptera). Tokyo, Hokuryukan, 443 pp, 192 pls. (in Japanese)

Kurosawa Y (1974) [A comment to the Japanese Buprestidae (10)]. Coleopterists' News, Tokyo 17/18: 1–4. [in Japanese]

Kurosawa Y (1975) [A comment to the Japanese Buprestidae (14)]. Coleopterists' News, Tokyo 27/28: 1–4. [in Japanese]

Lewis G (1879) A catalogue of Coleoptera from the Japanese archipelago. London, Taylor and Francis, 31 pp.

Li Jingke (1992) The Coleoptera fauna of Northeast China. Jilin, Education Publishing House, 205 pp.

Li Meng Lou (1989) *Agrilus zanthoxylumi*, p. 60–63. In: Li Meng Lou, Cao Zhi Min, Wang Pei Xin (Eds): Growth and pest control of Zanthoxylum bungeanum Maxim. Xi'an, Shaanxi Science & Technology Press.

Li Meng Lou, Li Zongming, Jia Aiye (1990) Spatial distribution pattern and damage characters of prigkly ash stem girdler. Journal of Nortwestern College of Forestry 5 (1): 34–38. [in Chinese with English subtitle and abstract]

Lin Gui Rui (2002) List of fruit tree pests of Taiwan and Mainland of China. Wufeng, Taichung, Taiwan, Taiwan Agricultural Research Institute, 847 pp. [in Chinese]

Löbl I, Smetana A (2007) Errata for Volume 3, In: Löbl I, Smetana A (Eds) Catalogue of Palaearctic Coleoptera. Volume 4. Elateroidea–Derodontoidea–Bostrychoidea–Cleroidea–Cucujoidea. Apollo Books, Stenstrup, 24–31.

Macabasco C (1964) The citrus pests and their control. Philippine Journal of Agriculture 26 (3–4): 133–154.

Mannerheim CG von (1837) Enumeration des Buprestides, et description de quelques nouvelles espèces de cette tribu de la famille des Sternoxes, de la collection de M. Le Comte Mannerheim. Bulletin de la Société Impériale des Naturalistes de Moscou 10: 1–126.

Miwa Y (1931) A systematic catalogue of Formosan Coleoptera. Entomological laboratory Taihoku Imperial University, Contribution No. 32, Reprinted from the report No. 55 Department of Agriculture, Government Research Institute, Taihoku, Formosa, 359 pp.

Miwa Y (1940) Buprestidae, In: Hirayama S (Ed) Genshoku Kōchū Zufu, Sanseido, Tokyo, 70–74, 52 pls. [in Japanese]

Miwa Y, Chûjô M (1936) Catalogus Coleopterorum Japonicorum. Buprestidae. Taihoku, Formosa. Taiwan–Konshu–Kenkyusho, 26 + 8 pp index, [corrigenda et addenda separately paginated]. [in Japanese]

Miwa Y, Chûjô M (1940) An iconography of some new and rare species of Buprestidae from the Japanese Empire. Nippon no Kôchû, Tokyo 3 (2): 53–74, 1 pl. (in Japanese and English)

Morimoto K, Tadauchi O (1995) Catalogue of the Japanese wildlife. [Inveretebrata II] Insecta, Tokyo, Japan Wildlife Research Center, 621 pp. [in Japanese]

Mühle H (2003) Taiwanese buprestids (Coleoptera, Buprestidae). Journal of the Zoological Society Wallacea 1: 43–48.

Mühlmann H (1954) Buprestidae, Prachtkäfer, Flatheaded borer, In: Blunck H (Ed) Handbuch der Pflanzenkrankheiten. Fünfter Band, Tierische Schädlinge an Nutzpflanzen, 2. Teil, Fünfte neubearbeitete Auflage, Zweite Lieferung, Coleoptera. P. Parey, Berlin und Hamburg, 62–88.

Naka K, Ohashi H (1996) Occurrence and chemical control of the flatheaded citrus borer, Agrilus auriventris (E. Saunders) in Wakayama Prefecture. Proceedings of the Kansai Plant Protection 38: 43–44, Figs [in Japanese with English subtitle]

Nelson GH, Bellamy CL (1993) A clarification of authors and publication dates in the Histoire naturelle et iconographie des insectes coléoptères by F. L. de Laporte & H. L. Gory (Coleoptera: Buprestidae). Giornale Italiano di Entomologia 6: 297–308.

Nonnaizab Qi Baoying, Li Yabai (1999) Insects of Inner Mongolia China, 506 pp. [in Chinese with English subtitle and preface]

Obenberger J (1914) Agrili generis specierum novarum diagnoses. Časopis České Společnosti Entomologické 11: 41–52.

Obenberger J (1916) Analecta II. Fam Buprestidae. Neue Beiträge zur systematischen Insektenkunde 1: 30–32.

Obenberger J (1923) Popisy nových australských krasců. Description of new Australian Buprestidae. Acta Entomologica Musaei Nationalis Pragae 1: 72–81.

Obenberger J (1924a) Kritische Studien über die Buprestiden (Col.). Archiv für Naturgeschichte 90 (A) Heft 3: 1–171.

Obenberger J (1924b) Symbolae ad specierum regionis palaearcticae Buprestidarum cognitionem. Jubilejní Sborník Československé Společnosti Entomologické 1924: 6–59.

Obenberger J (1924c) A study of the Buprestidae, collected by Charles Fuller Baker in Singapore, Borneo and the Philippine Islands. Philippine Journal of Science, Manila 25 (5): 539–660.

Obenberger J (1926) Buprestidae. In: Winkler A (Ed) Catalogus Coleopterorum regionis palaearcticae. Pars 6, Wien, A. Winkler, 620–663.

Obenberger J (1931) Příspěvek k poznání javanských krasců. De nonnullis insulae Javae Buprestidarum speciebus. Časopis Československé Společnosti Entomologické 28: 35–39.

Obenberger J (1935a) Synonymia Agrilorum (Col. Bupr.) II. Časopis Československé Společnosti Entomologické 32: 121.

Obenberger J (1935b) De regionis palaearcticae generis Agrili speciebus novis (Col. Bupr.). O nových palaearktických druzích krasců z rodu *Agrilus*. Časopis Československé Společnosti Entomologické 32: 161–171.

Obenberger J (1936a) Buprestidae V., p. 935–1246. In: Junk W & Schenkling S (Eds) Coleopterorum Catalogus, Volumen XIII, Pars 152, Gravenhage, Verlag für Naturwissenschaften, W. Junk, 311 pp.

Obenberger J (1936b) Synonymia Agrilorum (Col. Bupr.) II. Časopis Československé Společnosti Entomologické 33: 91–92.

Obenberger J (1940) Ad regionis palaearcticae Buprestidarum cognitionem additamenta. Studie o palaearktických krascích (Col. Bupr.). Acta Musaei nationalis Pragae (Zool. No. 3) 2 B, No. 6: 111–189.

Ogloblin DA, Reichardt AN (1932) Otryad Coleoptera. Zhuki. In: Stackelberg AA (Ed) Spisok vrednykh nasekomykh SSSR i sopredel'Nykh stran. Chast' I, Vrediteli sel'skogo khozyaistva, Verzeichnis der schädlichen Insekten der paläarktischen region. Teil I. Schädlinge der Landwirtschaft, Tipografya Pechatnaya, Leningrad, 273–327.

Ohgushi R (1963) Development of ovary and pre–oviposition period of citrus flat–headed borer, *Agrilus auriventris* Saunders under laboratory conditions. Japanese Journal of Applied Entomology and Zoology 7 (2): 92–96. [in Japanese with English subtitle and summary] doi: 10.1303/jjaez.7.92

Ohgushi R (1966a) Ecological studies on the citrus flat–headed borer, *Agrilus auriventris* Saunders. I. Season of emergence. Japanese Journal of Applied Entomology and Zoology 10: 55–63. [in Japanese with English subtitle and summary] doi: 10.1303/jjaez.10.55

Ohgushi R (1966b) Studies on the ecology of citrus flat–headed borer [*Agrilus auriventris* Saunders]. 2. Environmental conditions and infestation. Proceeding of Horticultural Society Japan 35: 361–366. [in Japanese with English summary] doi: 10.2503/jjshs.35.361

Ohgushi R (1978) On an outbreak of the citrus flat–headed borer, *Agrilus auriventris* E. Saunders in Nagasaki prefecture. Research on population ecology 9: 62–74. doi: 10.1007/BF02521397

Peng Zhongliang (1987) A check list of the buprestid beetles known to China. Journal of Southwest Agricultural University 9 (2): 125–133, 349–364. [in Chinese with English subtitle and summary]

Peng Zhongliang (1992) Buprestidae. In: Peng Jianwen, Liu Youqiao (Eds) Iconography of forest insects in Hunan China. Hunan, Academia Sinica & Hunan Forestry Institute, 1–60, 1–4, 387–408. [in Chinese with English summary]

Peng Zhongliang (1994) Notes on species of Buprestidae (Coleoptera) new to China. Entomological Journal of East China 3 (1): 17–20. [in Chinese with English summary]

Peng Zhongliang (2002) Buprestidae, p. 246–281. In: Huang Peikan (Eds) Fauna of Insects in Fujian Province of China Vol. 6: 894 pp.

Peng Zhongliang, Huang Bangkan (1995) Brief notes on diagnosis and biology of citrus buprestid beetle *Agrilus inamoenus* Kerremans (Coleoptera: Buprestidae). Wuyi Science Journal 12: 98–101, Figs [in Chinese with English subtitle and summary]

Quayle H J (1938) Insects of citrus and other subtropical fruits. Ithaca, New York, Comstock, XI + 583 pp.

Samouelle G (1819) The entomologist's useful compendium; or an introduction to the knowledge of British Insects. T. Boys, London, 496 pp, 12 pls.

Saunders E (1867) Notes on rare and descriptions of new species of Buprestidae collected by Mr. James Lamb in Penang. Transactions of the Entomological Society of London 5 (7): 509–521.

Saunders E (1870) Catalogue of the species contained in the genus Buprestis of Linnaeus, previous to its subdivision by Eschscholtz in 1829, referring each to its present genus. London, John van Voorst, V + [I] + 7–37 pp.

Saunders E (1871) Catalogus Buprestidarum Synonymicus et Systematicus. London, E. W. Janson, XXIII + 171 pp.

Saunders E (1873) Descriptions of Buprestidae collected in Japan by George Lewis, Esq. Journal of Proceedings of the Linnean Society of London, Zoology 11: 509–523.

Saunders E (1874) Notes on the Buprestidae collected by Professor Semper in the Philippine lslands; with descriptions of the new species. Transactions of the Entomological Society of London 2: 303–328.

Schönfeldt H von (1887) Catalog der Coleopteren von Japan mit Angabe der bezüglichen Beschreibungen und der sicher bekannten Fundorte. Jahrbücher des Nassauischen Vereins für Naturkunde 40: 29–204.

Schultze W (1916) A catalogue of Philippine Coleoptera. Philippine Journal of Science Manila 11 (1): 1–194.

Shi Fu Ming, Liu Yu Shuang, Qu Ping (2006) Comparative studies on elytral surface structures of Coraebus and its related genera (Coleoptera, Buprestidae). Acta Zootaxonomica Sinica 31 (4): 723–727.

Shimizu K, Nakashima Y, Momiki H (1961) [On the citrus flat–headed borer *Agrilus auriventris* Saunders. 2. Behavior of adult]. Plant Protection, Kyushu 7: 57–59. [in Japanese]

Tan JP (1925) The citrus bark borer (*Agrilus occipitalis*, Eschsch.). Philippine Agricultural Review 18 (4): 583–584.

Tanaka K (1928) On the citrus flat–headed borer [*Agrilus auriventris* Saunders], an important insect pest of citrus (Preliminary report). Nogyo oyobi engei [Agriculture & Horticulture], 3, 1437–1444. [in Japanese]

Ter Minasyan ME (1955) Buprestidae, Bruchidae, Anthribidae, Rhinomaceridae, Attelabidae. In: Arnol'di LV, Medvedev SI, Plavilshchikov NN, Stark VN & Ter Minasyan ME Otryad Coleoptera–Zhestkokrylye ili zhuki. In: Pavlovslii EN (Eds) Vrediteli lesa. Spravochnik. II. Akademiya Nauk SSSR, Zoologicheskii Institut, Leningrad, 425–737. [in Russian]

Théry A (1904) Buprestides récolts par le Dr Horn a Ceylan. Annales de la Société Entomologique de Belgique 48: 158–167.

Théry A (1927) Recherches synonymiques sur les Buprestides et descriptions d'Espéces nouvelles (Suite et fin). Bulletin et Annales de la Société Entomologique de Belgique 67 (1–2): 33–48.

Théry A (1934) Études sur les Buprestides (quatriéme partie). Bulletin et Annales de la Société Entomologique de Belgique 74: 131–151.

Théry A (1935a) Notes sur quelques Buprestidae (Col.) chinois et description d'une espèce nouvelle. Bulletin de la Société Entomologique de France 40: 132–134.

Théry A (1935b) Note sur les Buprestides indo–chinois décrits par M. A. Bourgoin. Bulletin de la Société Entomologique de France 40 (1): 14–15.

Théry A (1935c) Note sur les Buprestides du Museum de Leiden. Zoologische Mededeelingen 18: 241–256.

Théry A (1936) Notes synonymiques sur les Buprestides (Col.). Bulletin de la Société Entomologique de France 41 (4): 59–61.

Tôyama M (1985a) Agrilinae. In: Kurosawa Y, Hisamatsu S, Sasaji H (Eds) Colored illustrations of the Coleoptera of Japan. Vol. III. Osaka, Hoikusha Publishing, first edition, 13–32. [in Japanese]

Tôyama M (1985b) The buprestid beetles of the subfamily Agrilinae from Japan (Coleoptera, Buprestidae). Elytra 13 (1): 19–47.

Wei Shu Jun, Zheng Hong Hai, Huangfu Wei Guo, Shi Zu Hua, Chen Xue Xin (2006) Division of larval instars of citrus borer, *Agrilus auriventris* Saunders (Coleoptera: Buprestidae). Acta Entomologica Sinica 49 (2): 302–309. [in Chinese with English subtitle and summary]

Wei Shu Jun, Zheng Hong Hai, Huangfu Wei Guo, Shi Zu Hua, Chen Xue Xin (2007) Morphological observation on the immature stages of *Agrilus auriventris* Saunders (Coleoptera: Buprestidae). Acta Entomologica Sinica 50 (1): 79–84. [in Chinese with English subtitle and summary]

Williams GA (2002) A taxonomic and biogeographic review of the invertebrates of the Central Eastern Rainforest Reserves of Australia (CERRA) World Heritage Area, and adjacent regions. Technical Reports of the Australian Museum 16: 1–208. doi: 10.3853/j.1031-8062.16.2002.1353

Woo Sheh Ming (1964) Studies on the citrus buprestid beetle, *Agrilus auriventris* Saunders. Acta Phytophylacica Sinica 3 (1): 61–71. [in Chinese with English subtitle and summary]

Wu Hai (2006) Bionomics and control of *Agrilus zanthoxylumi*. Chinese Bulletin of entomology 43 (2): 236–239. [in Chinese with English summary]

Yamamoto S, Kamimura H, Iwasaki M (1961) On the investigation of citrus flat–headed borer [*Agrilus auriventris* Saunders] and gummosis in orchards. Report of Kumamoto Fruit Experiment. Station. No. 1: 1–8. [in Japanese]

Yoshikawa K, Ohgushi R, Sakagami S (1969) Preliminary report on entomology of the Osaka City University 5th scientific expedition to Southeast Asia 1966. With descriptions of two new genera of Stenogasterinae wasp. Nature and Life in Southeast Asia 6: 153–182.

Yuasa H (1932) Family Buprestidae. In: Esaki T, Hori H, Yasumatsu K, Nippon Konchu Zukan. Iconographia insectorum Japonicorum, Editio prima, Tokyo, Hokuryukan, 652–660.

Yuasa H (1933) On the structure of some Japanese buprestid–larvae, with notes on their life–history. Journal of the Imperial Agricultural Experiment Station, Tokyo 2 (2), 263–282. [in Russian with English summary]

Yuasa H (1949) Buprestidae. In: Illustrated pocket book of Japanese insects. Tokyo, Hokuryukan, 126–128. [in Japanese with English subtitle]

Zhang Rung Ke, Wang Tong Mu (1992) *Agrilus zanthoxylumi* Hou. In: Xiao Gangrou (Ed) Forest Insects of China. The second edition (Revised & enlarged). Beijing, China forestry publishing house, 402–403.

Zhang Runzi (1988) [Primary observation on Zanthoxulum–buprestid]. Forest Pest and Disease 4: 16–17. [in Chinese]

Zheng Hong Hai, Wei Shu Jun, Huangfu Wei Guo, Shi Zu Hua, Chen Xue Xin (2006) Spatial distribution pattern of *Agrilus auriventris* Saunders (Coleoptera: Buprestidae). Acta Entomologica Sinica 49 (5): 805–809. [in Chinese with English subtitle and summary]

Appendix

Character state matrix for species from *Agrilus occipitalis* species-group with the most important diagnostic characters. (doi: 10.3897/zookeys.256.4272.app) File format: Adobe PDF file (pdf).

Citation: Jendek E (2012) Revision of the *Agrilus occipitalis* species–group (Coleoptera, Buprestidae, Agrilini). ZooKeys 256: 35–79. doi: 10.3897/zookeys.256.4272.app