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A new species of *Hedya* Hübner from Iran with proposed rearrangement of some species currently assigned to *Metendothenia* Diakonoff (Lepidoptera: Tortricidae)

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Abstract

Hedya tritofa, new species, is described and illustrated based on eleven males and five females collected in northern Iran (Gilan, Mazandaran, and Golestan provinces). Morphology and diagnostic characters of *Hedya* Hübner, 1825, *Metendothenia* Diakonoff, 1973, the *Olethreutes* group of genera, and the *Neopotamia* group of genera are discussed. We propose the resurrection of the combinations *Hedya atropunctana* (Zetterstedt, 1840), **revised status**, and *H. separatana* (Kearfott, 1907), **revised status**, and the **new combination** *H. inouei* (Kawabe, 1987).

Key words. Olethreutinae, Olethreutini, *Neopotamia*, *Olethreutes*, spine clusters

Introduction

During a study of olethreutine moths collected in north and northwest Iran in summer 2007, we discovered a species that is superficially similar to *Metendothenia atropunctana* (Zetterstedt, 1840) but whose male genitalia differ from those of putatively related species in the distribution of spine clusters in the baso-medial surface of the valva. Moreover, the wing pattern revealed some similarities with species of *Hedya* Hübner, 1825. Additional material of the new species was obtained from field work and curation of the Hayk Mirzayans Insects Museum of Iranian Research Institute of Plant Protection (IRIPP).

Olethreutini, with about 1400 species in over 144 genera, occur in all parts of the world but chiefly in the Oriental and Holarctic regions (Horak & Brown 1991). The new taxon is interesting from a faunistic perspective because only nine species of Olethreutini previously were recorded from Iran (Barou 1967, Razowski 1963, 2003). Moreover, the circumscription, diagnosis, and relationships among *Hedya* Hübner, *Metendothenia* Diakonoff, 1973, and a few other related genera of Olethreutini are poorly resolved on a global basis. Recent insights into the knowledge of Olethreutini (Aarvik 2004, Horak 2006) and the study of the new species and related taxa revealed inconsistencies in the assignment of species to *Metendothenia* and *Hedya*. The purpose of this paper is to describe the new species and discuss morphological features that may better define these two genera.

Material and methods

This study is based mainly on material collected from northern Iran and deposited in the Hayk Mirzayans Insects Museum. Specimens were collected using light traps. Morphological characters were examined with Leica MZ9.5 stereomicroscopes. Photographs were taken through a Leica Macroscope Z16 APO equipped with a digital camera DFC 500 and a Dino-Eye Microscope Eye-Piece camera. Some images are the result of combining multiple images

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using the software Combine ZP. General editing of images was done using Photoshop CS3 software. Genitalia were dissected and stained following standard methods (Robinson 1976). Wing venation was studied following Forbes' method (Hood 1953). Wing pattern analysis and terminology follow Brown and Powell (1991) as refined by Baixeras (2002). General and genitalia terminology follows Horak (1999) and Klots (1970), respectively.

Systematics

Hedya tritofa sp. n.

Holotype: ♂, Siāhkal- Deylamān Rd., Tootki vill. (Gilān Prov.), N 37° 3´ 37.74˝, E 49º 50´ 56.41˝, 464 m, 22.vii.2010, Ālipanāh leg. (GS: HA 1170). Deposited in IRIPP.

Paratypes: 1♂, Rāmsar, Rāmsar- Javāherdeh Rd. (km 6) (Māzandarān Prov.), N 36° 54´ 29.3˝, E 50° 35´ 13.2˝, 554 m, 23.vii.2007, Ālipanāh, Zahiri leg. (GS: HA 928); 1 ♂, Bandar Anzali, Punel, 30 km S Asālem (Gilān Prov.), 250 m, 12.viii.1974, Mirzāyāns, Ilkhāni leg.; 4 ♂♂, Rāmsar, Eshkatechāl (Māzandarān Prov.), 1200 m, 28.v.2003, Gilāsiān, Nematiān leg.; 2 ♂♂, Tang-e Gol, Golestān National Park (Golestān Prov.), N 37° 22´ 14.7˝, E 55° 56´ 00.0˝, 718 m, 30.viii.2009, Ālipanāh, Buszko leg.; 1 ♀, Behshahr, Duk forest (Māzandarān Prov.), 840 m, 23.vii.1977, Pāzuki, Mortazavihā leg.; 1 ♀, Nekā (Māzandarān Prov.), N 36° 30´ 16.7˝, E 53° 23´ 27˝, 527 m, 30.ix.2007, Ālipanāh, Buszko, Zahiri leg.; 2 ♂♂, 3 ♀♀, Siāhkal- Deylamān Rd., Tootki vill. (Gilān Prov.), N 37° 3´ 37.74˝, E 49º 50´ 56.41˝, 464 m, 22.vii.2010, Ālipanāh leg. All material deposited in IRIPP.

Description. *Male* (Fig. 1). Head: Scales slightly erect, dark brown, with some dark iridescence on vertex and crown; smaller scales on fronto-clypeus concolorous; labial palpus brown or dark brown laterally, with length less than twice width of compound eye; proboscis developed, unscaled; antenna dorsally brown, ventrally cream, with short, dense ventral cilia; ocelli and chaetosemata well developed. *Thorax*: Scaling smooth, dorsally glossy dark brown to somewhat iridescent, progressively paler toward ventral areas; legs unmodified, brown dorsally, paler ventrally, concolorous with thorax; hair pencil from metatibia base. Forewing length 6.7–8.3 mm ($\bar{x}$= 7.2 mm, n= 11); upperside with basal, subbasal and median fasciae almost fused (Figs. 1, 3), with small but distinctive group of dark scales centered on base of M_1 and M_2 slightly distal to median fascia; distal one-half of wing almost white; postmedian fascia represented by small group of dark scales on margin where R_1 meets costa, preterminal fascia represented by similar fragment where R_3 meets costa; postmedian or preterminal fragments not expressed on termen or inner margin of wing; an irregular patch of scattered dark scales between R_4 and M_2, sometimes extending distally; a thin band of scales along margin from R_4 (costal) to M_1 (terminal); strigulae 1 to 4 indistinct, those between Sc and R_4 fused into conspicuous white costal marks between veins, concolorous with adjacent wing surface; terminal strigulae absent; fringe mostly brownish, creamy-white toward tornus; underside light brown, much paler toward termen, with overlapping area slightly iridescent; strigulae detectable on costa from Sc to R_4. Hindwing with upperside greyish brown, underside lighter; fringe concolorous with wing; anal roll simple, extending less than one-half length of 3A. *Abdomen*: Cream to dirty-cream. Genitalia (Figs. 4, 6) with uncus slender, elongate, hairy ventrally, especially at apex; socii large drooping hairy lobes; anal tube slightly sclerotized laterally (subscaphium), connected basally to base of socii through two slightly sclerotized plates (gnathos); cucullus about one-half length of valve, narrow, length ca. 5 × medial width; ventral lobe and distal margin of cucullus spined; medial surface progressively less hairy toward apical and dorsal areas, apical edge of cucullus with sparse setae; neck of valva almost naked, sometimes with few scattered, variably spinulose setae on the ventral edge; basomedial surface of valva with three spine clusters: one (Spc^1) on large prominent lobe at distal part of basal excavation and two (Spc^2 and Spc^4) between Spc^1 and ventral margin of neck, central cluster (Spc^2) including setae and long spines as well as short more robust spines in distal position; membrane of basal excavation with small group of short hairs (Spc^5) on slightly sclerotized plate near distal margin; juxta with dorsolateral processes extended to junction of valva and tegumen (point of articulation with tegumen); phallus stout, slightly curved, distally dentate on left; cornutus not detectable.

Female. Head and thorax: Essentially as in male, except antennae with ventral cilia sparse, metatibia lacking hair pencil, hindwing without anal roll; forewing length 7.2–5.5 mm ($\bar{x}$ = 6.7 mm, n= 5). Abdomen: Genitalia (Fig. 7) with posterior margin of seventh sternum broadly excavated, otherwise unmodified; sterigma a protruding

Figure 1

Figure 2

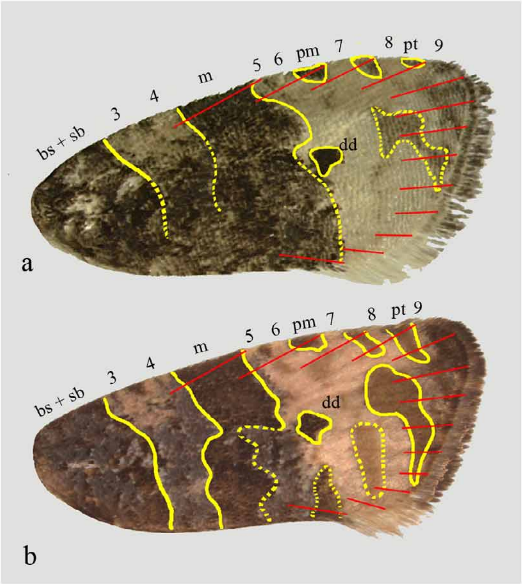

Figure 3

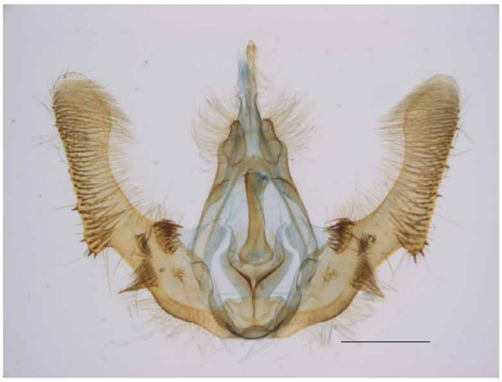

Figure 4

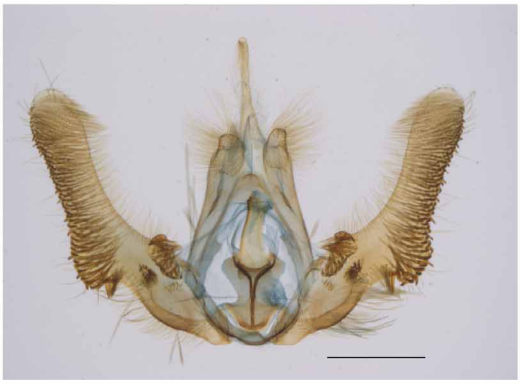

Figure 5

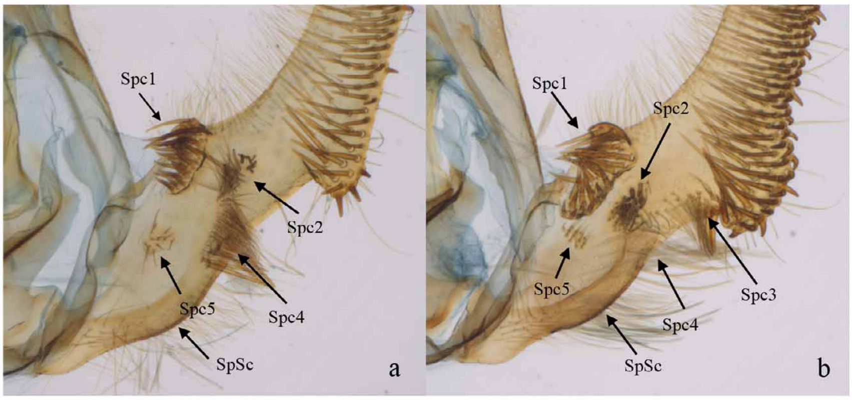

Figure 6

FIGURES 1–6. *Hedya* adults and male genitalia. 1. *H. tritofa*, male (Paratype, Iran, Māzandarān Prov., Rāmsar, Eshkatechāl, 1200 m, 28.v.2003, Gilāsiān, Nematiān leg.). 2. *M. atropunctana*, male (Germany, Wurtemberg, Schwarzwald, Wildbad, 520 m, 5.v.1973, L. Süssner). 3. Forewing pattern interpretation and comparison between *H. tritofa* (a: Siāhkal- Deylamān Rd., Tootki vill. (Gilān Prov.), N 37° 3′ 37.74″, E 49° 50′ 56.41″, 464 m, 22.vii.2010, Ālipanāh leg.) and *M. atropuntana* (b: same specimen as Figure 2) (yellow lines indicate limits between fascial and interfascial areas; broken lines indicate ill-defined limits; red lines indicate distal course of major veins; numbers indicate hypothetical position for pairs of strigulae; bs: basal fascia; sb: subbasal fascia; m: median fascia; pm: postmedian fascia; pt: preterminal; dd: discal dot). 4. *H. tritofa*, male genitalia (same data as Figure 1, GS: JB 20516). Scale bar = 500 µm. 5. *M. atropunctana*, male genitalia (same data as Figure 2, GS: JB 20515). Scale bar = 500 µm. 6. Comparison of male genitalia (neck of valva) between *H. tritofa* (a) and *M. atropunctana* (b) (same data as Figures 5 and 6) (Spc^{1} to Spc^{5}: spine clusters 1 to 5; SpSc: saccular spines).

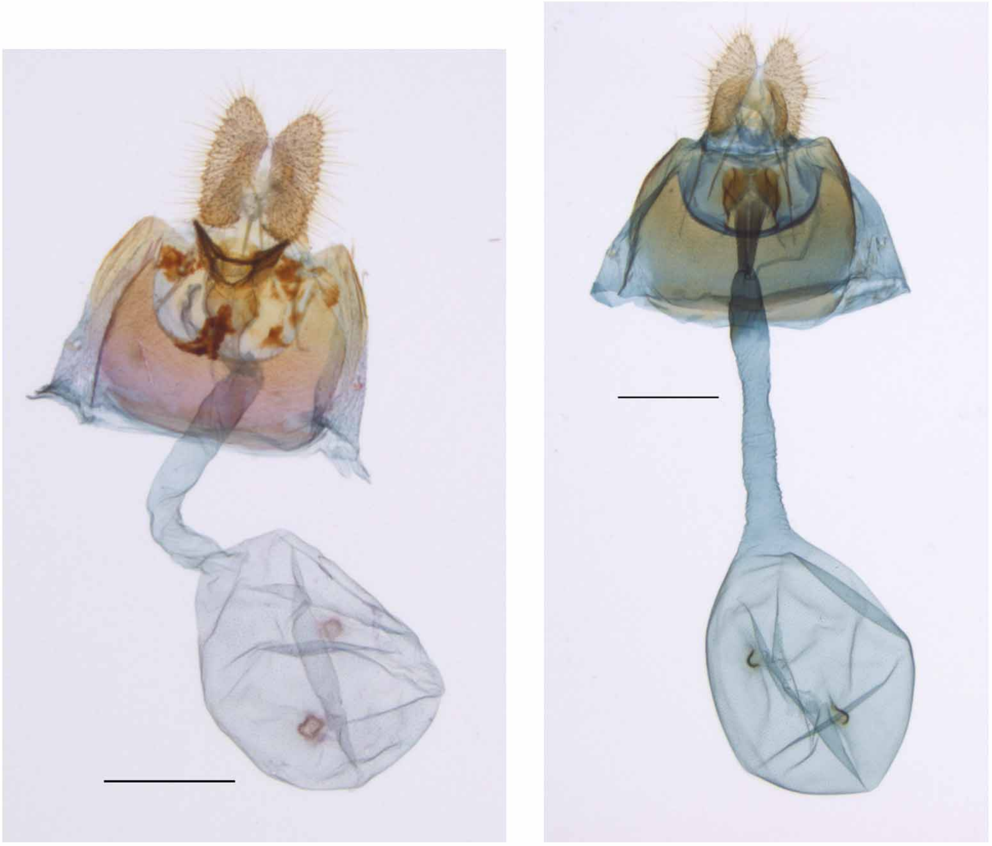

Figure 7

Figure 8

FIGURES 7–8. *Hedya* female genitalia. *H. tritofa*, female genitalia (Paratype, Iran, Māzandarān Prov., Nekā, N 36° 30´ 16,7˝, E 53° 23´ 27˝, 527 m, 30.ix.2007, Ālipanāh, Buszko, Zahiri, GS: JB 20234). Scale bar = 500 µm. 8. *M. atropunctana*, female genitalia (Germany, Wurtemberg, Schwarzwald, Wildseemoor, 900 m, 11.v.1971, L. Süssner, GS: JB 20233). Scale bar = 500 µm.

cylindrical aciculate lobe, expanded laterally and ventrally; lamella postvaginalis undeveloped; colliculum bottle-shaped, bivalval; ductus bursae long, length more than twice diameter of corpus bursae, slightly twisted, weakly sclerotized distally; ductus seminalis attached from near anterior extremity of colliculum; corpus bursae subspherical with signa represented by two slightly scobinate depressions; apophyses anteriores and posteriores relatively short.

Bionomy. Food plants and early stages unknown.

Distribution. Iran: Mazandaran (Ramsar, Behshahr, Neka), Gilan (Bandar Anzali, Siahkal) and Golestan (Golestan National Park) provinces.

Etymology. The specific epithet is derived from the three spine clusters on the baso-medial surface of the male valve: *tritofa* (*tri* = three + *tofa* = groups of spines).

Diagnosis. *Hedya tritofa* is similar to *Metendothenia atropunctana*, *M. separatana*, and *M. inouei*; the four species share the following characteristics: distal one-half of forewing mostly white, with small but distinctive group of dark scales on base of M$_1$ and M$_2$ (Fig. 3); postmedian and preterminal fasciae strongly reduced; and male genitalia symmetrical, with well developed cucullus. Males differ in the number and configuration of spine clusters (Fig. 6) on the baso-medial surface of the valval neck. Cluster Spc^3 is absent in *H. tritofa* (Fig. 6a) but present in *M. atropunctana* (Fig. 6b) and *M. separatana* (Gilligan et al. 2008: 206). *Metendothenia atropunctana* and *M. separatana* have Spc^1, Spc^2, and Spc^4 similarly expressed, Spc^4 being hairy, but in *M. separatana* Spc^1 is developed as a dorsal lobe, Spc^2 is reduced but in a homologous position, and Spc^3 consists of a group of rather long setaceous spines. This last taxon also has a transverse development at the base of cucullus that is lacking in the other two species. In *M. inouei* (Kawabe 1987: 142), Spc^1 is developed from the costa to the ventral edge of valva in such a way that it is difficult to determine whether or not it is the result of fusion with Spc^2+Spc^4. Females of the four species have an aciculate protruding sterigma, an excavated seventh sternum, and two small scobinate depressions as signa. The new species can be distinguished by the flangelike lobe of the sterigma that extends ventrally and laterally from the ostial margin (Fig. 7). In *M. atropunctana* (Fig. 8) and *M. inouei* (Kawabe 1987: 143) the sterigma is less conspicuous and often is referred to as tulip-shaped or heart-shaped (Diakonoff 1973, Kawabe 1987). In *M. separatana* the sterigma extends in a lamella antevaginalis (Gilligan et al. 2008: 259).

Discussion

Diakonoff (1973) interpreted the wing pattern of *M. atropunctana* as mimetic of bird droppings and considered it a convergent feature among many Palaearctic Olethreutini; representatives of many genera in Olethreutini, such as *Apotomis* Hübner, have superficially similar forewing patterns. Furthermore, genera scattered through Tortricidae and other families of Lepidoptera have similar pattern elements. Independent of the selective pressures that have produced this forewing pattern, the similarity of the four species mentioned above (i.e., *Hedya tritofa*, *Metendothenia atropunctana*, *M. separatana*, and *M. inouei*) should be interpreted as a plesiomorphic trait and not independently derived given their evident phylogenetic proximity. The presence of a small group of dark scales centered on the base of M_1 and M_2, referred to as the “discal dot” by Aarvik (2004), has received little attention in the literature but is a characteristic feature of many species of Olethreutini; it also is present in some Eucosmini and Grapholitini.

Heinrich (1926) was the first to focus on the spine clusters in the male genitalia, homologizing their positions by numbering them according to their dorsal-ventral distribution (i.e., Spc^1, Spc^2...Spc^n). He did not give a formal definition of “spine cluster”, but the term refers to any distinctive group of spines or bristles more or less uniformly developed and isolated from other groups by a naked surface. Because spines and setae are just grades of sclerotization, these groups also have been referred to as “setal clusters” (Brown 2009). It is difficult to establish which is the plesiomorphic condition (setaceous or spinulous), and mixed situations can be found as in Spc^2 in *H. tritofa*. Most of the clusters are restricted to the transition zone between the sacculus and the cucullus, but they occur on other places on the valve as well, such as the ventral margin of the sacculus (SpSc) and a sclerotized plate on the membrane of the basal excavation (Spc^5). Careful examination of *H. tritofa* and *M. atropunctana* demonstrates the importance of the position of the spine clusters and the difficulty of homology when changes in the position are detected (Fig. 6). The numbers used here for the different clusters are not assumed to be entirely consistent with those of Heinrich, although the homology of some is likely. Kawabe (1987) independently adopted a numbering scheme similar to the one used here and pointed out the mixed character of Spc^2 (different developments of spines + setae) in *M. inouei*. Cluster Spc^1 is easily distinguished from the other clusters by its position on a protruded lobe. A presumably homologous cluster is found in *Hedya* which Diakonoff (1973) interpreted as the pulvinus (= clasper?). The relatively distant position of Spc^1 in *M. separatana* suggests an alternative potential homology of Spc^2 with the clasper. In addition, the Spc^1 lobe is transformed into a rather long basal process in *M. balanacma* (Meyrick). A potentially homologous structure is present in *Eccopsis* Zeller, 1852, *Megalota* Diakonoff, 1966, *Cosmorrhyncha* Meyrick, 1913, and related genera in the *Neopotamia* genus group (Aarvik 2004). The two ventral clusters, Spc^3 and Spc^4, are present in related genera of Olethreutini (e.g., *Celypha* Hübner, 1825, *Pristerognatha* Obraztsov, 1960, *Hedya*), and together with the saccular cluster are responsible for much variation in the ventral edge of the valva in these taxa. The Spc^3 is often referred to as Spc^2 in taxa with only two clusters of spines in the valva. The Spc^5 is a more conservative structure and may be found in a large number of genera, although it has received little attention as a distinctive character.

The current concept of the genus *Hedya* was developed by Heinrich (1926) and Hannemann (1961) based on the North American and European faunas, respectively. Diakonoff (1973) assigned to the genus ten species from South Asia, New Guinea, and Japan. New taxa from the Oriental region were added by Kawabe (1974, 1978, 1993) and Oku (1974, 2005). It is a relatively diverse genus of Olethreutini with 31 species currently catalogued (Baixeras, Brown and Gilligan 2010), some of which are economically important (Zhang 1994). No autapomorphy clearly defines the genus (Razowski 1989), but the elongate cucullus in the male genitalia, the protruding cup-shaped sterigma, and two shallow or pointed scobinate signa in the female genitalia are characteristic of most species, especially those most closely related to the type species *Hedya salicella* (Linnaeus, 1758). The presence of an extensive white area in the distal half of the upperside of the forewing makes them superficially similar to some species of *Apotomis* Hübner.

Metendothenia was proposed by Diakonoff (1973) for a rather heterogeneous group of Olethreutini consisting of seven species he described from South Asia and New Guinea (i.e., *M. emmilta*, *M. spumans*, *M. calopa*, *M. hilarocroca, M. fidelis, M. rhodambon, M. metacycla*), *M. mesarotra* Meyrick (previously in *Argyroploce*), and two species transferred from *Hedya*: the Palaearctic *M. atropunctana* (Zetterstedt) and the Nearctic *M. separatana* (Kearfott). New taxa were added by Diakonoff (1983, 1992), Kawabe (1987, 1989), and Kawabe and Kusui (1978) (although *M. ogasawarensis* is presumably allied to *Eccopsis*). The genus *Metendothenia* has 17 species catalogued (Baixeras, Brown and Gilligan 2010), most of them poorly known with the exception of Palaerctic and Nearctic representatives (e.g., Bradley, Tremewan and Smith 1979, Gilligan, Wright and Gibson 2008, Miller 1987, Razowski 2003). As pointed out by Diakonoff (1973), there are at least three different groups of species in the genus. One organized around the type species *M. emmilta* Diakonoff share bizarre asymmetrical male genitalia with a distinctive basal process from the inner valva (labis *sensu* Diakonoff), a single scobinate signum in the female genitalia, and a characteristic long hair pencil in the male thorax as a secondary sexual character. The second group, consisting of *Metendothenia metacycla* and *M. spumans*, was transferred to *Diakonoffiana* Koçak, 1981, and is discussed in detail by Horak (2006). The third group is Holarctic and related to *M. atropunctana*, but the only similarity with *Metendothenia* s.str. is the presence of a basal lobe on the inner valva. They all have a paired signa, symmetrical male genitalia, and reduced male secondary sexual characters.

Based on the South Asiatic fauna, Diakonoff (1973) arranged the genera of Olethreutini into twelve groups. Four of the groups (Gatesclarkeanae, Endotheniae, Bactrae and Lobesiae) have been considerated by one or more authors as tribes (Falkovich 1962, Kuznetsov and Stekolnikov 1984, Dang 1990). Horak (2006) updated and analyzed the remaining groups. Two of them are relevant to our discussion: the *Olethreutes* group and the *Neopotamia* group (Olethreutae and Neopotamiae, respectively, *sensu* Diakonoff). Diakonoff (1973) placed *Hedya* and *Metendothenia* in the *Olethreutes* group but recognized the affinity of *Metendothenia* with the African genus *Eccopsis* (in the *Neopotamia* group). According to Aarvik (2004), the *Neopotamia* group is characterized by a signum in the female genitalia comprised of a single plate with 1–3 projections (dentate). Asymmetric male genitalia, a well developed basal process of the inner valva, and elaborate scent organs in males are also frequent. These characters are present in *M. emmilta* and closely related species (*Metendothenia* s. str.). Some other genera have two signa; a basal process from the inner valva may have arisen several times within the Olethreutini (Horak 2006); and the use of secondary sexual characters in Olethreutini classification is questionable (Baixeras 2002, Falkovich 1962, Obraztsov 1949). Furthermore, recent discussions on the African fauna support the position of *Metendothenia* s.str. in the *Neopotamia* group (Aarvik 2004, Razowski 2008).

The *Olethreutes* group of genera is characterized by elongate valvae in the male genitalia, a tendency to develop diverse spine clusters, and a simplified signum consisting of two small scobinate depressions. These characters are present in *H. tritofa, M. atropunctana, M. emmilta*, and *M. inouei*. The concept of *Metendothenia* associated with the Palaearctic and Nearctic species has prevailed in the literature since Diakonoff's proposal. But this monophyletic group of species (*tritofa, atropunctana, emmilta*, and *inouei*) is not related to *Metendothenia* s. str. (now in *Neopotamia* group). Razowski (1989) already pointed out the close relationship of the Palaeartic species of *Metendothenia* with those of *Hedya* and *Dudua* (both in the *Olethreutes* group), and recent progress by Aarvik (2004) and Horak (2006) has revealed that this is an unnatural grouping. We conclude that the concept of *Metendothenia* should be restricted to the species closely related to the type species *M. emmilta* and propose the resurrection of the combinations *H. atropunctana* (Zetterstedt, 1840), **revised status**, and *H. separatana* (Kearfott, 1907), **revised status**, and the **new combination** *H. inouei* (Kawabe, 1987).

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