ABSTRACT. – A population of Amphidromus (Amphidromus) mundus (Pfeiffer, 1853) was recently discovered on a Malaysian island in the South China Sea. Here we investigate and describe its internal anatomy for the first time, and its shell is also re-described. The small, white, chirally dimorphic shells with a reflected lip that is not attached to the outer wall, as well as its pale brown body colour allow clear discrimination from the related species A. (A.) perversus, A. (A.) inversus albus, and A. (A.) atricallosus. The distinctively long epiphallic caecum provides a clear discriminating character in genital anatomy. Type material could not be traced and a neotype is designated herein for nomenclatural stability.

KEY WORDS. – Amphidromus, Malaysia, taxonomy, biodiversity.

INTRODUCTION

Amphidromus Albers, 1850, is a genus of tree-dwelling snails that range from Indochina to the Philippines, through the Sunda Islands, and to the north of Australia (Pilsbry, 1900; Laidlaw & Solem, 1961; Solem, 1983). About 90 species are recognized (Laidlaw & Solem, 1961; Lehman & Maassen, 2004; Dharma, 2007; Severns, 2006; Chan & Tan, 2010). Most nominal species were based on few individuals, often with poor locality information. The paucity of data frequently leads to considerable confusion in the literature.

Seven nominal species of Amphidromus have been recorded from Peninsular Malaysia (Fulton, 1896, 1901; Pilsbry, 1900; Laidlaw & Solem, 1961; Maassen, 2001). One of these, Bulimus mundus Pfeiffer, 1853, has been regarded as being of uncertain taxonomic status, primarily because of the dubious locality records given in the original description (Laidlaw & Solem, 1961; Richardson, 1985) and a few recorded occurrences from disparate localities left the taxonomic status and distribution of this species uncertain (Laidlaw & Solem, 1961).

In February 2008, approximately 30 living land snails were collected from Pulau Besar, a small island off Peninsular Malaysia in the South China Sea. Among these specimens, some were provisionally identified as Amphidromus s.s. species. After comparison with material in reference collections and examination of Pfeiffer’s example of Bulimus mundus var. β, cited in Pfeiffer’s original description, we conclude that A. (A.) mundus has been rediscovered. However, in the absence of type material, the identity of this species remains in doubt and in our opinion, stability will best be served by the designation of a neotype and re-description under the terms provided by ICZN (1999, Article 75).

MATERIAL AND METHODS

Shell height (H) and shell diameter (D) were measured in mm, and the whorl count and H/D ratios were recorded. The radula was examined under a scanning electron microscope. In descriptions of the genitalia, ‘proximal’ refers to the region closest to the genital orifice and ‘distal’ to the region furthest away from the genital orifice. D = dextral; S = sinistral.

Institutional abbreviations. – BMNH, The Natural History Museum, London; CUMZ, Chulalongkorn University, Museum of Zoology, Bangkok; RBINS, Royal Belgian Institute of Natural Sciences, Brussels; ZRC, Raffles Museum of Biodiversity Research, Singapore; RMNH, National Museum of Natural History, Leiden; ZMB, Natural History Museum, Humboldt University, Berlin; ZMUC, Zoological Museum, University of Copenhagen, Denmark.
SYSTEMATIC ACCOUNT

Genus Amphidromus Albers, 1850
Subgenus Amphidromus Albers, 1850

Amphidromus (Amphidromus) mundus (Pfeiffer, 1853)

Bulimus mundus Pfeiffer, 1853a: 57 (Type locality: Singapore (=Singapore)). Pfeiffer, 1853b: 651. Pfeiffer, 1856: 261, 262, pl. 70, figs. 21 & 22.

Bulimus mundus var. β Pfeiffer, 1853a: 57 (Locality: Borneo (?). Pfeiffer, 1853b: 651.


Type material. – Neotype, herein designated, CUMZ 4917 (1 shell, Fig. 1A, height 35.3 mm, width 21.3 mm, 5½ whorls, h/d ratio 1.66). Topotypic material, CUMZ 4913 (Fig. 1B) (14D, 19S in ethanol, height 35.6 ± 1.69 mm, width 21.6 ± 0.93 mm, 5½ – 6 whorls, h/d ratio 1.65 ± 0.06), 4914 (7D, 6S shells, height 35.6 ± 1.25 mm, width 21.4 ± 0.90 mm, 5½ – 6 whorls, h/d ratio 1.66 ± 0.05); BMNH 20110305 (1D, 1S shells), SMF 336637 (1D, 1S shells).

Type locality. – Based on the neotype, the type locality is Pulau Besar, Mersing, Johor, Malaysia (2° 26’ 7.02” N, 103° 58’ 38.59” E).

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Other material examined. – Pfeiffer’s examined specimens of var. β from Borneo (?) or China (?): BMNH 19601542.1 (2S shells, Fig. 1C–E). Singapore: ZMB, Paetel coll. (1S shell); RMNH #19a (1D shell); BMNH 98.10.25.131 (2S shells). Singapore or Borneo: RBINS Dautzenberg ex. Crosse coll. (1D shell), Dautzenberg coll. 6990 (1D shell). Java: ZMB Seckendorf coll. (1D shell). Unknown locality: ZMB Bürger coll. (1S shell), Wallenberg coll. (1S shell); RBINS Dautzenberg coll. #6990α (1S shell); ZMUC #295 (2S shells).

Taxonomic remarks. – The nominal species “Bulimus mundus” was described from “Gruner’s collection”. After his death, the collection was sold and the most part was purchased by H. Maltzan, whose collections are currently housed in Aquazoo-Löbbecke Museum in Düsseldorf. However, some of Gruner’s specimens are also extant in other museums including SMF and ZMB (Témkin et al. 2009: 44). After a long investigation, the original type series of “Bulimus mundus” from “Gruner’s collection” was not located, and is presumed to be lost (M. Glaubrecht, R. Janssen, B. Hausdorf, R. Seemann and S. Stoll, personal communication). The absence of type material of the nominate form has been the cause of doubt about the identity and status of this species (Laidlaw & Solem, 1961). We consider that the specimen of Bulimus mundus var. β cited by Pfeiffer (1853a) from the Cuming collection, is an example of this species but having
been identified by Pfeiffer as a variety, it was excluded from the original type series of Bulimus mundus. Because of the uncertain origin of this lot according to the label information (‘Borneo?’ and ‘China?’), the form β is deemed unsuitable for designation as a neotype. The neotype selected here from our Pulau Besar collection allows a proper re-description of this taxon with the aim to stabilise the taxonomy.

**Description.** – Shell (Fig. 1A): Medium sized to small, (height 32.7–40.3 mm, diameter 19.3–23.8 mm) white, solid, ovate conic; umbilicus perforate; chirally dimorphic. Apex acute; spire short; suture depressed. Whorls slightly convex; last whorl round to ovate. Dark varix absent; periostracum thin and transparent. Aperture broadly ovate. Lip thickened, expanded and reflexed but not attached externally to last whorl. Parietal callus thickened; columnella twisted.

External anatomy (Fig. 1B): Living specimens with pale brown body, covered with dark recessed reticulations on skin. Foot broad and long with pale margin, extended across posterior tail. Upper tentacles drumstick-shaped, orange-brown, with dark eyespots on tentacular tips. Lower tentacles short, orange to pale orange; head and mouthparts brown. Mantle edge light orange; mantle cavity with dark pigmentation.

Genital anatomy (Fig. 2A): Atrium (at) relatively short (n = 5). Penis (p) cylindrical, about ¾ of vagina length, and enlarging slightly distally. Epiphallus (e) long and slightly smaller in diameter than penis. Flagellum (fl) almost the same length as epiphallus with coiled distal portion. Appendix (ap), located beyond coiled portion of flagellum, nearly same length as flagellum. Vas deferens (vd), a narrow tube, extending from oviduct ending at epiphallus. Penial retractor muscle (pm) long, thin, originating distally from penis, attached to penis near distal end.

Internal wall of penis corrugated, exhibiting series of thickened, swollen, longitudinal penial pilasters (pp), which form a fringe around conical penial verge. Penial verge (pv) short, conic with smooth surface (Fig. 2B).

Vagina (v) long, slender and cylindrical. Gametolytic duct (gd) extends from vagina, proximally as enlarged cylindrical tube, abruptly tapering to small tube distally, terminally connected to gametolytic sac (gs). Free oviduct (fo) short, oviduct compact and enlarged to form lobule alveoli. Prostate gland ventrally fused with oviduct. Albumen gland (ag) slightly large and lingulate. Hermaphroditic gland (hg) contracts from numerous small lobules; narrow and convoluted hermaphroditic duct (hd) connects to middle of talon (Fig. 2A).

Internally the vagina possesses longitudinal vaginal pilasters (vp). Pilasters have continuous ridges with short smooth ridges near genital orifice; extends to slightly swollen portion with irregular shaped, deep crenellations (Fig. 2B).

Digestive anatomy (Fig. 2C, 2F): Jaw light brown and conereous with strong vertical ridges. Radular teeth arranged in anteriorly pointed V-shaped rows, each row containing about 206 teeth (102-(17-15)-1-(15-17)-103). Central tooth tricuspid, spatulate, with small ectocones (Fig. 2D). Lateral teeth bicuspid, endcone large with truncated cusp, ectocone larger with curved cusp. From tooth 15 to 17 outwards lateral teeth gradually transformed to tricuspid marginals (Fig. 2E). Marginal teeth asymmetric, endcone medium; mesocone large with curved margins; ectocone small.

**Distribution.** – The confirmed distribution of this species is currently restricted to the type locality, Pulau Besar, Johor, Malaysia. Species determinations of samples from museum collections with records from a numerous localities, such as Singapore, the Philippines, Borneo and Java (Laidlaw & Solem, 1961: 589; S. Panha, personal observation in collections) require verification. Occurrence in China, as given on the label of 'B. mundus forma β' cited above, can be ruled out with certainty because China is outside of the geographic range of Amphidromus (Solem, 1959, 1983; Laidlaw & Solem, 1961; Sutcharit & Panha, 2006a).

**DISCUSSION**

Because of the absence of type material and uncertainty about its distribution, the status of Amphidromus (A.) mundus has long been uncertain. Based on the shell morphology only, Laidlaw & Solem (1961) assumed that Bulimus mundus Pfeiffer, 1853 was probably identical with A. (A.) perversus (Linnaeus, 1758), a species exhibiting a wide range of shell variation. According to this study, A. (A.) mundus can be distinguished from the former species by possessing a smaller, white shell, a shorter spire, a globose last whorl and a reflected lip that is not attached to the outer wall. In addition, the genitalia of A. (A.) mundus (Fig. 2A, B) exhibit a slightly longer epiphallic caecum and a corrugated vaginal pilaster (Solem, 1983; Sutcharit & Panha, 2006a).

Two Amphidromus species from Peninsular Malaysia, A. (A.) atricallosus perakensis Fulton, 1901, A. (A.) atricallosus temasek Tan, Chan & Panha, 2011 and A. (A.) inversus albulus Sutcharit & Panha, 2006, are similar but distinct from A. (A.) mundus. The differences from A. (A.) atricallosus perakensis and A. (A.) atricallosus temasek are a smaller, stout and white shell, short spire, and a much shorter appendix (Collinge, 1902; Sutcharit & Panha, 2006a; Tan et al., 2011). Amphidromus (A.) atricallosus (Gould, 1843) exhibits a white shell morph (Sutcharit & Panha, 2006a, Figs. 3, 4), however, the pale brown body with pale orange on the tentacles in A. (A.) mundus (Fig. 1B) is clearly distinct from the white to yellowish body with a bright orange head and stripes along the foot and sole of A. (A.) atricallosus (Fig. 1C). Amphidromus (A.) mundus is clearly distinguished from A. (A.) inversus albulus; most notably, A. (A.) mundus possesses a long penial appendix, which is almost absent in A. (A.) inversus albulus. In addition, the dark pigment of the lung cavity and the pale orange tentacles and mantle collar of A. (A.) mundus are clearly distinct from those of A. (A.) inversus albulus (see also Sutcharit & Panha, 2006b for comparison).
We consider that *Amphidromus (A.) mundus* is a robustly defined species that differs from the three adjacent species *A. (A.) perversus*, *A. (A.) atricallosus perakensis*, *A. (A.) atricallosus temasek* and *A. (A.) inversus albulus*, in its shell, genital morphology and the soft body pigmentation.

ACKNOWLEDGEMENTS

We are grateful to F. Naggs and J. Abblet (NHM, London), T. Backeljau (RBINS, Brussels), W. J. M. Maassen (RMNH, Leiden), R. Janssen (SMF, Frankfurt), M. Glaubrecht (ZMB,
Berliner) and H. Enghoff (ZMUC, Copenhagen) for kindly permitting the authors to study specimens, and also thank A. Tan, Z. Yasin and B. W. Ng (USM, Penang, Malaysia); the Animal Systematics Research Unit members for collecting specimens. We are especially grateful to N. Kitana and S. Natupakpong for providing copies of important literature. We are indebted to B. Hausdorf (ZMH, Hamburg), R. Seemann (Mueritzzeum, Waren), and S. Stoll (Aquazoo-Löbecke Museum, Düsseldorf) in connection with our search for Pfeiffer’s original type material. This project was funded by the BRT-R 252108; the TRF-RG 4980201; the Darwin Initiative Project (no. 14-653); the Higher Education Research Promotion and National Research University Project of Thailand, Office of the Higher Education Commission FW646A (2011-2013).

LITERATURE CITED


