

A NEW SUBSPECIES OF *AMPHIDROMUS* (A.) *INVERSUS* (MÜLLER, 1774) FROM PENINSULAR MALAYSIA

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Abstract *Amphidromus (Amphidromus) inversus* (Müller, 1774) was recently re-described and considered to consist of only three subspecies: the nominotypical subspecies, *A. (A.) inversus annamiticus* (Crosse & Fischer, 1863) and *A. (A.) inversus andamanensis* (Pfeiffer, 1871). Here we describe a new subspecies that was discovered during a recent malacological survey in eastern peninsular Malaysia. The prominent characteristics of the new subspecies are the chirally dimorphic, whitish shell, absence of brownish radial streaks and sub-peripheral band, and the long epiphallus with variable coiling.

Key Words *Amphidromus inversus*, tree snail, Camaenidae, Malaysia

INTRODUCTION

Ranging from Indochina to Lesser Sunda Island *Amphidromus (Amphidromus) inversus* (Müller, 1774) is the most widely distributed *Amphidromus* species (Pilsbry, 1900; Laidlaw & Solem, 1961). The recent review of *Amphidromus* by Sutcharit & Panha (2006) recognized three subspecies of *A. (A.) inversus*. The nominotypical subspecies occurs in Singapore, Sumatra, Borneo and Celebes; *A. (A.) inversus annamiticus* (Crosse & Fischer, 1863) ranges from central Vietnam, to eastern and southern peninsular Thailand and *A. (A.) inversus andamanensis* (Pfeiffer, 1871) has been recorded from Borneo and its satellite islands (Pilsbry, 1900; Laidlaw & Solem, 1961; Solem, 1965; Sutcharit & Panha, 2006). Bishop (1977), Solem (1983) and Sutcharit & Panha (2006) demonstrated the value of the morphology of reproductive organs proximal to the genital orifice for discriminating *Amphidromus (Amphidromus)* at species level and showed that, among the eight species examined, *A. (A.) inversus* possessed a clearly distinct genital morphology.

In March, 2004 we carried out a land snail survey on Kapas Island in the South China Sea off eastern peninsular Malaysia (Fig. 1). Among the species collected was an *Amphidromus* species, which we provisionally identified as a new taxon. Following detailed examination of the genitalia we consider this to be an undescribed subspecies of *A. (A.) inversus*.

MATERIALS AND METHODS

Shell height (H) and shell diameter (D) were measured in mm, whorl counts were taken and H/D ratios recorded. The radula was examined under a Scanning Electron Microscope. In descriptions of the genitalia, we used 'proximal' to refer to the region closest to the genital orifice and 'distal' to refer to the region furthest away from the genital orifice. Type material and examined specimens were deposited in the Chulalongkorn University Museum of Zoology, Bangkok, Thailand (CUMZ) and additional paratype specimens were deposited at the Natural History Museum, London (NHM) and Senckenberg Museum, Frankfurt (SMF).

The following abbreviations are used in the descriptions of anatomy as described in Sutcharit & Panha (2006): ag, albumin gland; at, atrium; e, epiphallus; fl, flagellum; fo, free oviduct; gd, gametolytic duct; gs, gametolytic sac; hd, hermaphroditic duct; hg, hermaphroditic gland; ov, oviduct; p, penis; pp, penial pilaster; pr, penial retractor muscle; pv, penial verge; ta, talon; v, vagina; vd, vas deferens; vp, vaginal pilaster. D = dextral; S = sinistral.

SYSTEMATIC DESCRIPTION

FAMILY CAMAENIDAE ALBERS, 1850
Genus *Amphidromus* Albers, 1850
Subgenus *Amphidromus* Albers, 1850

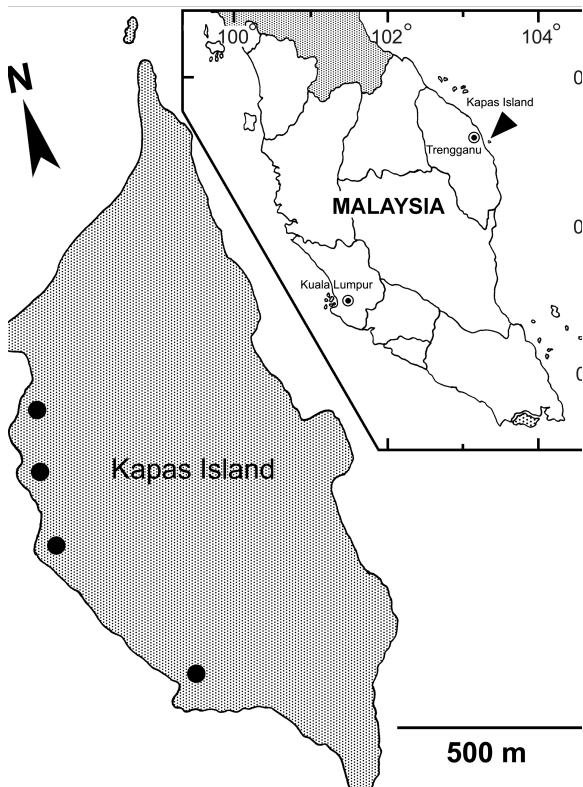


Fig. 1 Map of Peninsular Malaysia and magnification of its inset section of Kapas Island ($5^{\circ} 13' 045''$ N; $103^{\circ} 15' 706''$ E). The dark circles indicate the collecting sites of *A. (A.) inversus albulus* new subspecies.

Type species *Helix perversus* Linnaeus, 1758, by subsequent designation of von Martens (1860). *Amphidromus (Amphidromus) inversus* (Müller, 1774)

Amphidromus (Amphidromus) inversus albulus
new subspecies
Figs 2-4

Holotype Collected from Kapas Island (Pulau Kapas), Marang, Terengganu, peninsular Malaysia, CUMZ 2323 (Fig. 2A).

Paratypes Collected from Kapas Island, Marang, Terengganu, peninsular Malaysia, NHM 20050160 (1D+1S); SMF 327982 (1D+1S); CUMZ 2299 (3D+8S); 2300 (5D+17S); 2324 (4D+1S), (Fig. 2B, C); 2327 (14D+20S).

Shell Measurements Holotype: shell height 45.32 mm, shell diameter 25.43 mm and whorl count $7\frac{1}{8}$ whorls. Paratypes: 45 specimens ranged in shell height from 31.90 mm to 46.77 mm (39.79 ± 2.98 in averages), shell diameter from 19.37

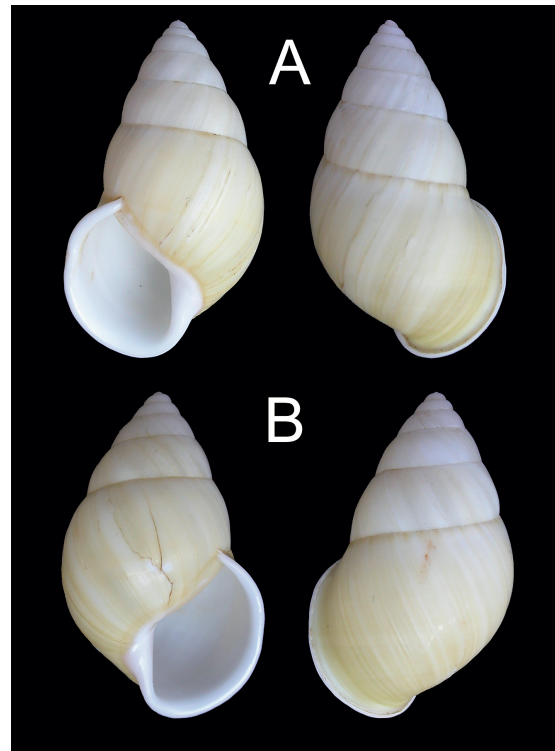


Fig. 2 Shell characteristics of *A. (A.) inversus albulus* new subspecies. **A** Holotype (CUMZ 2323). **B** Paratype (CUMZ 2324). **C** Comparison of shell and soft-body colour of the nominotypical subspecies (left) from Singapore (CUMZ 2320) and a paratype of *A. (A.) inversus albulus* a new subspecies (right) from Kapas Island (CUMZ 2300).

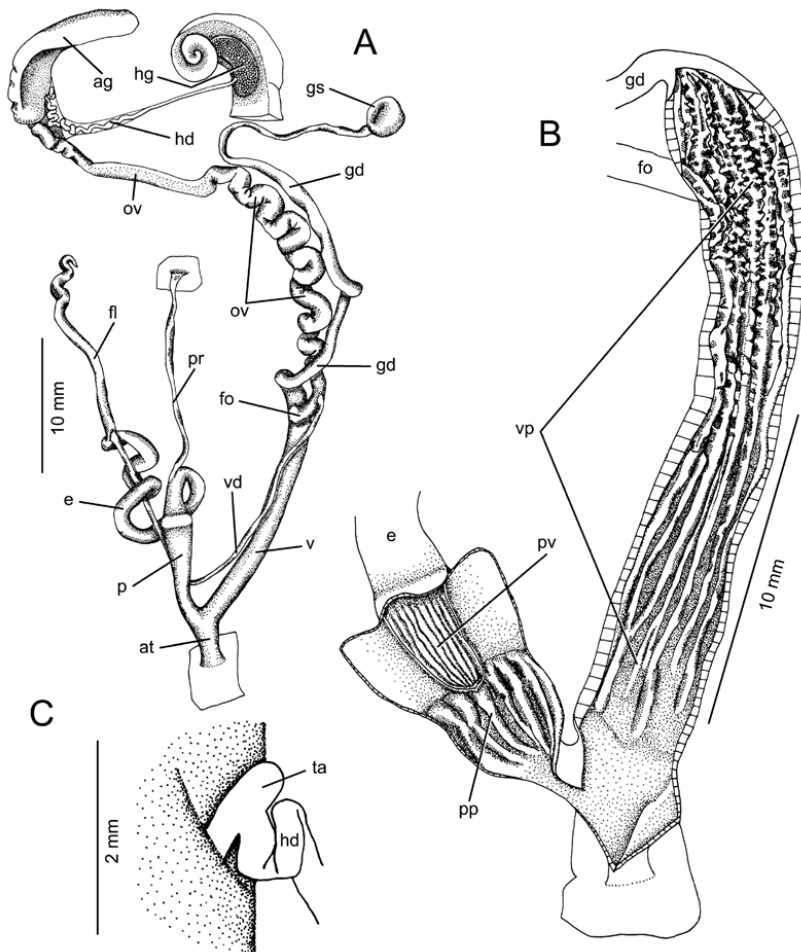


Fig. 3 Reproductive system of *A. (A.) inversus albulus* new subspecies (CUMZ 2324; 7th March, 2004). **A** The general view of genital system. **B** Interior structure of penis, atrium and vaginal chamber. **C** The connection of the hermaphroditic duct to the talon.

mm to 26.80 mm (23.19 ± 1.52 in averages), h/d ratio from 1.55 to 1.86 (1.72 ± 0.07 in averages) and whorls count from $6^2/8$ to $7^1/8$ whorls.

Type Locality Kapas Island, South China Sea, east of Marang town, Terengganu, Peninsular Malaysia ($5^\circ 13'045''$ N; $103^\circ 15' 706''$ E) (Fig. 1).

Diagnosis *Amphidromus (A.) inversus albulus* n. ssp. can be characterized by possession of whitish shell and the absence of brownish radial streaks or a brownish sub-peripheral band as are normally present in the three recognized subspecies. Specimens exhibit a creamy periostracum, dimorphic shell coiling and slightly ovate and smaller shell size than other subspecies. It differs from *A. (A.) inversus annamiticus* in possess-

ing dimorphic coiling, absence of a tinted pink apex colour and with slightly longer epiphallus.

Description Shell of medium size, ovate, solid, umbilicus imperforate and chirally dimorphic (Fig. 2A, 2B). Apex whitish and acute; spire conical; suture slightly depressed. Whorls slightly convex and last whorl rounded. Shell whitish to creamy; periostracum creamy to corneous. Aperture broad and roundly ovate. Peristome white, thickened and expanded; lip slightly folded and reflected. Columella whitish and straight; parietal callus white and slightly thickened. Dark varix absent.

Living animals (Fig. 2C (right)) possess brown to brownish body and are usually covered with light brown to creamy reticulated skin as in nominotypical subspecies (Fig. 2C (left)). Foot broad and long and grayish to brownish. Mantle edge brownish to pale brown. Upper tentacles blackish, long, drumstick shaped and with dark eye spots. Lower tentacles, head and mouthpart are brown to light brown. Mantle cavity of pale cream and dark pigmentation absent.

Atrium (at) long and cylindrical ($n=10$). Penis (p) long, conical, about half of vaginal length, and distally folded at penial verge base (Fig. 3A). Epiphallus (e) long with variable coiling. Flagellum (fl) smaller than epiphallus, terminating in folded coil. Appendix absent. Vas deferens (vd) long narrow tube, entering from free oviduct (fo) passing into spiral structure of epiphallus and terminating in distal epiphallus. Penial retractor muscle (pr) long, thin and originating distally on penis.

Internal wall of penis ribbed, forming series of swollen longitudinal pilasters (pp). These smooth pilasters line introverted penial chamber, and encircle penial verge tip. Penial verge (pv) long and cylindrical with thin longitudinal ridges (Fig. 3B).

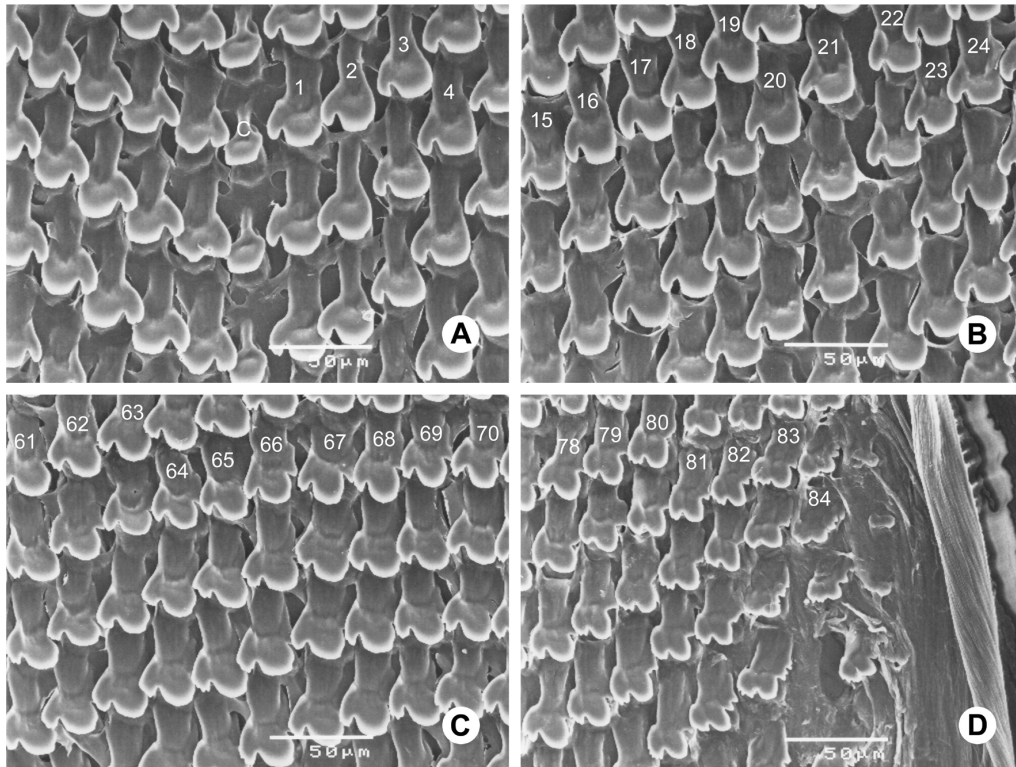


Fig. 4 SEM images of radula of *A. (A.) inversus albulus* new subspecies (CUMZ 2324). **A** Central teeth with the first to the fourth lateral teeth. **B** Lateral teeth with the tricuspid marginal teeth transition. **C** Marginal teeth. **D** Outermost marginal teeth. Central tooth is indicated by 'C' and the other numbers indicate the order of lateral and marginal teeth.

Vagina (v) a long and cylindrical tube held in position by a series of muscle bands rising from the foot floor. Gametolytic duct (gd) long and folded; distally terminating in a swollen gametolytic sac (gs). Free oviduct (fo) short; oviduct (ov) with several curled lobules. Albumen gland (ag) a curved ligulate (Fig. 3A). Hermaphroditic gland (hg) connected with middle of talon (ta) by a convoluted hermaphroditic duct (hd) (Fig. 3C).

Internal walls of vagina possess several longitudinal vaginal pilasters (vp). Proximally, they smooth crenulated ridges, and distally become irregularly wrinkled ridges with deep crenellations (Fig. 3B).

Each row contains about 169 (84-(19-21)-1-(20-24)-84) teeth. Central tooth unicuspid and spatulate with blunt cusp (Fig. 4A). Lateral teeth bicuspid. Endocone cylindrical, slightly oblique, with wide notch; ectocone large with truncated to rounded cusp (Fig. 4A). Marginal teeth start around tooth number 19 to 24 (Fig. 4B & C); endocone large; mesocone medium with curved or serrated cusp, ectocone small with sharp cusp.

Endocone and mesocone of the outermost marginal teeth are of similar size; ectocone small with two or more sharp cusps. (Fig. 4D).

Derivation of name The specific epithet '*albulus*' is Latin for whitish and refers to the whitish shell colour of the new subspecies.

Distribution *Amphidromus (A.) inversus albulus* n. ssp. is known only from the type locality. Kapas Island is located about 5 to 6 km off the east coast of Marang, Terengganu (Fig. 1). The island is on a north/south axis and is dominated by a granite mountain. Evergreen forest is found on higher elevations and a dry forest occurs along the coastal beach. Specimens occurred commonly on a wide range of tree species including those under cultivation in plantations. There was little rainfall at the time of our visit (March, 2004) and snails were inactive with their apertures sealed to tree trunks, branches, twigs and under leaves and from 1 to over 10 meters above ground.

DISCUSSION

Shell characters of *A. (A.) inversus albulus* n. ssp. bear a superficial resemblance to those of the whitish shell variant of *A. (A.) inversus annamiticus*, but the latter subspecies is slightly larger and can be readily distinguished by its retention of a pink tint in the upper spire (Fig. 2C).

In *A. (A.) inversus albulus* n. ssp., characteristics such as the possession of a coiled distal end to the flagellum, the absence of appendix, hermaphrodite duct connected to the middle talon, the internal sculpture of penis and vagina and shape of penial verge are shared with *A. (A.) inversus inversus* s. str. and *A. (A.) inversus annamiticus* (see Sutcharit & Panha, 2006). Other than a slightly longer epiphallus in *A. (A.) inversus albulus* n. ssp., no significant differences of genital characters were observed from those of *A. (A.) inversus annamiticus*.

All examined specimens of the new subspecies exhibit a whitish shell colour and brownish bands are absent. The distinctly corneous to pale brown hue to the shell is of periostracal origin whereas in other subspecies brown pigments are deposited in the calcareous layer. This character is possibly a result of either shell albinism or faint pigmentation on the structural bands, which is dissociated from body pigmentation (Comfort, 1950). There are few publications on shell albinism and genetic inheritance in land snails (see Backeljau, Baur & Baur 2001, and reference there in). The Mendelian inheritance of the new subspecies remains to be tested in the near future.

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