



CHAPTER IV

TAXONOMIC REVIEW OF THE GENUS *CYCLOPHORUS* MONTFORT, 1810 IN THAILAND

4.1 Introduction

The operculate land snails genus *Cyclophorus* Montfort, 1810 occurs in various forest types with the most favorite habitat in leaf litter and detritus. Most species live on the ground. Some are occasionally found on limestone rock or in the caves. It is not very agile at the day time and especially in dry condition. It spends most of the time living under leaf litter to avoid the snail hunters such as birds, small mammals and large primates. Sometimes the snails are seen crawling on twigs mostly after rain, but it does not usually climb up trees. *Cyclophorus* is the most dominant genus of the family Cyclophoridae. It contains over 100 species distributed in sub-tropical and tropical Asia (Reeve, 1861; Nevill, 1881; Möllendorff, 1894; Blandford, 1903; Gude, 1921; Benthem Jutting, 1948, 1949; Zilch, 1956; Habe, 1964; Solem, 1966; Minato and Habe, 1982).

Cyclophorus exhibits the unique characteristics of shell large solid and low conical with horny thin multispiral operculum, taenioglossate radula. Both male and female are distinctly determined by clear reproductive characters, The sex is separated, female genital organ discriminated with bursa copulatrix and a separately implanted seminal receptacle. (Benthem Jutting, 1948).

Taxonomic lists and the basic classification of *Cyclophorus* species have been done and published by Reeve (1861), Nevill (1881), Morlet (1891), Möllendorff (1894), Kobelt (1902), Blandford (1903), Gude (1921),

Bentham Jutting (1948, 1949), Zilch (1956), Habe (1964), Solem (1966) and Abbott (1989) used shell morphology and colour patterns to separate the species.

In the present study, Thai *Cyclophorus* samples from recent collections deposited in Chulalongkorn University Museum of Zoology (CUMZ) have been revised. The concentration was on shell, genitalia and radula morphology of the fourteen poorly known taxa *Cyclophorus volvulus* (Müller, 1774), *C. aurantiacus* (Schumacher, 1817), *C. semiscalcatus* (Sowerby, 1843), *C. speciosus* (Philippi, 1847), *C. cantori* (Benson, 1851), *C. fulguratus fulguratus* (Pfeiffer, 1852), *C. fulguratus* ssp.1, *C. malayanus* (Benson, 1852), *C. saturnus saturnus* Pfeiffer, 1862, *C. saturnus* ssp.1, *C. courbeti* Ancey, 1888, *C. subfloridus* Ancey, 1888, *C. diplochilus* Möllendorff, 1894, *Cyclophorus* sp. and one possibility on a species from Halabala National Park, southern most of Thailand because only a tree shell was found. More field surveys are needed to clarify their existence and status.

4.2 Systematic Accounts

Family Cyclophoridae

Genus *Cyclophorus* Montfort, 1810

Type species: *Helix volvulus* Müller, 1774

Diagnosis: Shell moderately medium to large (2 to 7 cm width), low conical, generally broader than high. Peristome continuous, thickened, expanded. Lip mostly reflected. Operculum thin, horny, multispiral with a central nucleus.

The taenioglossate radula long like ribbon, the radula has numerous rows with seven teeth per transverse row (Kobelt, 1902; Kasinathan, 1975) that is a central (middle or rhachis) tooth, flanked on both sides by one lateral tooth and two marginal teeth.

The majority of *Cyclophorus* are dioecious. The genital system is similar in basic plan in both sexes. It extends along the columellar side of the visceral mass coils, where it can be seen immediately beneath the mantle, and anteriorly near the junction of the body with the mantle skirt on the right side. In the female, the genital duct opens into outside of the mantle, while in the male it is continued through the penis which lies behind the right cephalic tentacle. The genital system description, we have followed the nomenclature used by Creek (1951).

The gonad, testis or ovary locates in the upper whorls of the visceral mass. The female organs are the ovary, oviduct, seminal receptacle, bursa copulatrix, uterus (pallial oviduct) and vagina. The male organs are the testis, vas deferens, seminal vesicle, prostate gland (pallial vas deferens) and penis.

Male genital system is one of the largest organs of the snails which embedded in almost the entire apex on the right side. In fresh animal, the testis is orange. It attached to the digestive gland, in the upper coils of visceral mass. It is formed by numerous whitish tubules that join and form ducts, and lead into the thin vas deferens (vd). The vas deferens widens into a very long seminal vesicle (sv), with a large number of little folds, slender, and pale yellow colour, run towards the anterior end which connects prostate gland. The seminal vesicle runs down on the columellar side of the body and enters the prostate gland directly. The prostate gland (pg) runs to the genital opening near the anus and seminal vesicle stalk enters at the base of posterior end. Genital opening (go) opens at distal of anterior end to one-thirds of anterior part. Seminal groove extends from anterior part of prostate gland to the penis. The penis is typically situated on the head behind the right tentacle, digitiform, slender, bulbous at the base, pointed at the tip, it is shorter than tentacle.

The ovary is bright orange, embedded in the digestive gland and is found mostly on the columellar side or the right side of the visceral mass. The oviduct (ov) leads from Oviduct lies on the columellar side of body, lateral to esophagus and ventral to stomach and digestive gland. At its distal end, the oviduct opens into an albumin gland (ag), the base of it join with seminal receptacle and the bursa copulatrix opening. Seminal receptacle (sr) acts as a reservoir for spermatozoa during the entire breeding season. Bursa copulatrix (bc) consist of pouch and stalk which is located almost completely. The opening of the bursa copulatrix is continuous without interruption with a wide and elongated opening, which extends along the right side of the mantle skirt. According to Graham (1964) bursa copulatrix is a sac run into the place which the semen is discharged during copulation, and the seminal receptacle is a pouch in which sperm are stored until the

time of fertilization. During copulation, sperm are deposited in the vagina where that stalk of the bursa joins the vagina. Some sperm travel up the oviduct and eventually enter the seminal receptacle where they are stored until required in fertilization. Albumin gland is very large. The duct from the bursa copulatrix opens directly into the lateral of the albumin gland. The albumin gland lies along the right wall of the mantle from the posterior end almost to the anterior mantle margin. It runs parallel to the rectum.

Key to species of Thai *Cyclophorus* shells

- 1a. Spire depressed (Fig. 4.1A).....2
 1b. Spire turbinate (Fig. 4.1B).....3
- 2a. Last whorl with strong peripheral keel..... *C. orthostylus*
 2b. Last whorl with weak peripheral keel..... *C. semisulcatus*
- 3a. Shell large size, shell width >45 mm.....4
 3b. Shell smaller size, shell width <45 mm.....8
- 4a. Aperture rosy colour shade..... *C. aurantiacus*
 4b. Aperture other colour shades.....5
- 5a. Aperture yellowish colour..... *Cyclophorus* sp.
 5b. Aperture whitish..... *C. saturnus* ssp.1
 5c. Aperture of orange colour variation6
- 6a. Aperture distinctly expanded (Fig. 4.2G, H)..... *C. saturnus saturnus*
 6b. Aperture less expanded (Fig. 4.2C).....7
- 7a. Columellar aperture locates over half of umbilicus.....*C. speciosus*
 7b. Columellar aperturcates almost freely from umbilicus.....*C. malayanus*

- 8a. Aperture distinctly expanded and reflected with clear orange colour shade
(Fig. 4.2E, F, G, H).....9
- 8b. Aperture less expanded or not expanded.....10
- 9a. Aperture of single layer formation..... *C. cantori*
- 9b. Aperture of double layers.....*C. diplochilus*
- 10a. Aperture without expanded and reflected (Fig. 4.2A, B).....11
- 10b. Aperture less expanded and reflected12
- 11a. Ground colour brown..... *C. fulguratus* ssp.1
- 11b. Ground colour white..... *C. fulgurtus fulguratus*
- 12a. Ground colour dark brown with distinct zigzag white striations.....*C. courbeti*
- 12b. Ground colour white with no striations pattern13
- 13a. Shell size ranges 29-38 mm with reflected aperture, columellar aperture locates over
half of umbilicus..... *C. subfloridus*
- 13b. Shell size ranges 32-41 mm without reflected aperture, columellar aperture locates
almost freely from umbilicus..... *C. volvulus*

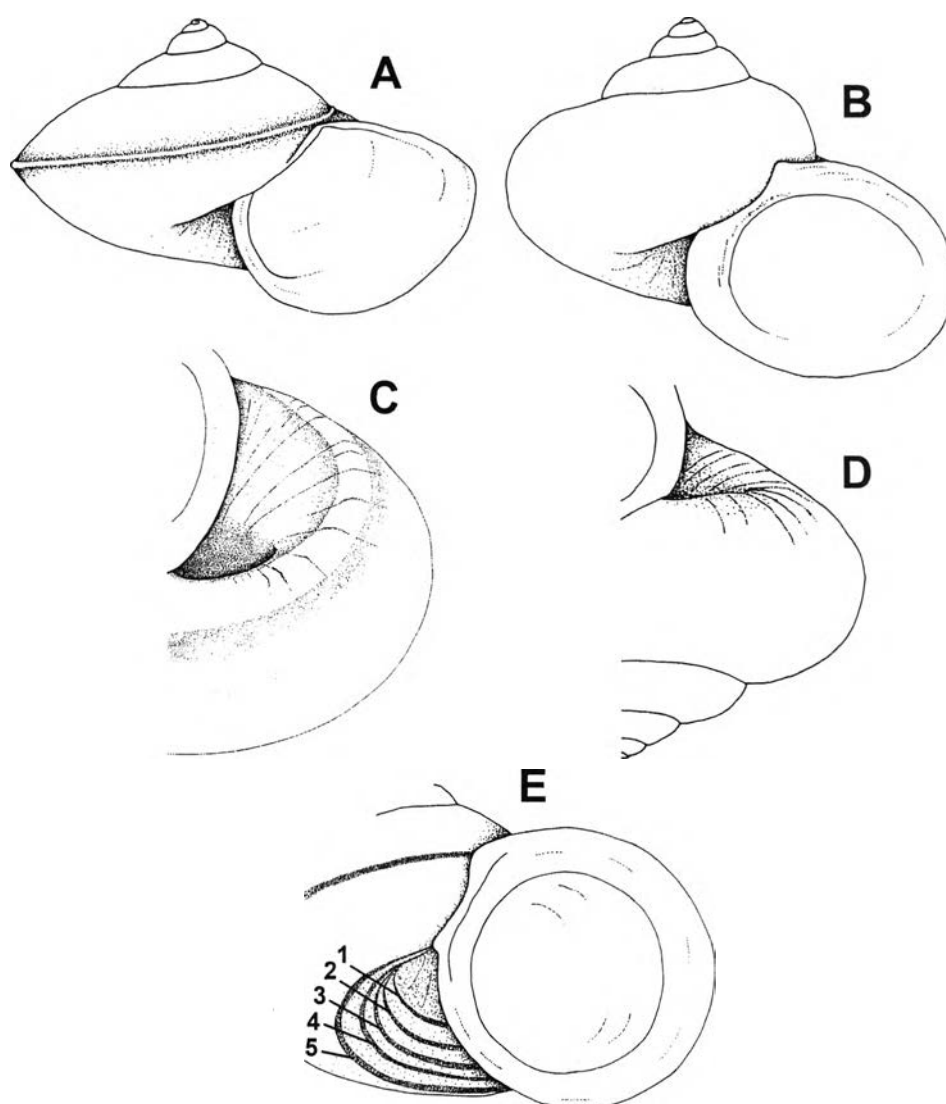


Figure 4.1 Terminology of shell characteristics: **(A)** Shell spire depressed with very strong peripheral keel, **(B)** Shell spire turbinate without peripheral keel, **(C)** angle around umbilicus, **(D)** around umbilicus without angle, **(E)** banded around umbilicus.

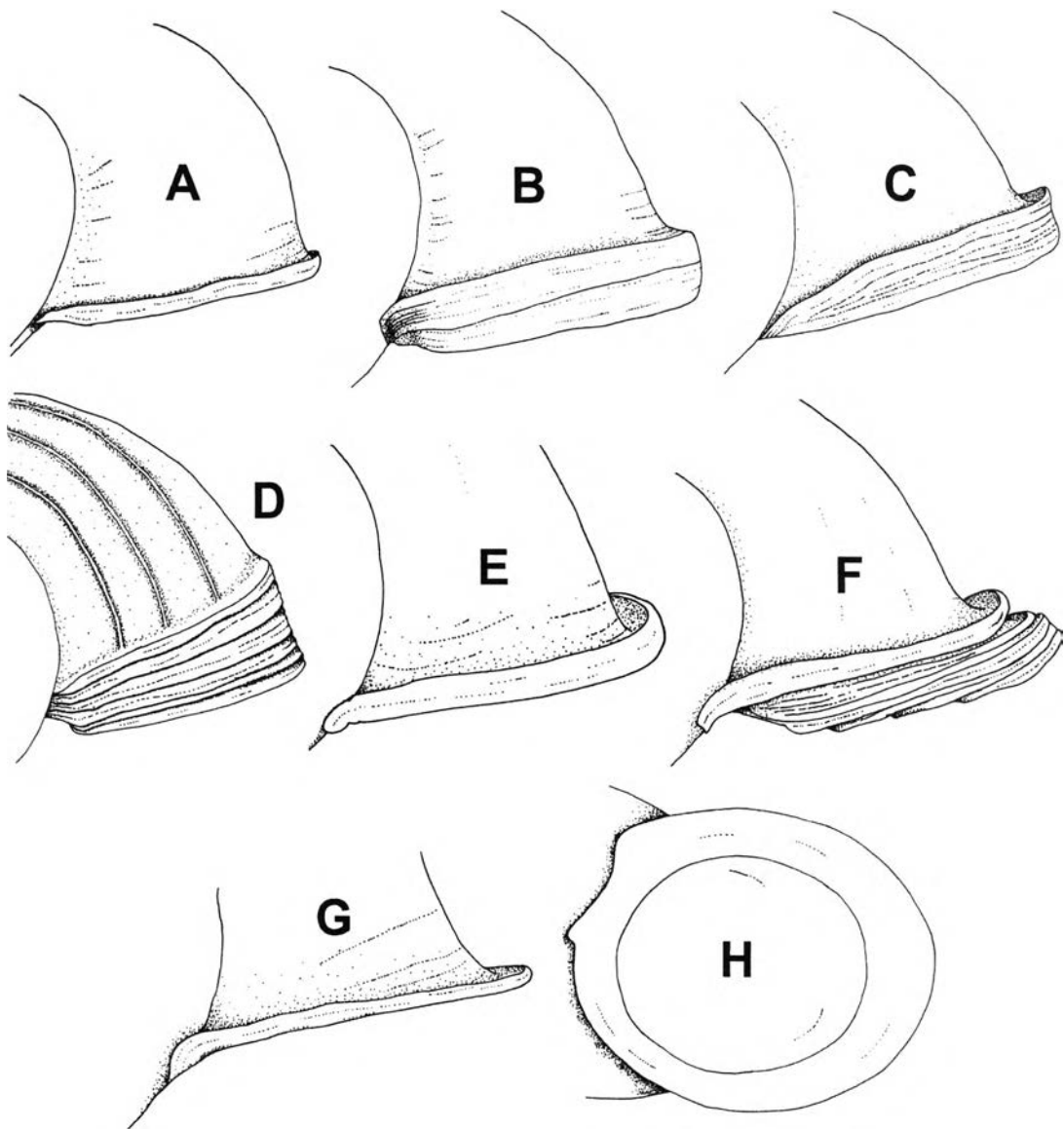


Figure 4.2 Terminology of aperture characteristics **(A)** thinned without expanded and reflected, **(B)** thickened without expanded and reflected, **(C)** less expanded and reflected, **(D)** thickened continuous without reflected, **(E)** strongly expanded and reflected, **(F)** strong expand and reflected with double layers, **(G)** strong expanded, **(H)** apertural view; strong expanded.

***Cyclophorus volvulus* (Müller, 1774)**

(Figures 4.3A, 4.6A, 4.9A, B)

Helix volvulus Müller, 1774: 82.

Cyclophorus volvulus —Reeve, 1861: sp. 24. Habe, 1964: 126-127, pl.1, figs. 1,2.

Cyclophorus (Cyclophorus) volvulus —Kobelt, 1902:143.

Material examined: Chonburi (CUMZ 900, 9111107, 1108, 1109, 1113, 1114, 1115, 1275, 1290, 1291, 1316, 1433, 1447), Laos (Laos 1212), Lopburi (CUMZ 825, 845, 1205, 1218, 1274, 1276, 1292, 1383), Pang Nga (CUMZ 1326), Prachuap Kirikhan (CUMZ 899, 1307, 1416), Rayong (CUMZ 1244), Supanburi (CUMZ 880, 889), Suratthani (CUMZ 1221, 1228, 1321)

Shell (Fig. 4.3A, Table 4.1): Medium, thick, solid with low conical shape. Periostracum exhibits colour variation from dark to pale brown with white umbilicus and a narrow white spiral band on the last whorl. Aperture rounded with a thin parietal callus, white, columellar aperture locates almost freely from umbilicus, without thickened and expanded. Umbilicus deep, rather wide. Operculum rounded, thin, dark brown, multispiral.

Radula (Fig. 4.6A): Central tooth semicircular 5 denticles with large center and smaller arrangement of the others. Lateral teeth locates alternately with central tooth, bicuspid, endocone small with sharp cusp, ectocone large. Marginal teeth have different arrangement into two layers of inner marginal teeth locates the same level of central tooth, the shape similar to crab great chela, bicuspid of small sharp endocone and large sharp inflated ectocone, the outer marginal teeth locates at the edge of the ribbon with a little lower position from lateral teeth, bicuspid with almost the same shape as inner marginal teeth.

Genital system (Figs 4.9A, B)

Male (Fig. 4.9A): Prostate gland (pg) large, pale yellow, divided into two portions of anterior longer and bilobed short posterior. Seminal vesicle (sv) spatulated.

Female (Fig. 4.9B): Bursa copulatrix (bc) round, white and possesses thin wall. Seminal receptacle (sr) slender of pouch-liked structure, and bright orange in colour. Albumin gland (ag) light yellow in color.

Geographical range: India, Hong Kong, Cambodia, China, Malaya, Laos, Vietnam.

Remarks: It seems that *C. volvulus* has widely ranges in Southeast Asia with various shell morphological forms. The Chinese species, *C. exaltatus* (Pfeiffer, 1854) know from South China likely to be related with *C. volvulus* in shell shape and coloration. Reeve (1861) remarked that *C. exaltatus* is a small *C. volvulus*.

***Cyclophorus aurantiacus* (Schumacher, 1817)**

(Figures 4.3B, 4.6B, 4.9C-D, 4.17A)

Annularia aurantiaca Schumacher, 1817: 196.

Cyclostoma aurantiacum —Pfeiffer, 1847: 31, pl. 4, figs 8, 9.

Cyclophorus aurantiacus —Pfeiffer, 1852: 62. Reeve, 1861; sp.3, pl.10, figs 3a, 3b. Nevill, 1878: 266. Möllendorff, 1889: 341. Benthem van Jutting, 1960: 11. Abbot, 1989: 40.

Cyclophorus (Salpingophorus) aurantiacus —Kobelt & Möllendorff, 1897: 109. Kobelt, 1902: 125, sp.81. Gude, 1921: 71, sp.102.

Material examined: Petchaburi (CUMZ 800, 864, 891, 1386, 1455), Kanchanaburi (CUMZ 1196, 1208), Tavoy, Burma (SMF 34783).

Shell (Fig. 4.3A, 4.17A, Table 4.1): Shell very large, thick, conic, the first three whorls are well arranged of spiral line. On the 4-6 whorls, surface sculpture composed of growth lines, with streaks and blotches of dark brownish, faint peripheral keel, umbilicus deep and wide with two dark brown bands (one small one larger) running from reflected lip to the umbilical end with locating between two white bands (smaller in exact umbilical position and the larger distinctly locates in the exact center position) Aperture rounded, rosy, less expanded and reflected.

Radula (Fig. 4.6B): Radula Central tooth triangular with distinct sharp central point. Lateral teeth locate as a independent symmetrical row from central tooth with bicuspid formation, small ectocone and large sharp entocone. It connects with the other side tooth through a weak central spatulated structure. Marginal teeth consist of two portions, inner teeth of sharp tricuspid with large central cusp, outer teeth similar to *C. volvulus* but larger and longer.

Genital system (Figs 4.9 C, D)

Male (Fig. 4.9C): Seminal vesicle (sv) long stalk and pouch enlarged at posterior end. Prostate gland (pg) long slender and thickened, posterior very large.

Female (Fig. 4.9D): Bursa copulatrix (bc) possesses thin wall bean shaped structure with light yellow. Seminal receptacle (sr) small, ovated and bright orange in color.

Geographical range: Mergui Archipelago and Tavoy of Burma, Bukit Pondong, Perak of Malay Peninsula and Sian (Gude, 1921; Suvatti, 1950).

Remarks: This species is a remarkable for it largest size in the present study.

***Cyclophorus semisulcatus* (Sowerby, 1843)**

(Figure 4.3C, 4.17B)

Cyclostoma semisulcatum Sowerby 1843: 124, pl. 25, fig. 99. Pfeiffer, 1848: 86, pl. 11, figs 1-2. Reeve, 1861: sp. 29. Nevill, 1878: 269. Crosse, 1879: 338. Kobelt, 1902: 103. Möllendorff, 1902: 161. Benthem Jutting, 1949: 53.

Cyclophorus (Litostylus) semisulcatus —Kobelt, 1908: 683, pl. 101, figs 11, 12.

Zilch, 1956: 35.

Material examined: Malaysia (CUMZ 861, 1286), Narathiwat (CUMZ 1029, 1342), Malaka (SMF 34728).

Shell (Fig. 4.3C, 4.17B, Table 4.1): Shell rather large, discoidal, with low conic spire of depressed whorls, and rather thin. Suture deeply impressed. Umbilicus wide and deep of white colour with many spiral lines running from reflected lip to the umbilical end. Body whorl dark brown with spiral white band running almost central position, many spiral lines running on the upper of last whorl from lip edge to almost last whorl portion. Aperture rosy without expanded and little reflected but thicken continuous.

Geographical range: Burma, Malaysia, India and Thailand (Habe, 1964).

Remarks: This species is remarkable for depressed whorls and the wide umbilicus.

***Cyclophorus speciosus* (Philippi, 1847)**

(Figures 4.3D, 4.6C, 4.10A, B)

Cyclostoma speciosus Philippi, 1847: 123. Pfeiffer, 1849: 170, pl. 25, fig. 1-3. Reeve, 1861: sp.4. Blandford, 1903: 280, sp. 19.

Cyclophorus (Annularia) speciosus —Kobelt, 1902: 98. Solem, 1966: 10

Material examined: Chachoengsao (CUMZ 873, 1002, 1079, 1397), Chonburi (CUMZ 1473), Nakhon Nayok (CUMZ 823, 1219, 1273, 1217, 1272, 1273, 1366), Suphanburi (CUMZ 874), Vietnam (CUMZ 1033).

Shell (Fig. 4.3D, Table 4.1): Shell large, solid with conic spire. Shell light brown of ground color, and covered with a thin dark brown periostracum. A dark brown broad band encircling body whorl just below the periphery. Body whorl large with weak transverse rib on its periphery. Aperture orange rounded with lip weakly expanded and reflected. Umbilicus deep, but partly covered with columellar margin. Operculum circular, brown, multispiral.

Radula (Fig. 4.6C): Central tooth semicircular with 5 distinct denticles with large center and smaller arrangement of the others. Lateral teeth located alternately with central tooth, tricuspid, center large with two smaller sharp teeth beside. Marginal teeth have different arrangement into two layers of inner marginal teeth located the same level of central tooth, tricuspid but some perform additional indistinct outermost sharp cusp the shape similar to crab great chela, center large with two sharp cusps beside, the outer marginal teeth located at the edge of the ribbon with a little lower position from lateral teeth, bicuspid of much larger ectocone.

Genital systems (Figs 4.10A, B)

Male (Fig. 4.10A): Seminal vesicle (sv) short stalk and pouch enlarged at posterior end. Prostate gland (pg) long slender and thickened, posterior large.

Female (Fig. 4.10B): Seminal receptacle (sr) bright orange, slender, no distinct stalk and pouch. Bursa copulatrix (bc) light yellow fold into two parts, round and flat square.

Geographical range: South China, Burma, Cambodia and Thailand (Kobelt, 1902; Blandford, 1903; Habe, 1964).

Remarks: This is similar to *C. saturnus* ssp.1, but easily distinguished it by thickened shell, aperture not expanded and the dark orange or rosy aperture.

***Cyclophorus cantori* (Benson, 1851)**

(Figures 4.3E, 4.6D, 4.10C, D, 4.17C)

Cyclostoma cantori Benson 1851: 186. Reeve, 1861: p.54 figs. 54a, 54b.

Material examined: Krabi (CUMZ 801, 803, 808, 821, 1067, 1104, 1170, 1193, 1240, 1243, 1301, 1344, 1370, 1460), Nakhonsri Thammarat (CUMZ 833, 1083, 1121, 1279, 1332, 1347, 1362, 1471), Narathiwat (CUMZ 909), Pang Nga (CUMZ 802, 878, 1371, 1373, 1379, 1411, 1441, 1474), Petchaburi (CUMZ 1049, 1249, 1319, 1387, 1391), Phuket (CUMZ 1105, 1106, 1173), Prachuap Kirikhan (CUMZ 1008), Ranong (CUMZ 804, 1146, 1187, 1234, 1462), Suratthani (CUMZ 862, 879, 898, 923, 1013, 1014, 1058, 1242, 1261, 1303, 1328, 1470, 1475), Satun (CUMZ 1126, 1151), Trang (CUMZ 883, 927, 1052, 1053, 1055, 1056, 1313, 1352, 1443), Yala (CUMZ 1310).

Shell (Fig. 4.3E, 4.17C, Table 4.1): Shell moderately umbilicated, globose, rather absolutely keel-angled round the middle, rather thin, brownish, lightly freckled with fulvous-brown above the periphery, broadly banded of a darker tone below it; spire somewhat raised, whorls rounded, last whorl rotundately inflated towards the aperture, rather distantly linearly banded around the umbilicus, lip very broadly flatly expanded, dark orange.

Radula (Fig. 4.6D): Basic structure similar to *C. speciosus* but differs in shorter of outer marginal teeth.

Genital system (Figs 4.10C, D)

Male (Fig. 4.10C): Seminal vesicle (sv) enlarge, not distinct stalk and pouch. Prostate gland (pg) long slender and thicken, posterior part very large lobe. Genital opening (go) covered with thin layer.

Female (Fig. 4.10D): Albumin gland (ag) small plump. Seminal receptacle (sr) long slender pouch, not distinct stalk and pouch, and bright orange in color. Bursa copulatrix (bc) fold to two parts, first part smaller than second part, light yellow in colour and thined wall.

Geographical range: Burmah, Malaysia and Siam (Suvatti, 1950).

Remark: The specimen of *Cyclophorus cantori* of Reeve (1861) figured is the original type collected by Dr. Cantor, and named by Mr. Benson in 1851. The shells of much larger size in Dr. Cuming's collection refered to *C. cantori* by Dr. Pfeiffer, appear to be a distinct species, see *C. pfeifferi* (Reeve, 1861), pl. 3, f. 11a, 11b. Our specimens are smaller than *C. pfeifferi* with the spire more elevated and ground colour is brown but whitish was found in *C. pfeifferi*. The specimen figured was name by Dr. Reeve (1861) and it differ from *C. expansus* (Pfeiffer, 1851) by little striated near suture but the latter species rather everywhere granosely striated.

***Cyclophorus fulguratus fulguratus* (Pfeiffer, 1852)**

(Figures 4.3F, 4.4A, 4.6E, 4.11A, B, 4.17E)

Cyclostoma fulguratum Pfeiffer, 1852: 63.

Cyclostoma fulguratum Pfeiffer, 1854: 345, pl. 45, figs 9, 10.

Cyclophorus (Glassostylus) fulguratus —Solem, 1966: 10.

Cyclophorus fulguratus —Kobelt 1902: 112. Reeve, 1861: sp. 35.

Material examined: Chachoengsao (CUMZ 1417, 1444), Chaiyaphum (CUMZ 1254), Chanthaburi (CUMZ 863, 1076, 1135, 1180), Chiang Mai (CUMZ 1538), Laos (CUMZ 1140), Lamphun (CUMZ 1335), Lopburi

(CUMZ 1337), Nakhon Sawan (CUMZ 809, 857, 860, 881, 1064, 1065, 1141, 1144, 1164, 1222, 1231, 1429, 1435, 1489), Pethchaburi (CUMZ 858, 1031, 1032, 1039, 1040, 1289, 1420), Ratchaburi (CUMZ 918, 1376), Rayong (CUMZ 1190), Saraburi (CUMZ 827, 829, 884, 892, 904, 1037, 1174, 1175, 1294, 1295, 1403, 1412, 1428, 1483), Sra Kaeo (CUMZ 1327) Sukhothai (CUMZ 839, 846, 1188, 1189, 1200, 1201, 1341, 1427, 1430, 1476), Suphanburi (CUMZ 1401, 1402), Tak (CUMZ 859, 1176), Uthaitani (CUMZ 810, 853, 1061, 1062, 1063, 1066, 1232, 1236, 1248).

Shell (Figs. 4.3F, 4.4A, 4.17E, Table 4.1): Shell medium size, rather globosely turbinated, whitish, mostly little striated, some transversely freckled with zigzag chestnut streaks, conspicuously banded below the periphery, then zigzag streaked, unspotted around the umbilicus, whorls rounded, rather inflated, everywhere minutely granosely striated; aperture circular, lip mostly not expanded and reflected, mostly white but some pale orange.

Radula (Fig. 4.6E): Basically structure similar to *C. volvulus* but the lateral denticles of central tooth (c) longer than central denticle.

Genital system (Figs 4.11A, B)

Male genital system (Fig. 4.11A): Seminal vesicle (sv) can not determine stalk and pouch.

Female genital system (Fig. 4.11B): Female bursa copulatrix (bc) long and insert in expanded albumin gland (ag), seminal receptacle (sr) enlarged pouch like plump fingered, labial on albumin gland.

Geographical range: Tonkin of Vietnam and Siam (Kobelt, 1902; Suvatti, 1950).

Remark: Shell shape very close to *C. exaltatus* in their shape but it has whitish ground colour and more striated than the later species. Moreover there are white colors around umbilicus while *C. exaltatus* has brown streak

line. Some authors noted that *C. floridus* (Pferffer, 1854) appear also to be merely a variety of *C. fulguratus*.

***Cyclophorus fulguratus* ssp.1**

(Figures 4.4B, 4.6F, 4.11C, D)

Cyclophorus floridus Pfeiffer, — Kobelt 1902: 138. Reeve, 1861: sp. 58.

Material examined: Chanthaburi (CUMZ 822, 1181, 1199, 1209, 1224), Chachoengsao (CUMZ 1001, 1153, 1155, 1363, 1407), Chonburi (CUMZ 1359, 1478), Khon Kaen (CUMZ 815, 1365, 1449), Kalasin (CUMZ 816, 1123, 1165, 1364, 1398), Laos (CUMZ 1160), Nakhon Nayok (CUMZ 1220), Nakhon Phanom (CUMZ 812, 1158, 1399), Nakhon Ratchasrima (CUMZ 828, 1302), Nong Bua Lamphu (CUMZ 890, 1171, 1172), Petchabun (CUMZ 1258), Sakon Nakhon (CUMZ 813, 832, 841, 843, 847, 848, 849, 850, 851, 1005, 1006, 1007, 1030, 1145, 1159, 1204, 1385, 1448), Saraburi (CUMZ 1197).

Shell (Figs 4.4B, 4.4A, Table 4.1): Shell medium size, rather globosely turbinated, brown, mostly no striated, conspicuously banded at the periphery, unspotted around the umbilicus, whorls rounded, rather inflated, aperture circular, lip mostly not expanded and reflected, mostly white but some pale orange.

Radula (Fig. 4.6E): Basically structure similar to *C. volvulus* but the lateral tooth (l) rounded denticles differ from other triangular.

Genital system (Figs 4.11C, D)

Male genital system (Fig. 4.11C): Seminal vesicle (sv) distinct small stalk and its pouch enlarge posterior end.

Female genital system (Fig. 4.11D): Bursa copulatrix (bc) rounded long and bent, seminal receptacle (sr) small slender like fingered, labial on albumin gland.

Remark: Shell shape very close to *C. fulguratus* (Pfeiffer, 1852) but it has more depressed spire and rather larger than the later species (Table 4.2). A form assumed to be subspecifically related to *C. fulguratus*. It differs from *C. fulguratus* by being by having unicolored in the periostracum. *C. fulguratus* is light spiral bands. Moreover there are differing in both male and female genitalia characters.

They are usually in the hole with pulmonate snail genus *Hemiplecta distincta* in the dry dipterocarp forest in northeastern Thailand.

***Cyclophorus malayanus* (Benson, 1852)**

(Figures 4.4C, 4.7A, 4.12A, B, 4.17F)

Cyclostoma malayanum Benson, 1852: 269.

Cyclophorus malayanus —Martens, 1867: 133. Stoliczka, 1872: 10, figs 1-5.

Crosse, 1879: 338. Morgan, 1885: 410-411. Möllendorff, 1887: 309. Tenison Woods, 1888: 1065. Kobelt, 1902: 195. Gude, 1921: 80. Laidlaw, 1928: 29. Abbott, 1989: 40.

Material examined: Chunporn (CUMZ 1016, 1017), Krabi (CUMZ 819, 1068, 1192, 1237, 1336, 1369, 1488) Nakhonsrithamarat (CUMZ 1143, 1296, 1318, 1346, 1361, 1375), Pang Nga (CUMZ 1148, 1246, 1322, 1325, 1368, 1372, 1378, 1382, 1388, 1484, 1490), Patthalung (CUMZ 1069, 1233, 1287, 1299, 1305, 1311, 1351, 1358, 1432, 1440, 1452, 1454), Petchaburi (CUMZ 1041, 1042, 1045, 1046, 1047), Ranong (CUMZ 1147), Satun (CUMZ 1152, 1439), Songkhla (CUMZ 830), Suratthani (CUMZ 820, 894, 907, 915, 1012, 1015, 1050, 1072, 1073, 1084, 1087, 1088, 1089, 1090,

1092, 1094, 1095, 1097, 1098, 1099, 1110, 1102, 1111, 1116, 1117, 1118, 1122, 1125, 1142, 1229, 1241, 1250, 1251, 1260, 1265, 1268, 1278, 1293, 1329, 1330, 1348, 1350, 1353, 1393, 1404, 1424, 1425, 1436, 1481, 1469), Trang (CUMZ 877, 896, 1054, 1255, 1213, 1317, 1338, 1351, 1360, 1392, 1442), Penang, Malaysia (SMF 34943).

Shell (Fig. 4.4C, 4.17F, Table 4.1): Shell rather largely umbilicated, somewhat transversely turbinated, banded and freckled with reddish chestnut, narrowly pale at the periphery, then rather narrowly dark banded, band here and there articulated, faintly linearly banded around the umbilicus; whorls depressed convex, smooth, partially granosely striated; aperture nearly circular, lip without reflected and expanded.

Radula (Fig. 4.7A): The remarkable radula of this species, the central denticle of central tooth (c) very longer than its lateral denticle differ from others species.

Genital system (Figs 4.12A, B)

Male genital system (Fig. 4.12A): Posterior part of prostate gland (pg) enlarge and round in their shape, seminal vesicle (sv) long slender and enlarge in posterior part.

Female genital system (Fig. 4.12B): Bursa copulatrix (bc) very large and fold to two lobes, seminal receptacle (sr) no appear, albumin gland very plump and labial at anterior end.

Geographical range: India, Malaysia and Siam (Möllendorff, 1894; Suvatti, 1950).

Remark: These species looks similar to *C. aurantiacus* in their shape but it differs from the later species by white or very pale orange. I believe Reeve (1861) that the true *C. malayanus* of Penang is a distinct species. A fine large *Cyclophorus* of the Samui group Habe (1964) consider to belong to it.

***Cyclophorus saturnus saturnus* Pfeiffer, 1862**

(Figures 4.4D, 4.7B, 4.13A, B, 4.17G)

Cyclophorus saturnus Pfeiffer, 1862: 116, pl. 12, fig. 6. Pfeiffer, 1865: 61.

Martens, 1867: 65. Rochelbrane, 1882: 64. Fischer, 1891: 102.

Cyclophorus (Salpingophorus) saturnus —Kobelt & Moellendorff, 1897: 109.

Material examined: Chiang Mai (CUMZ 1019, 870), Chiang Rai (CUMZ 806, 1028, 1434, 1453, 1487, 1434)

Khampangpet (CUMZ 902), Lampang (CUMZ 1131, 1133, 1563), Laos (CUMZ 855, 856, 866, 867, 895, 901, 903, 921, 1038, 1124, 1161, 1213, 1283, 1395), Mae Hongson (CUMZ 1156), Pha Yao (CUMZ 865, 912, 1166, 1167, 1178, 1384), Siam (SMF 34945).

Shell (Fig. 4.4D, 4.17G, Table 4.1): Shell rather large for the genus, low conic with a depressed conic spire, thickened and solid. Body whorl roundly convex and surrounded without peripheral keel. Outer surface covered with brown periostracum throughout their shell toward the umbilicus and distinguish narrow white and dark brown band on the periphery. Aperture rather ovate, margin continuous, very expanded and reflected as an apertural varix, and mostly orange within. Umbilicus broadly. Operculum orbicular, brown, multispiral and concave centrally on its outer surface.

Radula (Fig. 4.7B): Basically structure similar to *C. courbeti* but it larger than the later species.

Genital system (Figs 4.13A, B)

Male genital system (Fig. 4.13A): Prostate gland (pg) stretch out at posterior part with distinct genital opening, seminal vesicle (sv) long slender and enlarge in posterior part and long in their shape with short stalk.

Female genital system (Fig. 4.13B): Bursa copulatrix (bc) irregular fold to two large lobes and two small lobe, seminal receptacle (sr) round pouch and long stalk like drum stick, albumin gland (sg) enlarge on anterior part no labial at anterior end.

Geographical range: Laos, Cambodia

Remark: The remarkable character is low conic spire with very large and orange peristome. The distribution this species is wide range in northern Thailand.

***Cyclophorus saturnus* ssp. 1**

(Figures 4.4E, 4.7C, 4.13C, D)

Material examined: Chachoensao (CUMZ 844), Chanthaburi (CUMZ 822, 836, 838, 840, 885, 887, 897, 922, 926, 1018, 1134, 1178, 1179, 1182, 1183, 1184, 1185, 1186, 1198, 1120, 1223, 1256, 1266, 1270, 1271, 1306, 1377, 1451), Kanchanaburi (CUMZ 1282, 925, 925), Loei (CUMZ 1130, 1253, 1300, 1314, 1426), Nakhon Ratchasima (CUMZ 1412, 1458), Petchaburi (CUMZ 1320), Saraburi (CUMZ 1413, 1491), Sra Kaeo (CUMZ 842), Supanburi (CUMZ 1409), Uthaithani (CUMZ 1060, 1074, 1075, 1077, 1078, 1081, 1082, 1466)

Shell (Fig. 4.4E, Table 4.1): Shell rather large for the genus, turbinate with a rather conic, thickened and solid. Body whorl roundly convex and surrounded by a slightly peripheral keel. Outer surface covered with brown periostracum throughout their shell toward the umbilicus and distinguish narrow white and dark brown band on the periphery. Aperture circular, margin continuous, thinned, very expanded and reflected, and white within. Umbilicus rather narrow and deep. Operculum orbicular, brown, multispiral and concave centrally on its outer surface.

Radula (Fig. 4.7C): Basically structure similar to *C. courbeti* but it is larger than the later species.

Genital system (Figs 4.13C, D)

Male genital system (Fig. 4.13C): Prostate gland (pg) very long slender, thinned, seminal vesicle (sv) very small and short stalk.

Female genital system (Fig. 4.13D): Bursa copulatrix (bc) long ovate shape, not fold, seminal receptacle (sr) long slender pouch, albumin gland (ag) very long and slender, thinned, no labial at anterior end.

Geographical range: Laos, Cambodia

Remark: The remarkable character is conic spire with large and white peristome. The distribution of this species is wide range in eastern Thailand.

***Cyclophorus courbeti* Ancey 1888**

(Figures 4.4F, 4.7D, 4.12C, D)

Cyclophorus courbeti Ancey, 1888: 93. Fischer, 1891: 104.

Cyclophorus (Eucyclophorus) courbeti —Kobelt & Moellendorff, 1897: 110.

Cyclophorus (Cyclophorus) courbeti —Kobelt, 1902: 136, sp. 118.

Cyclophorus (Salpingophorus) courbeti —Kobelt, 1908: 617, pl. 85 fig. 1-2 (SMF 129096), 3-5 (SMF129100). Zilch, 1956: 45.

Material examined: Chiang Mai (CUMZ 805, 837, 882, 886, 888, 1009, 1010, 1011, 1020, 1034, 1035, 1036, 1137, 1138, 1288, 1394, 1396, 1445, 1493), Chiang Rai (CUMZ 1127, 1177, 1419), Chaiyaphum (CUMZ 1485), Lampang (CUMZ 1132), Laos (CUMZ 893, 905, 928, 1389), Pha Yao (CUMZ 1357), Prachuap Kirikhan (CUMZ 1008), Tak (CUMZ 807, 1129), Uthaitani (CUMZ 1298), Vietnam (CUMZ 854, 869, 1215, 1331)

Shell (Fig. 4.4F, Table 4.1): Shell medium, very thicken and solid, narrowly umbilicus. Outer surface covered with a dark brown periostracum with angularly wave white streaks. Pale brown seen around umbilicus. Aperture circular, margin continuous, less expanded and reflected and yellow within. Umbilicus narrow and deep. Operculum orbicular, brown, multispiral and concave centrally on its outer surface.

Radula (Fig. 4.7D): Basically structure similar to *C. saturnus* but it is smaller than the later species.

Genital system: (Figs 4.12C, D)

Male genital system (Fig. 4.12C): Prostate gland (pg) slender and long, seminanal vesicle (sv) long slender pouch and very short stalk.

Female genital system (Fig. 4.12D): Bursa copulatrix (bc) fold to three lobes, seminal receptacle (sr) small slender pouch, albumin gland (ag) slim and no labial at anterior end.

Geographical range: Burmah and Thailand

Remark: The distribution wide range in northern Thailand.

***Cyclophorus subfloridus* Ancey 1888**

(Figures 4.4G, 4.7E, 4.14A, B, 4.17H)

Cyclophorus (Glossostylus) subfloridus — Kobelt, 1908: 7-9 (SMF 34750).

Material examined: Chaiyaphum (CUMZ 1259), Nong Bua Lamphu (CUMZ 1169), Phitsanulok (CUMZ 824, 1149, 1334), Vietnam (CUMZ 1262).

Shell (Fig. 4.4G, 4.17H, Table 4.1): Shell moderately medium conic, light brown with a rose tinted apex and with light spiral bands, particularly along the periphery, bands differ in width, irregular in number. Some always

conspicuous along periphery and additional ones clearly evident below periphery. Bands weakly impressed as spiral lines into the vermiculate sculpture. Aperture circular, lip weakly expanded but distinct reflected; connected across parietal wall by a thick callus. The operculum deeply dished, with the nuclear region being slightly more depressed.

Radula (Fig. 4.7E): Basically structure similar to *C. saturnus* but it is smaller than the later species.

Genital system (Figs 4.14A, B)

Male genital system (Fig. 4.14A): Prostate gland (pg) slender and long, posterior fold to two lobe. Seminal vesicle (sv) long slender pouch and short stalk.

Female genital system (Fig. 4.14B): Bursa copulatrix (bc) fold to five lobes, the first four lobes plump, last lobe rather flat. Seminal receptacle (sr) small long, slender. Albumin gland (ag) most thickens at central part, no labial at anterior end.

Geographical range: Vietnam, Laos, Burma and Thailand

Remark: The shell shape of *C. subfloridus* is similar to *C. fulguratus* but its differ from the later specie by having on collumellar aperture locate. Moreover, the major differences were found in both male and female genitalia *C. subfloridus* has collumellar aperture locates over half of umbilicus, while *C. fulguratus* has collumellar aperture locates almost freely from umbilicus.

***Cyclophorus diplochilus* Möllendorff 1894**

(Figures 4.5A, 4.7F, 4.14C, D, 4.17D)

Cyclophorus diplochilus Möllendorff, 1894: 153, pl. 16, fig. 24 (Holotype).

Cyclophorus (Salpingophorus) diplochilus —Kobelt, 1908: 691, pl. 102, fig. 1-8 (Lectotype). Zilch, 1956: 45.

Material examined: Laos (CUMZ 1162), Suratthani (CUMZ 826, 875, 876, 916, 1004, 1085, 1086, 1091, 1093, 1096, 1101, 1112, 1230, 1269, 1280, 1281, 1423), Nakhonsri Thammarat (CUMZ 1456), Pang Nga (CUMZ 1247, 263, 1323, 1324, 1340, 1367, 1380, 1381, 1446, 1459), Ranong (CUMZ 1356).

Shell (Fig. 4.5A, 4.17D, Table 4.1): Medium size shell, thick and solid, narrowly umbilicus, smooth, turbinate. Ground colour of outer surface white, brown wavy streaks on suture and narrow dark brown band on periphery. Three narrow brown bands near umbilicus. Aperture slightly oblique circular, double layers, first layer strong expanded and reflected, second widen to the right, inner yellow contrasting with the white outer one.

Radula (Fig. 4.7F): Basically structure similar to *C. subfloridus*.

Genital system (Figs 4.14C, D)

Male genital system (Fig. 4.14C): Prostate gland (pg) thickens and long, posterior part very large. Seminal vesicle (sv) long slender and enlarge at posterior part before connect vas deferens (vd).

Female genital system (Fig. 4.14D): Bursa copulatrix (bc) fold to two large lobes, the first lobe longer than that one. Seminal receptacle (sr) small pouch and short stalk like drum stick. Albumin gland (ag) most thickens at posterior part, no labial at anterior end.

Geographical range: Koh Samui, Thailand (Möllendorff, 1894; Kobelt, 1902; Zilch, 1956)

Remark: *C. diplochilus* is firstly described from Samui Island, Suratthani, Thailand (Möllendorff, 1894). This is a peculiar species and very distinct from other known species. All specimens show yellow-bronze peristome, duplicated and widening to the right side. Gould (1856) mentioned that this species is very closely to *C. cucullatus* from Mergui, Burmah. However, *C. cucullatus* differ from *C. diplochilus* in smaller, white,

the last whorl subangulate, the columellar margin not dilatate, the outer peristome duplicated in irregular in their shape.

***Cyclophorus orthostylus* Möllendorff, 1898**

(Figures 4.5B, 4.8A, 4.15A, B, 4.17I)

Cyclophorus (Litostylus) orthostylus Möllendorff, 1898: 80 (SMF 34719).

Kobelt, 1902: 101-102, sp.14. Kobelt, 1908: 7-8. Zilch, 1956: 34.

Material examined: Sakon Nakhon (CUMZ 831, 1238), Annam (SMF 34718).

Shell (Fig. 4.5B, 4.17I, Table 4.1): Shell medium, thined, low conical, and with a depress spire. A sharp keel surrounds the body whorl on its periphery. Outer surface covered with a dull fulvous periostracum, variegated with dark brown splashed markings especially near the suture. Aperture oblique ovate in shape, peristome rosy, somewhat without thickened and expanded, columellar aperture freely from umbilicus. Umbilicus narrowly but deeply perforated. Operculum circular, thin, corneous yellow in colour and centrally concave on its outer surface.

Radula (Fig. 4.8A): Radula teeth similar to *C. malayanus* but the central denticle of central teeth (c) is shorter.

Genital system (Figs 4.15A, B)

Male genital system (Fig. 4.15A): Prostate gland (pg) thickens and long, posterior part very large. Seminal vesicle (sv) long stalk, short pouch and enlarge at posterior part before connect vas deferens (vd).

Female genital system (Fig. 4.15B): Bursa copulatrix (bc) long and slender, one-fourth of albumin gland size. Seminal receptacle (sr) small and slender. Albumin gland (ag) most thickens in lunate shape, no labial at anterior end.

Geographical range: Vietnam and Thailand

Remark: It look like *C. borneensis* (Metcalf, 1851) but different by having larger shell, stronger peripheral keel and red-orange colour of aperture.

***Cyclophorus* sp.**

(Figures 4.5C, 4.8B, 4.15C, D)

Cyclophorus siamensis — Habe, 1964: 123, pl. 1, figs. 8, 9. (not Sowerby, 1848)

Material examined: Kanchanaburi (CUMZ 920, 1021, 1022, 1023, 1024, 1026, 1194, 1195, 1207, 1211, 1252, 1437, 1468, 1494), Laos (CUMZ 1202, 1203), Petchaburi (CUMZ 834, 835, 914, 1043, 1044, 1048, 1930, 1450, 1467, 1482, 1486).

Shell (Fig. 4.5C, Table 4.1): Shell very large, turbate with a rather low conic spire, thickened and solid. Body whorl roundly and surrounded by a slightly margined peripheral cord. Outer surface covered with a dark brown periostracum with angularly waved pale yellow streaks toward below the periphery, becoming white toward the base. Aperture circular, margin continuous, thickened, expanded and reflected as an apertural varix, yellow shade within. Umbilicus rather narrow and deep. Operculum orbicular, brown, multispiral and concave centrally on its outer surface.

Radula (Fig. 4.8B): Radula teeth similar to *C. aurantiacus*.

Genital system (Figs 4.15C, D)

Male genital system (Fig. 4.15C): Prostate gland (pg) thicken, long, very thicken at anterior part, Seminal vesicle (sv) long, can not determine stalk of its.

Female genital system (Fig. 4.15D): Bursa copulatrix (bc) long, slender, weakly fold near the posterior end. Seminal receptacle (sr) beautiful long, slender, no labial at anterior end.

Geographical range: Thailand.

Remarks: This unknown species is a very large species resembling *C. aurantiacus* (Schumacher, 1817) from Burma, the type species of the subgenus, but differs from the latter species in the globose shell covered with a shiny dark brown periostracum the narrowly umbilicus.

Note

The possibility of a species of *Cyclophorus* (Fig. 4.5D) from Betong, Halabala Natinal Park, Narathiwat (CUMZ 1400). Shell medium conic shell; height 18.58-21.17 mm, width 29.47-30.41 mm, whorls ranges 5-5¼, thinned, spire depressed, last whorl distinct angle at periphery with strongly peripheral keel. green-brown with dark brown streaks near suture and on sharpened keel, Aperture slightly oblique ovate, thinned inner white, without expanded and reflected. The remarkable is the sharpness of its peripheral keel. This species looks similar to *C. acutimarginatus* (Sowerby, 1842) from Philippine (Zilch, 1956) but it is different from the latter species by larger shell size, more depressed shell and brownish periostracum.

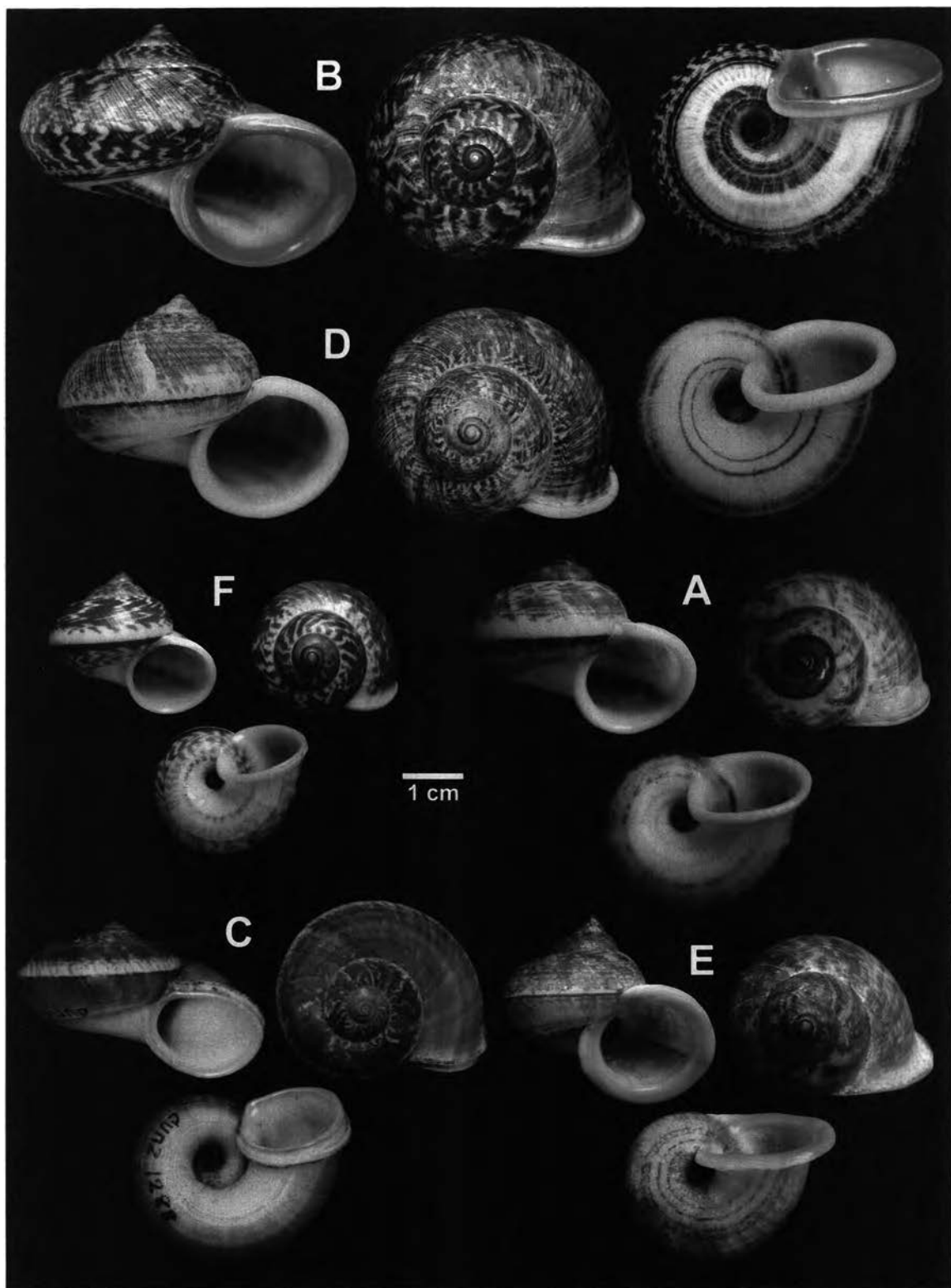


Figure 4.3 Shells in three views; Apertural, Apical and Umbilical views of *Cyclophorus* (A) *C. volvulus* (Lopburi, 825), (B) *C. aurantiacus* (Petchaburi, 800), (C) *C. semisulcatus* (Narathiwat, 1342), (D) *C. speciosus* (Nakhon Nayok, 823), (E) *C. cantori* (Pang Nga, 802), (F) *C. fulguratus fulguratus* (Saraburi, 1403)

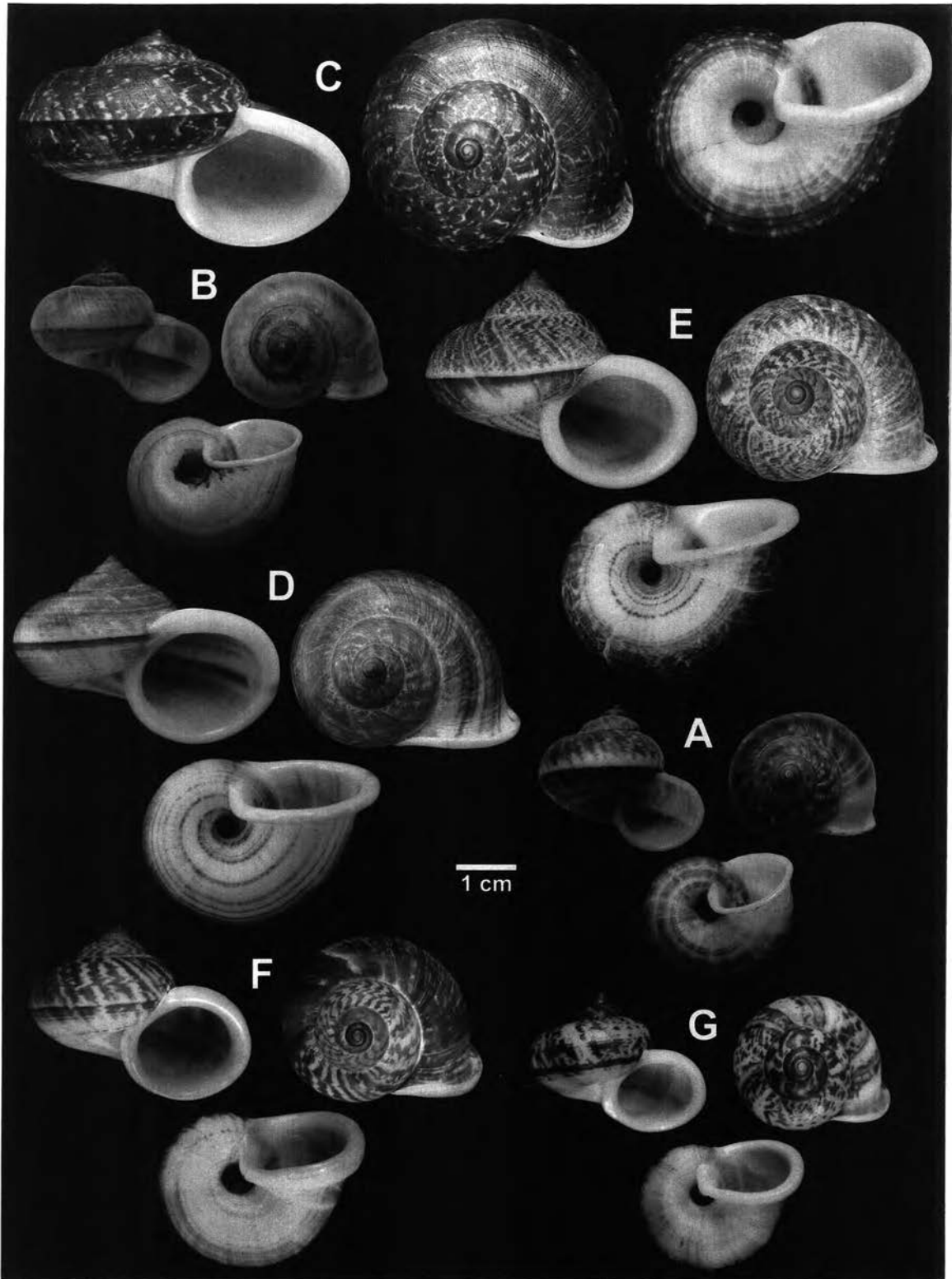


Figure 4.4 Shells in three views; Apertural, Apical and Umbilical views of *Cyclophorus* (A) *C. fulguratus fulguratus* (Uthaithani, 810), (B) *C. fulguratus* ssp.1 (Sakon Nakhon, 1087), (C) *C. malayanus* (Krabi, 819), (D) *C. saturnus saturnus* (Chiang Rai, 1123), (E) *C. saturnus* ssp.1 (Chanthaburi, 1211), (F) *C. courbeti* (Chiang Mai, 805), (G) *C. subfloridus* (Pitsanulok, 824).

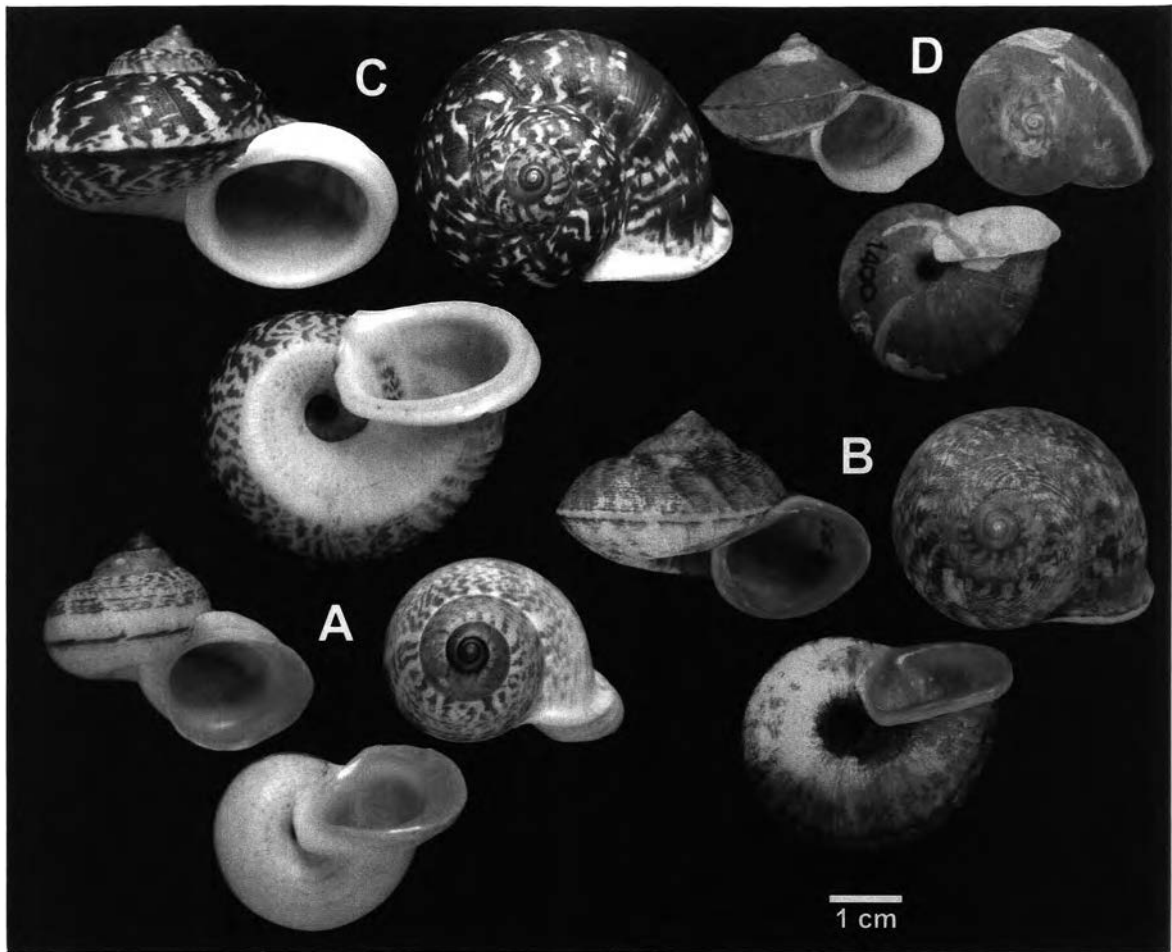


Figure 4.5 Shells in three views; Apertural, Apical and Umbilical views of *Cyclophorus* (A) *C. diplochilus* (Suratthani, 826), (B) *C. orthostylus* (Sakon Nakhon, 1238), (C) *Cyclophorus* sp. (Petchaburi, 1048), (D) *Cyclophorus* (Narathiwat, 1029).

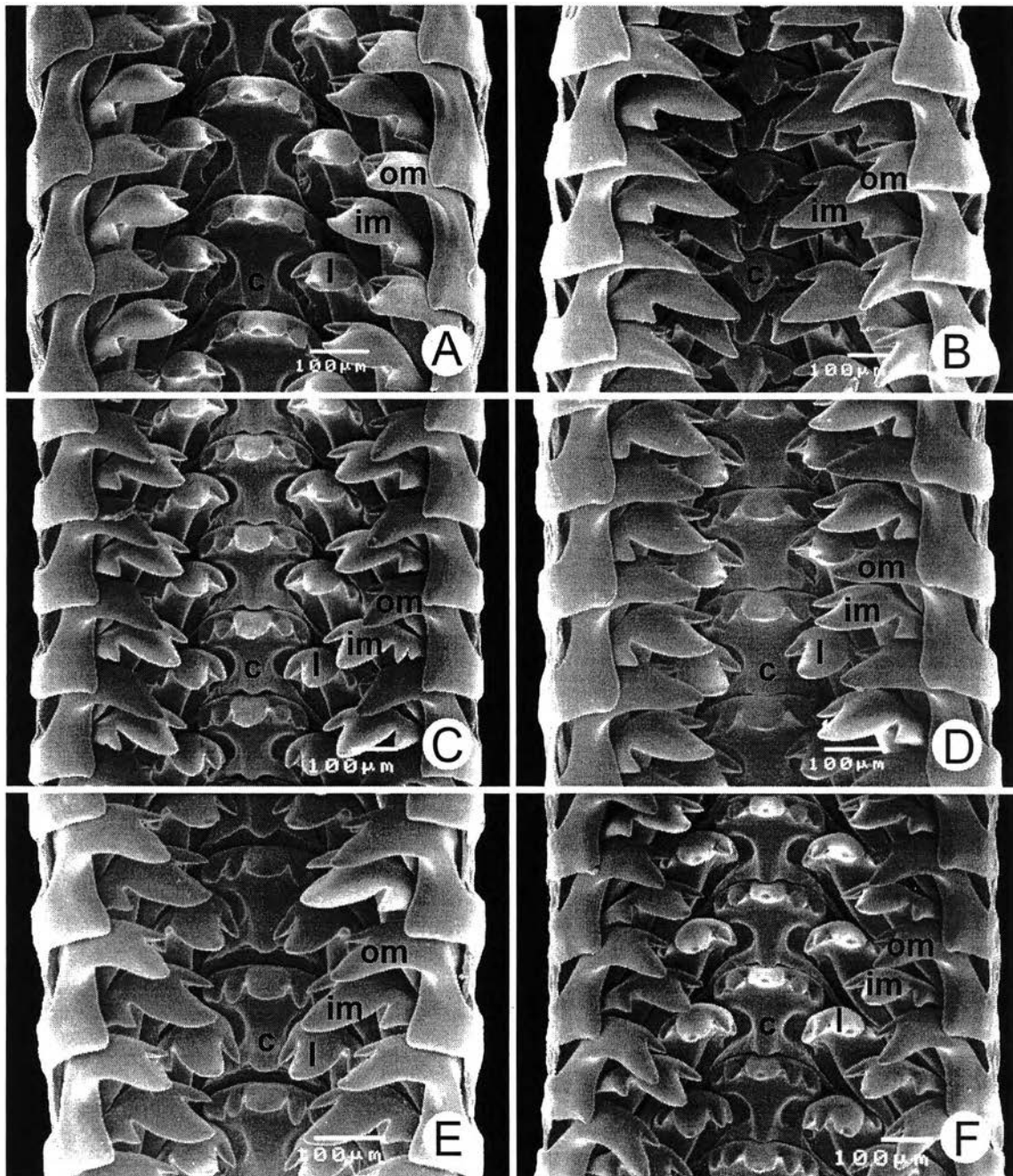


Figure 4.6 Radula under scanning electron microscope (SEM) of *Cyclophorus* (A) *C. volvulus* (Lopburi, 825), (B) *C. aurantiacus* (Petchaburi, 800), (C) *C. speciosus* (Nakhon Nayok, 823), (D) *C. cantori* (Pang Nga, 802), (E) *C. fulguratus fulguratus* (Uthaithani, 810), (F) *C. fulguratus* ssp.1 (Sakon Nakhon 841).

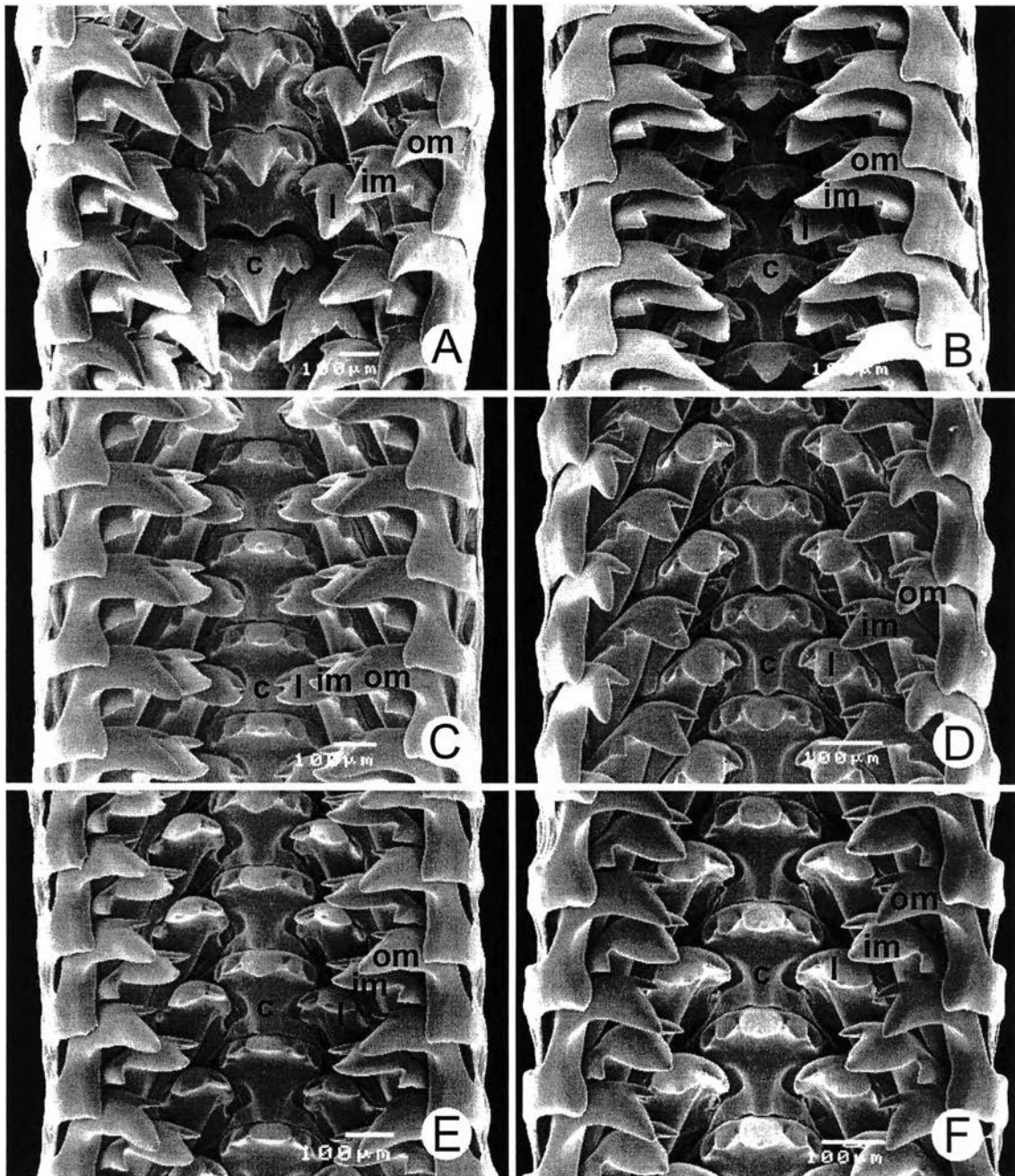


Figure 4.7 Radula under scanning electron microscope (SEM) of *Cyclophorus* (A) *C. malayanus* (Krabi, 819), (B) *C. saturnus saturnus* (Chiang Rai, 870), (C) *C. saturnus* ssp.1 (Chanthaburi, 822), (D) *C. courbeti* (Chiang Mai, 805), (E) *C. subfloridus* (Pitsanulok, 824), (F) *C. diplochilus* (Suratthani, 826).

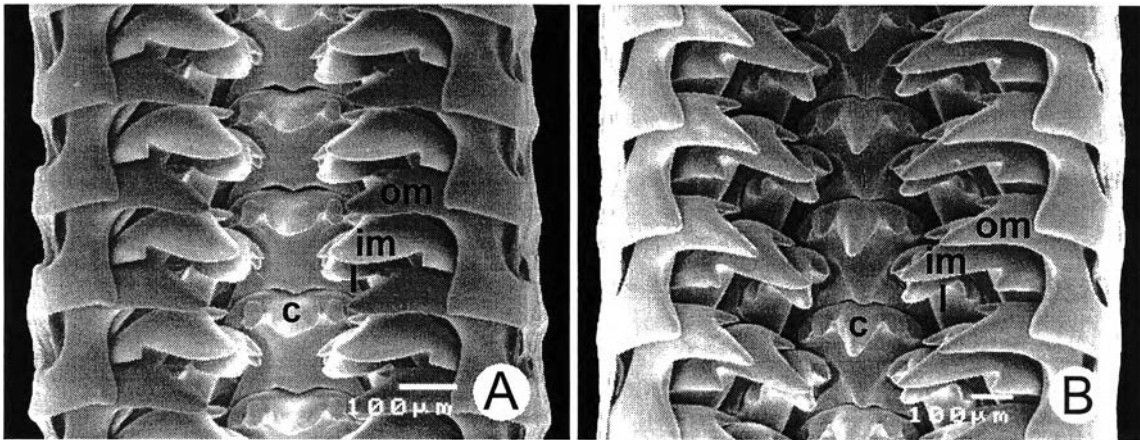


Figure 4.8 Radula under scanning electron microscope (SEM) of *Cyclophorus* (A) *C. orthostylus* (Sakon Nakhon, 831), (B) *Cyclophorus* sp. (Petchaburi, 834).

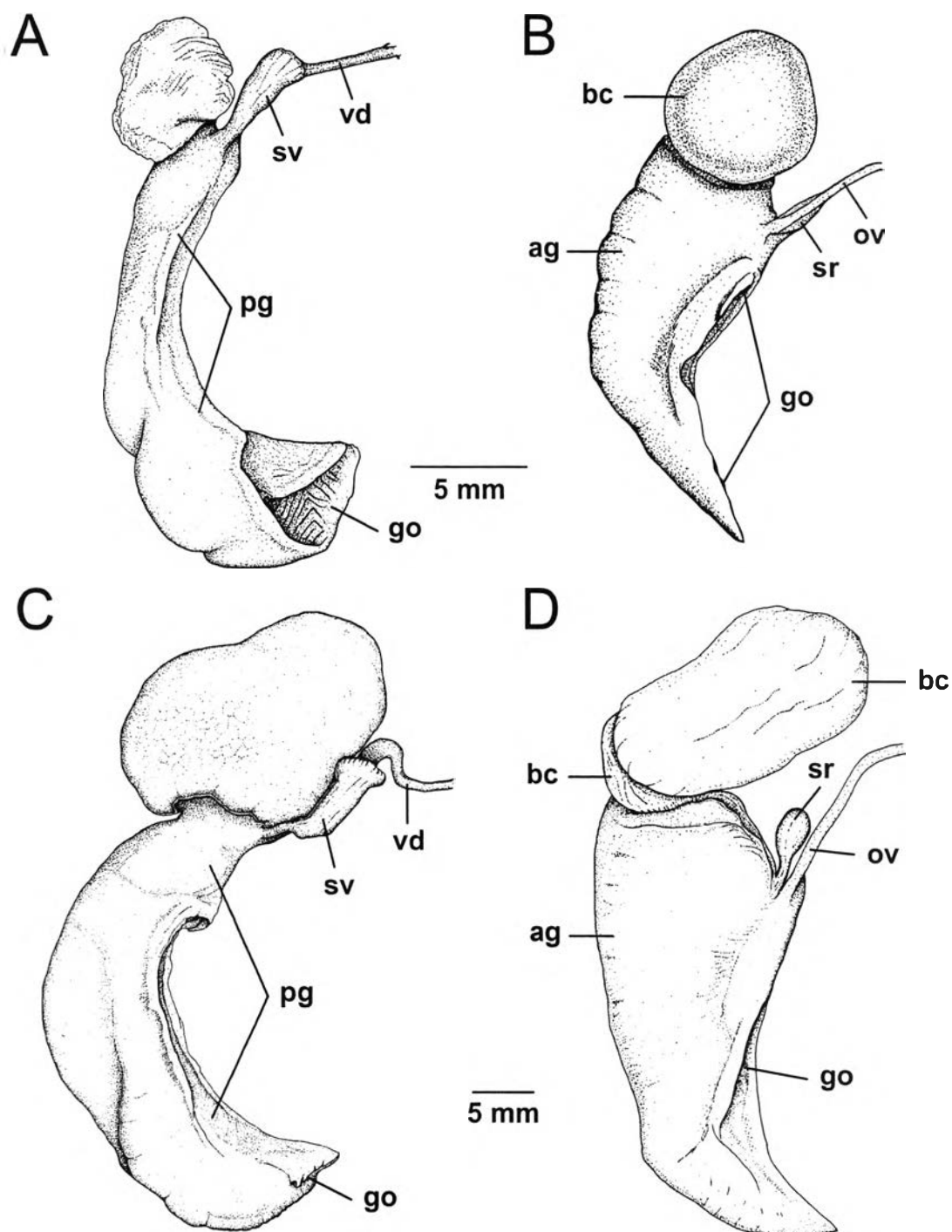


Figure 4.9 Genital system of male and female *Cyclophorus* (A) male *C. volvulus* (Lopburi, 825), (B) female *C. volvulus* (Lopburi, 825), (C) male *C. aurantiacus* (Petchaburi, 800), (D) female *C. aurantiacus* (Petchaburi, 800).

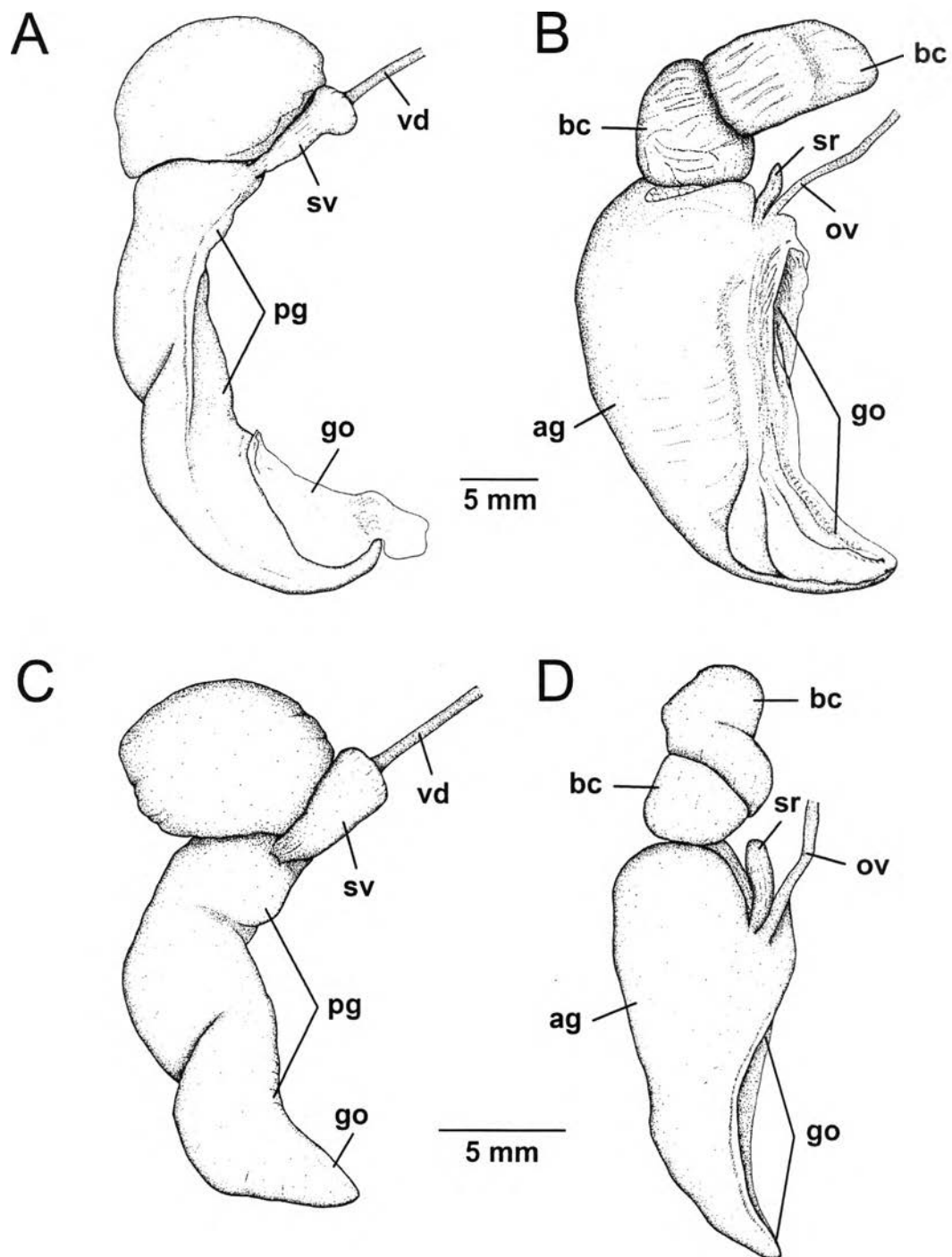


Figure 4.10 Genital system of male and female *Cyclophorus* (A) male *C. speciosus* (Nakhon Nayok, 823), (B) female *C. speciosus* (Nakhon Nayok, 823), (C) male *C. cantori* (Pang Nga, 802), (D) female *C. cantori* (Pang Nga, 802).

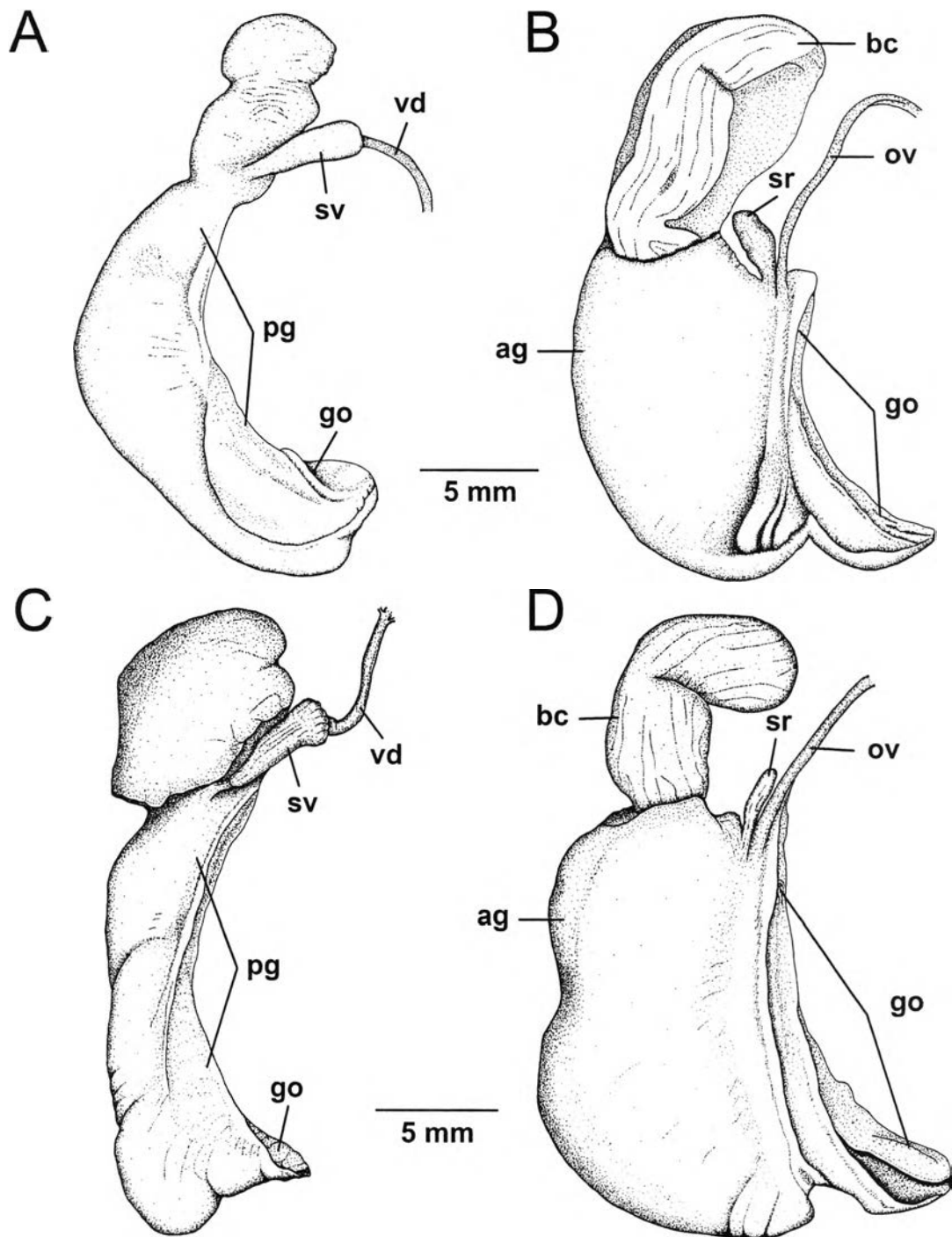


Figure 4.11 Genital system of male and female *Cyclophorus* (A) male *C. fulguratus fulguratus* (Uthaitani, 810), (B) female *C. fulguratus fulguratus* (Uthaitani, 810), (C) male *C. fulguratus* ssp.1 (Sakon Nakhon, 813), (D) female *C. fulguratus* ssp.1 (Sakon Nakhon, 813).

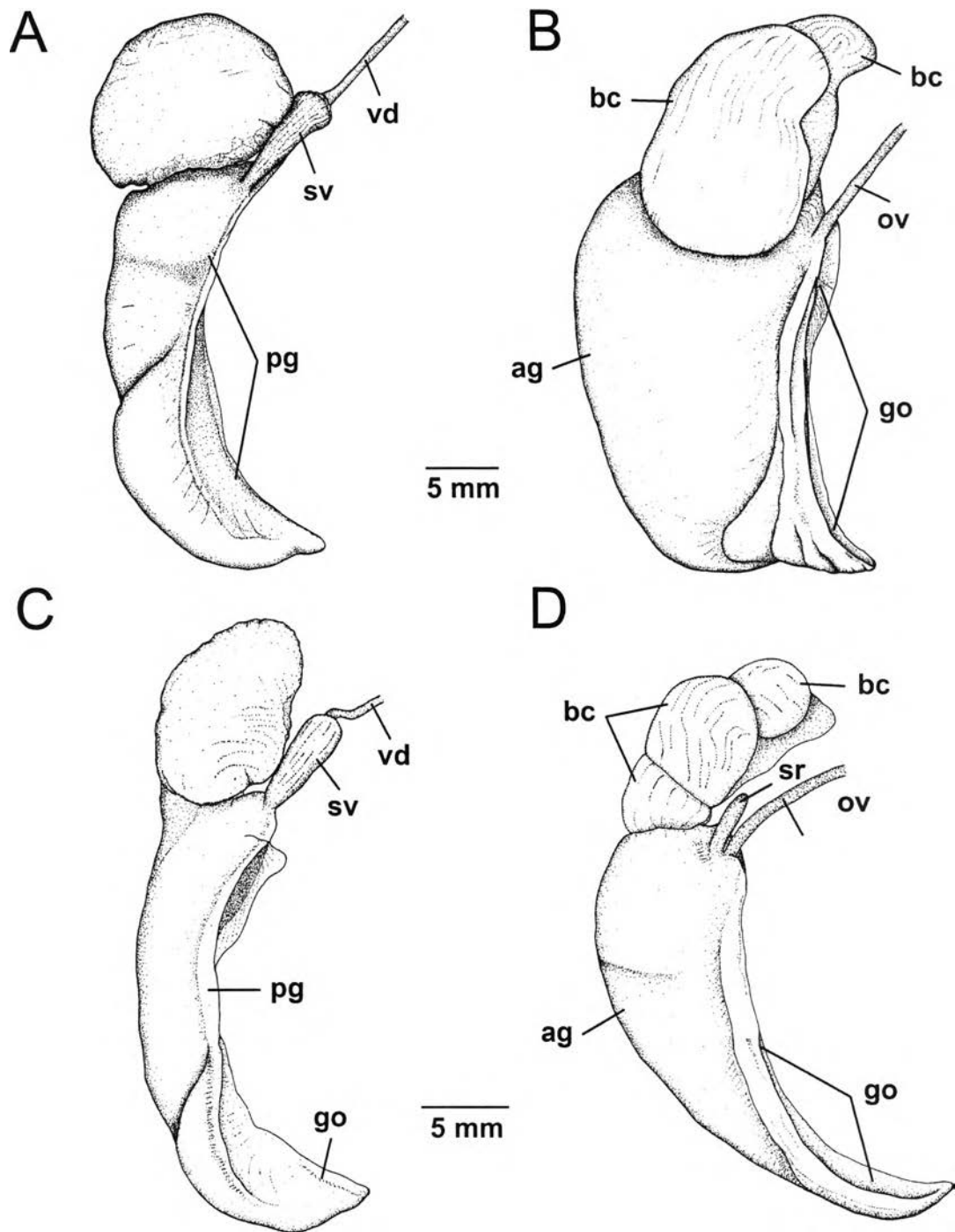


Figure 4.12 Genital system of male and female *Cyclophorus* (A) male *C. malayanus* (Krabi, 819), (B) female *C. malayanus* (Krabi, 819), (C) male *C. courbeti* (Chiang Mai, 805), (D) female *C. courbeti* (Chiang Mai, 805).

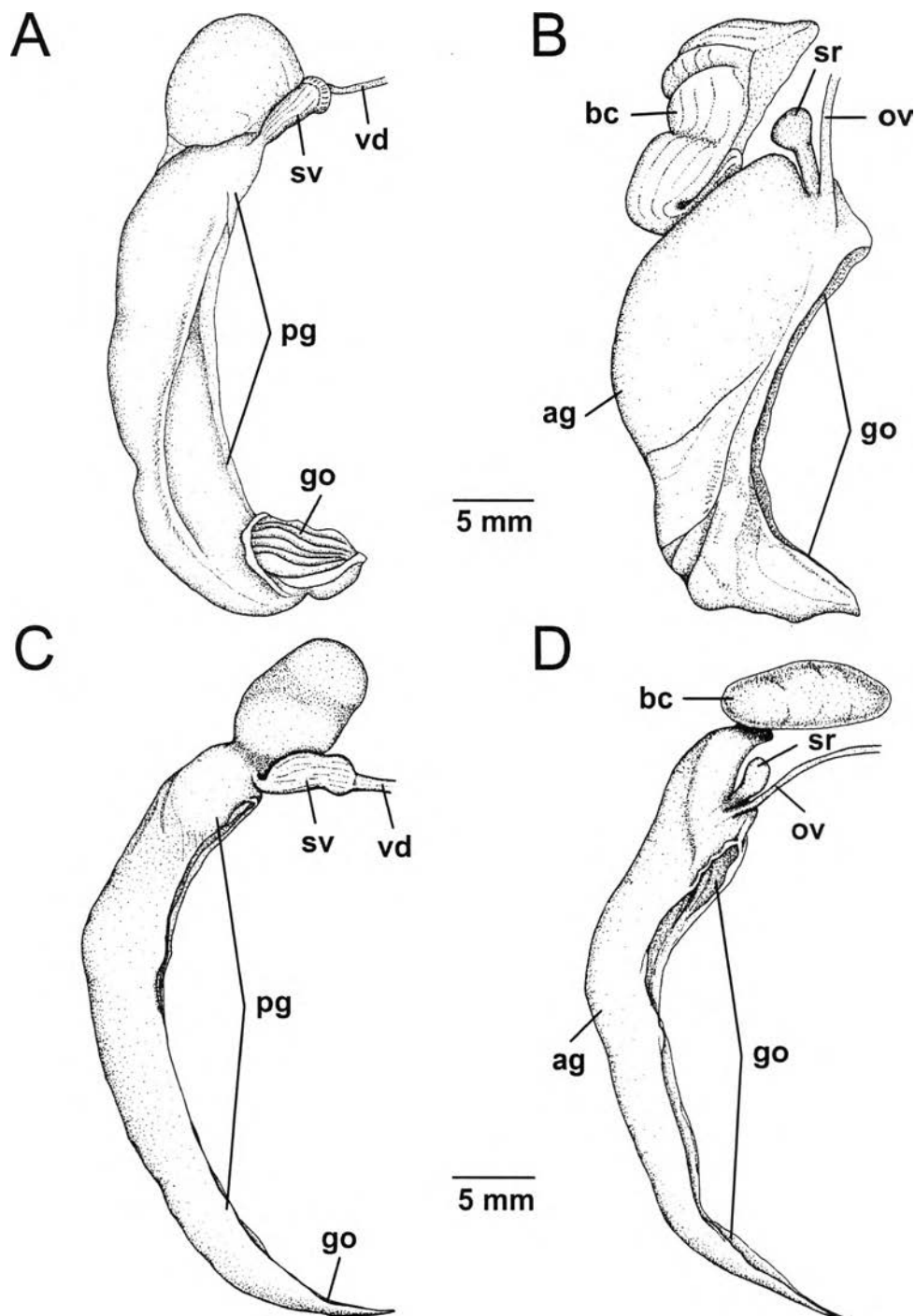


Figure 4.13 Genital system of male and female *Cyclophorus* (A) male *C. saturnus saturnus* (Chiang Rai, 806), (B) female *C. saturnus saturnus* (Chiang Rai, 806), (C) male *C. saturnus ssp.1* (Chanthaburi, 822), (D) female *C. saturnus ssp.1* (Chanthaburi, 822).

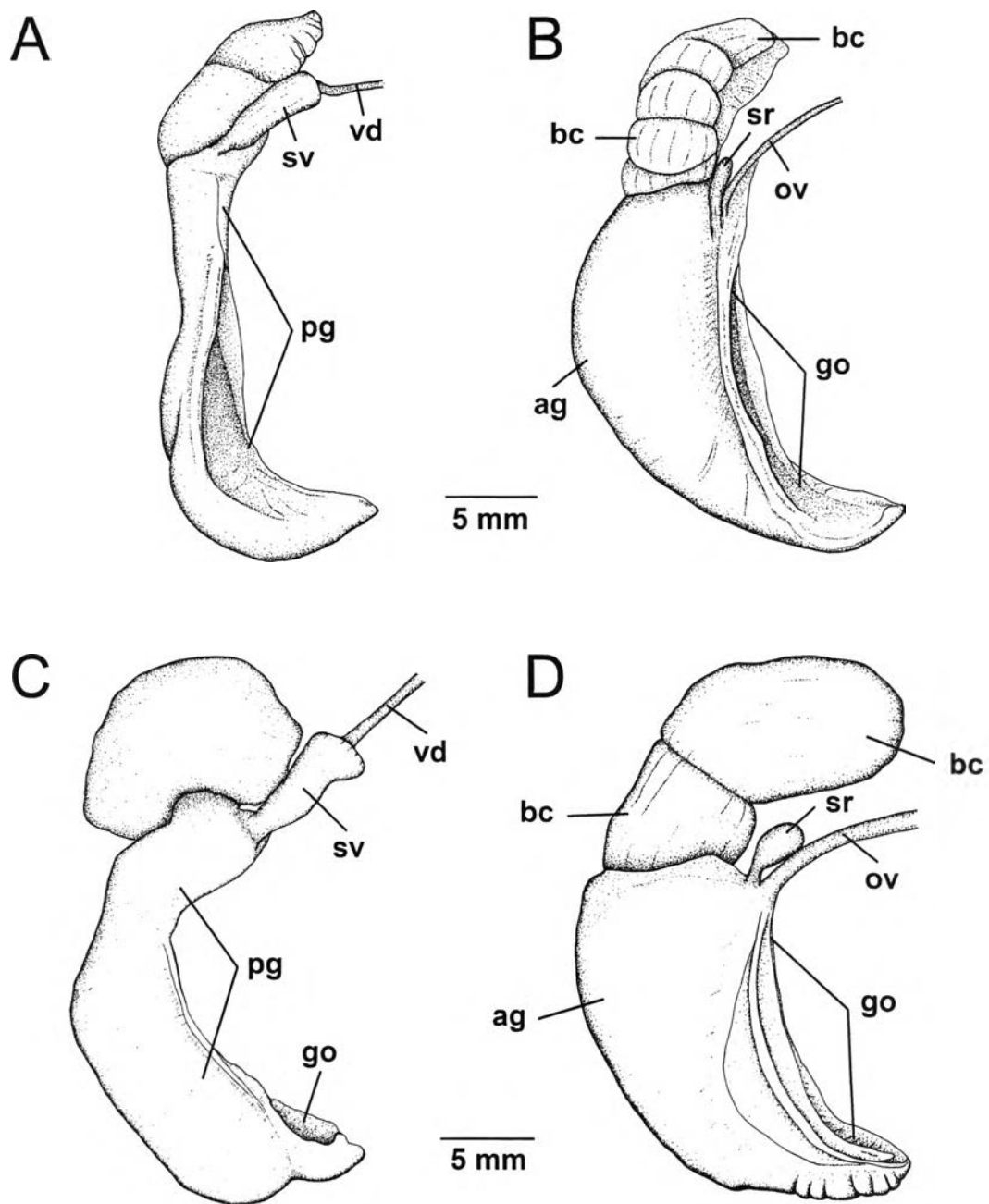


Figure 4.14 Genital system of male and female *Cyclophorus* (A) male *C. subfloridus* (Pitsanulok, 824), (B) female *C. subfloridus* (Pitsanulok, 824), (C) male *C. diplochilus* (Suratthani, 826), (D) female *C. diplochilus* (Suratthani, 826).

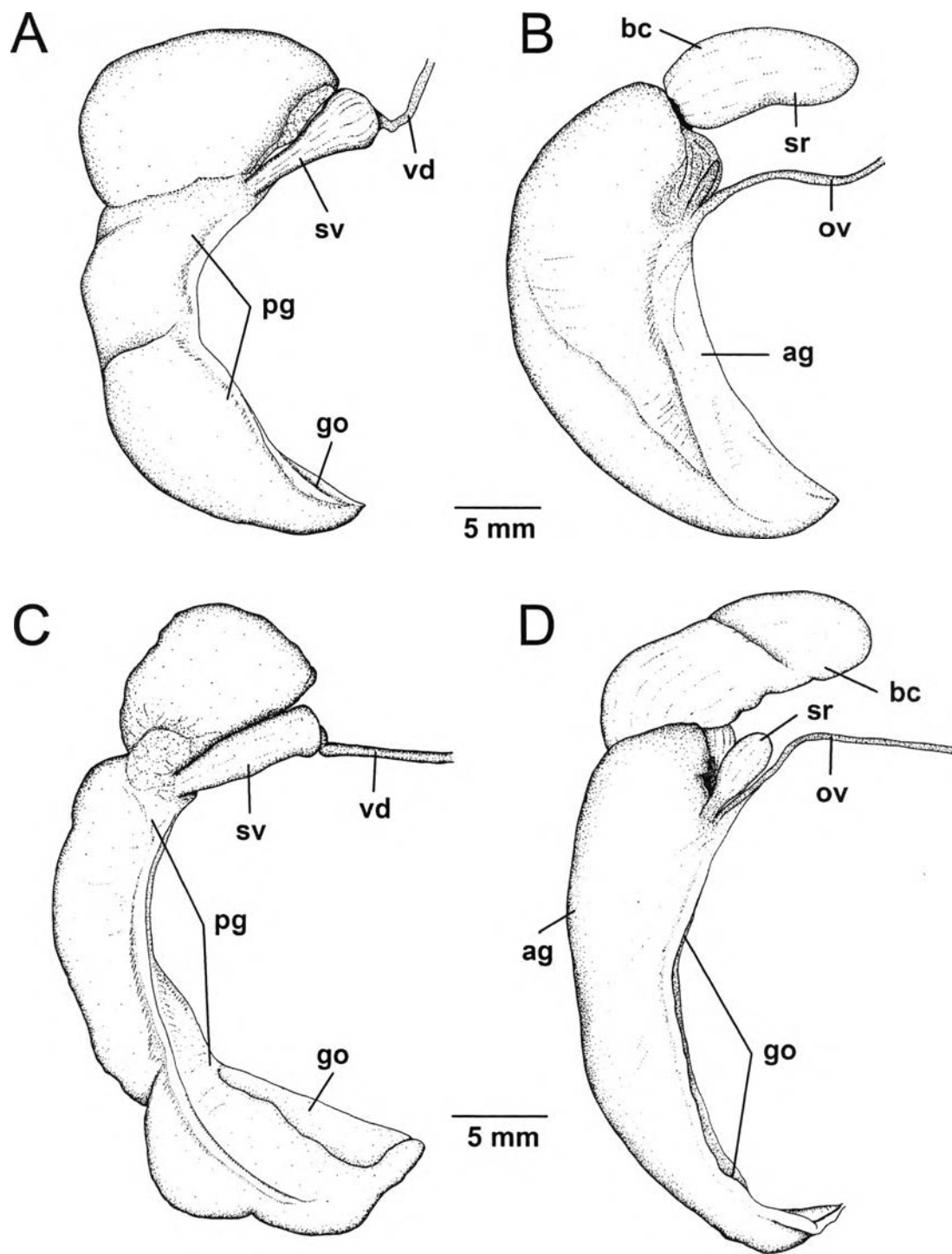


Figure 4.15 Genital system of male and female *Cyclophorus* (A) male *C. orthostylus* (Sakon Nakhon, 831), (B) female *C. orthostylus* (Sakon Nakhon, 831), (C) male *Cyclophorus* sp. (Petchaburi, 834), (D) female *Cyclophorus* sp. (Petchaburi, 834).

Table 4.1 Measurement shell characters for each *Cyclophorus*. Catalogue numbers of specimens are indicated in parentheses.

Species, Locality and CUMZ nos.	Number of adult shell examined	Ranges, Mean \pm SD in mm of:			Whorl Ranges
		Shell Height	Shell Width	h/d Ratio	
<i>C. volvulus</i> (Müller, 1774)					
- Wang Kanleuang, Lopburi (825)	30	28.3-36.89 31.27 \pm 1.82	32.31-41.04 35.81 \pm 1.96	0.81-0.94 0.87 \pm 0.03	6 $\frac{1}{4}$
<i>C. aurantiacus</i> (Schumacher, 1817)					
- Kang Krajan, Phetchaburi (800)	20	42.70-52.63 44.85 \pm 1.93	57.08-64.74 59.67 \pm 2.33	0.72-0.79 0.75 \pm 0.01	6 $\frac{1}{4}$
<i>C. semisulcatus</i> (Sowerby, 1843)					
- Khao Thanyong, Narathiw (1342)	32	34.15-37.76 36.03 \pm 1.50	50.09-54.52 52.37 \pm 1.83	0.68-0.72 0.69 \pm 0.02	5 $\frac{3}{4}$
<i>C. speciosus</i> (Philippi, 1847)					
- Wang Takrai, Nakhonnayok (823)	26	37.36-43.54 40.60 \pm 1.72	46.68-52.57 49.38 \pm 1.86	0.79-0.85 0.82 \pm 0.02	6
<i>C. cantori</i> (Benson, 1851)					
- Chewlhan, Suratthani (1014)	11	19.64-30.27 23.96 \pm 3.29	22.81-37.64 29.04 \pm 3.29	0.78-0.86 0.83 \pm 0.03	6-6 $\frac{1}{4}$
- Klongsang Suratthani (1093)	18	27.41-32.57 29.51 \pm 1.95	30.53-38.75 34.92 \pm 2.41	0.80-0.91 0.85 \pm 0.03	6-6 $\frac{1}{2}$
- Kangrajan Petchaburi (1044)	15	25.69-32.22 28.43 \pm 2.26	28.80-37.53 33.23 \pm 2.97	0.79-0.90 0.86 \pm 0.04	6-6 $\frac{3}{4}$
<i>C. fulguratus fulguratus</i> (Pfeiffer, 1862)					
- Thepsathaporn, Uthaiyhani (1232)	32	22.89-28.19 25.59 \pm 1.30	26.40-31.47 28.92 \pm 1.26	0.83-0.93 0.88 \pm 0.03	6-6 $\frac{1}{4}$
- Botanical garden, Saraburi (1175)	29	23.57-27.59 25.81 \pm 1.23	27.75-31.41 29.48 \pm 1.19	0.81-0.92 0.86 \pm 0.03	5 $\frac{3}{4}$ -6 $\frac{1}{2}$
<i>Cyclophorus fulguratus</i> ssp.1					
- Ban Kokglang, Sakon Nakhon (1006)	11	28.80-33.15 31.13 \pm 1.64	34.67-41.13 37.86 \pm 2.18	0.80-0.86 0.82 \pm 0.02	6-6 $\frac{1}{4}$

Table 4.1 (Continue) Shell size of *Cyclophorus*. Catalogue numbers of specimens are indicated in parentheses.

Species, Locality and CUMZ nos.	Number of adult shell examined	Ranges, Mean \pm SD in mm of:			Whorl Ranges
		Shell Height	Shell Width	h/d Ratio	
<i>C. malayanus</i> (Benson, 1852)					
- Sramorakot, Krabi, 819)	37	36.55-44.67	50.82-60.93	0.67-0.76	6 $\frac{1}{4}$
		39.86 \pm 1.92	56.49 \pm 2.39	0.71 \pm 0.02	
<i>C. saturnus saturnus</i> Pfeiffer, 1862	9	36.12-41.42	46.64-57.48	0.72-0.81	5 $\frac{3}{4}$ -6 $\frac{1}{2}$
- Lamnamkok, Chiang Rai (1123)		38.59 \pm 1.40	50.91 \pm 3.30	0.76 \pm 0.03	
- Doi Chiang Dao, Chiang Mai (1019)	27	32.55-42.23	42.99-56.20	0.70-0.80	5 $\frac{3}{4}$ -6 $\frac{1}{2}$
		37.20 \pm 2.49	49.35 \pm 3.32	0.75 \pm 0.03	
<i>C. saturnus</i> ssp.1	22	36.22-45.49	45.35-56.28	0.78-0.86	6-6 $\frac{3}{4}$
- Phlieu, Chanthaburi (822)		40.39 \pm 1.82	49.66 \pm 2.19	0.81 \pm 0.02	
<i>C. courbeti</i> Ancey, 1888					
- Brijinda, Chiang Mai (805)	22	26.37-31.33	32.66-38.18	0.76-0.86	6 $\frac{1}{4}$
		28.55 \pm 1.65	35.39 \pm 1.67	0.81 \pm 0.02	
<i>C. subfloridus</i> Ancey, 1888					
- Nernmaprang, Phitsanulok (824)	26	24.92-31.37	29.05-37.82	0.80-0.89	6-6 $\frac{3}{4}$
		26.76 \pm 1.41	31.68 \pm 1.86	0.85 \pm 0.02	
<i>C. diplochilus</i> Möllendorff, 1894					
- Samui, Suratthani (826)	31	27.32-32.57	32.11-45.15	0.74-0.87	6-6 $\frac{3}{4}$
		29.64 \pm 1.73	36.00 \pm 2.74	0.80 \pm 0.04	
<i>C. orthostylus</i> Möllendorff, 1898					
- Sangkore, Sakon Nakhon (1238)	10	27.81-29.4	39.42-41.95	0.67-0.76	5-5 $\frac{1}{4}$
		28.42 \pm 0.86	40.98 \pm 1.36	0.69 \pm 0.02	
<i>Cyclophorus</i> sp.					
- Erawan W.F., Kanchanaburi (1022)	10	42.45-45.99	56.39-61.33	0.74-0.80	6-6 $\frac{1}{2}$
		44.99 \pm 1.12	58.24 \pm 1.59	0.77 \pm 0.02	

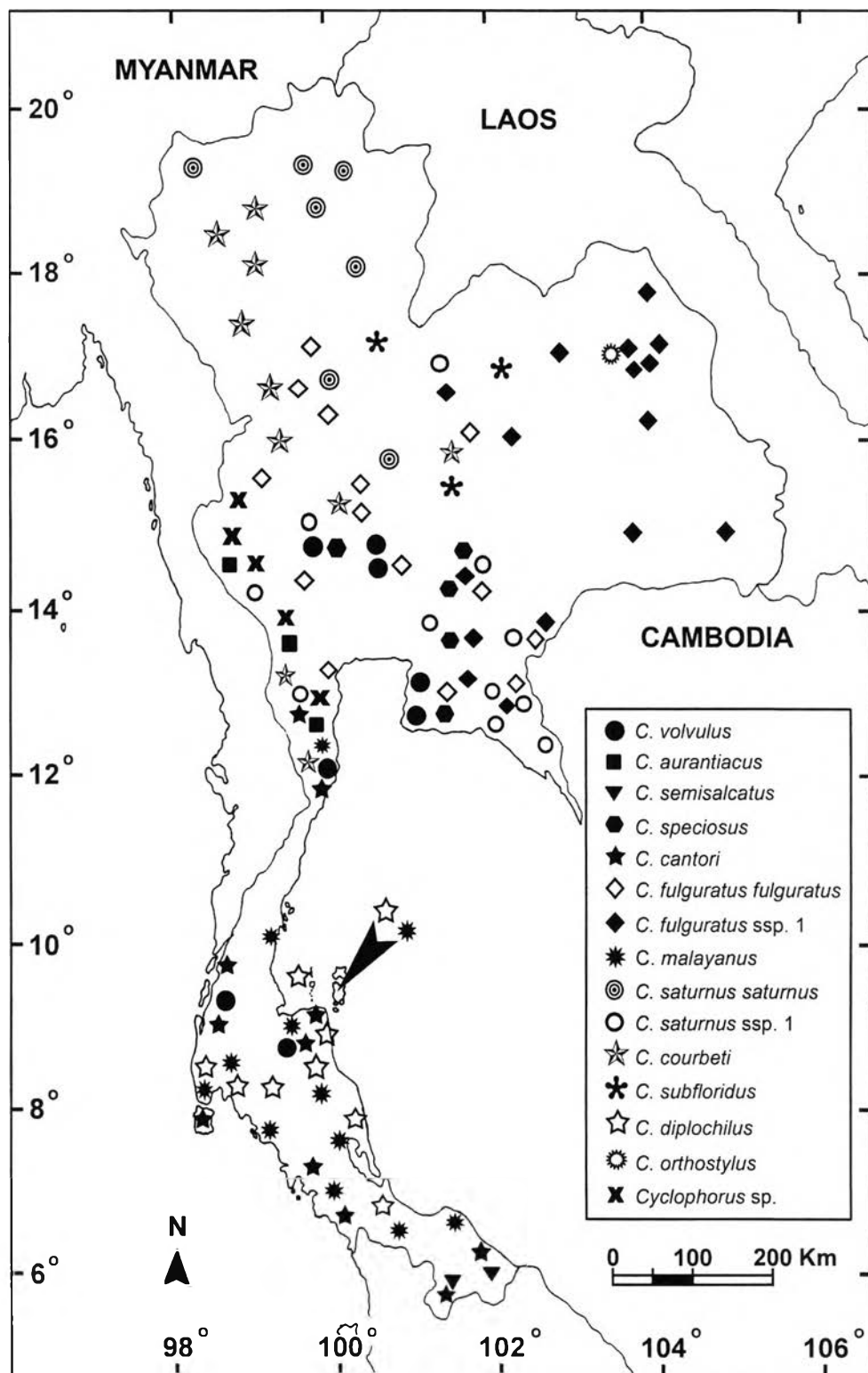


Figure 4.16 Distribution of 15 *Cyclophorus*.

Figure 4.17 Type specimens **(A)** *C. aurantiacus* (paratype SMF34783) Tavoy, Burma. **(B)** *C. semisalcatus* (syntype SMF 34728/2) Malaka. **(C)** *C. cantori* (syntype NHM) Penang, Malaysia. **(D)** *C. diplochilus* (holotype NHM) Samui, Siam. **(E)** *C. fulguratus* (paratype NHM) Pegu, Burma. **(F)** *C. malayanus* (lectotype SMF 34943) Penang, Malaysia. **(G)** *C. saturnus* (paratype SMF 34945) Siam. **(H)** *C. subfloridus* (paratype NHM) Tonkin, Vietnam. **(I)** *C. orthostylus* (lectotype SMF 34718) Annam.

