

CHAPTER 4

RESULT

In the present study, 15 species of Thai *Rhiostoma* were identified. The list and the descriptions of each species are presented in the Table 4.1

Table 4.1 Summary of *Rhiostoma* from previous papers and the present study.

Present study	References
Family Cyclophoridae	
Subfamily Pterocyclinae	
Genus <i>Pterocyclus</i>	
<i>P. asiphon</i> (Moellendorff, 1894) (new propose from present study)	Moellendorff (1894)-Thailand; Benthem Jutting (1960), Patamakanthin (2001)-Malaysia.
Genus <i>Rhiostoma</i>	
<i>R. chupingense</i> Tomlin, 1938	Tomlin (1938), Hemmen <i>et al.</i> (1999)-Malaysia. Patamakanthin (2001)- Malaysia & Thailand.
<i>R. hainesi</i> Pfeiffer, 1862	Salisbury (1949), Habe (1965), Abbott (1989), Hemmen <i>et al.</i> (1999), Patamakanthin (2001)-Thailand.
<i>R. housei</i> (Haines, 1858)	Moellendorff (1894), Blanford(1902-1903), Habe (1965), Solem (1966), Abbott (1989)-Thailand.
<i>R. jalorensis</i> Sykes, 1903	Sykes (1903), Salisbury (1949)-Malaysia; Hemmen <i>et al.</i> (1999), Patamakanthin (2001)-Thailand.
<i>R. samuiense</i> Tomlin, 1931	Tomlin (1931), Hemmen <i>et al.</i> (1999), Patamakanthin (2001)-Thailand.
<i>R. sp.1</i>	-
<i>R. sp.2</i>	-
<i>R. sp.3</i>	-
<i>R. sp.4</i>	-
<i>R. sp.5</i>	-
<i>R. sp.6</i>	-
<i>R. sp.7</i>	-
<i>R. sp.8</i>	-
<i>R. sp.9</i>	-

Genus *Rhiostoma* Benson, 1860

Type species : *Rhiostoma haughtoni* Benson, 1860

Locality : Myanmar.

Description : Shell is sub-discoidal or proboscis shape, widely umbilicated, anterior part of last whorl disconnect to penultimate whorl, peristome free, notch present on upper edge of aperture, backward tube or triangular projection present at the end of the notch. Operculum calcaroconeous, cylindrical, anti-clockwise multispiral, concave inside, flat and smooth, convex outside.

Distribution : Thailand, Myanmar, Cambodia, Vietnam, and Malaysia.

Pterocyclus asiphon (Moellendorff, 1894)

1894 *Rhiostoma asiphon*, Moellendorff. Proc. Zool. Soc. Lond., 146-156, pl.16. (Samui Islands : Gulf of Thailand)

1960 *Rhiostoma asiphon*, Benthem Jutting. Basteria, 24(1-2) : 1-28. (Kampong Tebing Tinggi, Kangar and Kaki Bukit, Kampong Wang Tangga; Perlis : Malaysia)

2001 *Rhiostoma asiphon*, Patamakanthin. Of Sea and Shore. 23, 4 : 222-223. fig. G1-2. (Kangar; Perlis : Malaysia)

Shell : The shape is sub-discoidal with 5 rounded whorl, solid, widely umbilicate, and flatted spire. Last whorl coilling, disconnected part of last whorl absent, major diameter range 19.14-22.09 mm. and shell height range 11.16-14.04 mm. Shell surface smooth with regular growth lines. Periostracum is thin diaphanous brown color. Dorsal side of shells present uniform or variegate with brown zigzag pattern on white background, ventral side present uniform in white color. Sub-peripheral band absent or present one or two dark brown bands. Aperture circular, peristome is thick and interrupt by apertural notch presentation. Air breathing tube absent or present, the absent group has a large notch and big projection, the present group has a large hole and big incomplete tube, both of these characters are the sinus of genus *Pterocyclus*. Keel absent because disconnected part of last whorl absent. Swollen ridge present from the

projection or tube along the growth lines behind peristome, and then fuse with peristome below the sub-peripheral band.

Operculum : Calcaroconeous, shallow cylindrical, outside concave, anti-clockwise multispiral.

Body : The first half of trunk is black with fade down in a small area near mantle cavity. The second half of the body is visceral mass covered with thin transparent mantle layer.

Radula : Taenioglossate radula sheet contain 7 teeth in each row. There are a central, 2 lateral and 4 marginal teeth. Central tooth usually has 5 to 7 cusps, the head is slightly convex or flat, the width is longer than the length, central cusp is larger than other cusps, ridge connecting is stocky. Lateral teeth have 4 cusps, the third is largest in elongate linguiform and other cusps are smaller than it in robust serrate shape, inner part of basal plate is very short but outer part is very long. Marginal teeth turn in, the first marginal teeth have 4 cusps, third cusp is largest in elongate linguiform, other cusps are smaller than it in robust serrated shape. The second marginal teeth have 4 cusps, the first and the third are serrate shape, the second is digitiform, the fourth is largest in triangular shape.

Genital system :

Male :

Testis occupies entirely on the uppermost part of visceral hump, dull orange in color.

Vas deferens runs forward from testis to prostate gland on the collumella side of visceral mass, thin, slender, and pale yellowish color, it lies parallel to large esophagus.

Prostate gland locates on the collumella side of visceral mass, it is large and visible from above of mantle. The shape is fusiform, flattened, pale yellowish color, separated in two parts by thickness. The posterior part is one-fourths of the length, flattened in quadrangle shape, pale orange in color, vas deferens enters at the middle of

posterior part, without seminal vesicle, genital opening opens from the anterior end reach to one-eighths of anterior part length.

Seminal groove extends from the prostate along the right side of the head to the tip of the penis.

Penis locates on the right side of the head behind the tentacle, digitiform, stocky, very short, It is shorter than tentacle.

Female :

Ovary locates on the columella side of the early whorls. It embedded in the digestive gland consists 7 gland, color is bright orange with a few brown spot in each gland, the second gland is unilobate, other glands are multilobate.

Oviduct is pale yellowish color, runs forward from ovary to uterus along the columella side with nearby the greater duct of esophagus.

Seminal receptacle is robust digitiform projects from posterior of uterus, its length long over the posterior end, pale orange in color.

Bursa copulatrix is lunate shape, the length more than half of uterus length, flattened, diaphanous, half of it in right side has an opaque part, opens into the outer side of uterus.

Uterus is lunate shape, plump, posterior end is round, anterior end is slightly taper and pointed at the end, color is pale yellow. Oviduct enters to uterus on inner side at the base of seminal receptacle. Vagina slit opens from the distal of anterior end reach to one-thirds or half of uterus length, its labial is simple.

Habitat : *Pterocyclus asiphon* were collected from limestone areas at Khao To Phaya Wang and Sumano Cave in the hole on the ground under leaf litter.

Locality : Sumano Cave, Phatthalung; Khao To Phaya Wang, Satun; and limestone hill in Ban Na Tham, Songkhla.

Distribution : Samui Islands, in the Gulf of Thailand; Phatthalung; Satun; Songkhla; and Perlis, Malaysia.

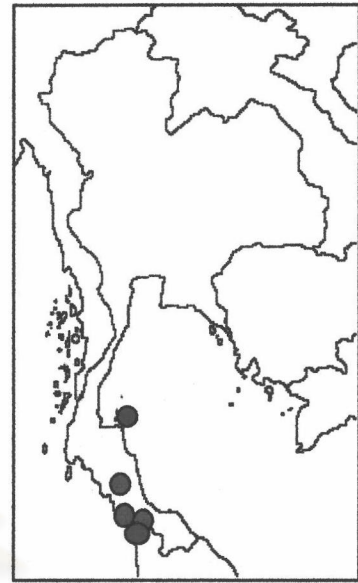
Diagnosis : *Pterocyclus asiphon* is totally different from all other species of *Rhiostoma* in following characters : swell ridge presents behind peristome from the projection and then fuse with peristome below the sub-peripheral band; operculum is shallow and concave at outside; the first marginal teeth of radular has 4 cusps; length of genital opening is very small about 1/8 of anterior part of prostate gland length. This species may be misidentified by previous papers, because it has the characters of genus *Pterocyclus* including sinus on upper peristome and shallow cylindrical operculum.



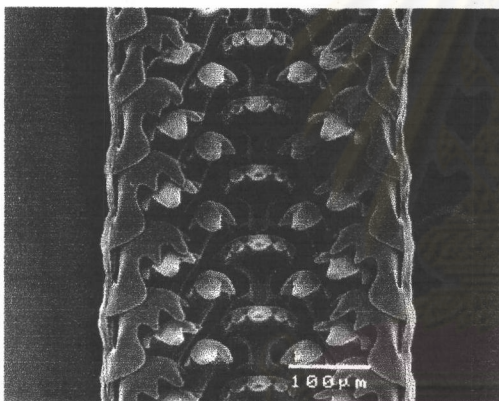
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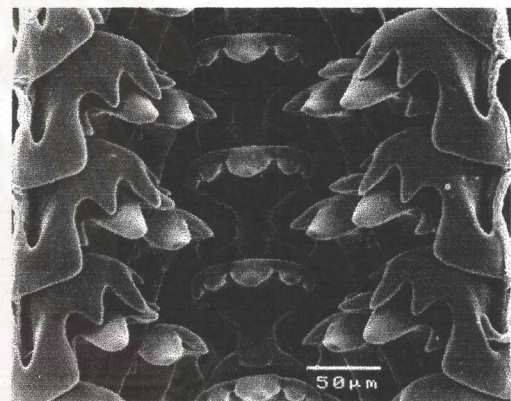
a



b



c



d

Figure 4.1 a) *Pterocyclus asiphon*; b) distribution; Samui Island; Phatthalung; Satun; Songkhla : Thailand and Perlis : Malaysia. (● collected from the present study, ● literature review); c) radula sheet d) enlarged radula sheet

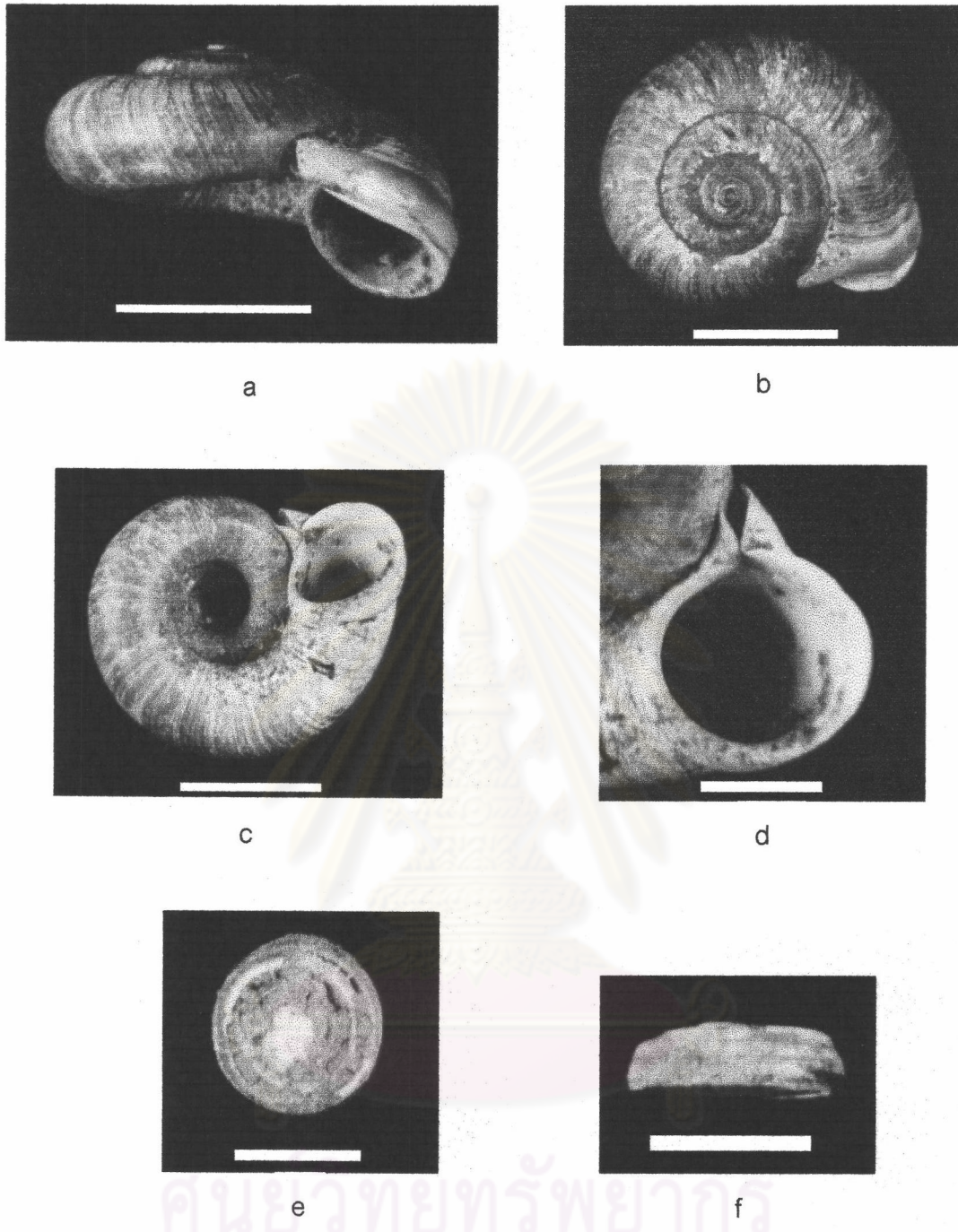


Figure 4.2 *Pterocyclus asiphon*; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; e) operculum at dorsal side; f) operculum at lateral side; (scale bars : a-c = 10 mm.; d-f = 5 mm.)

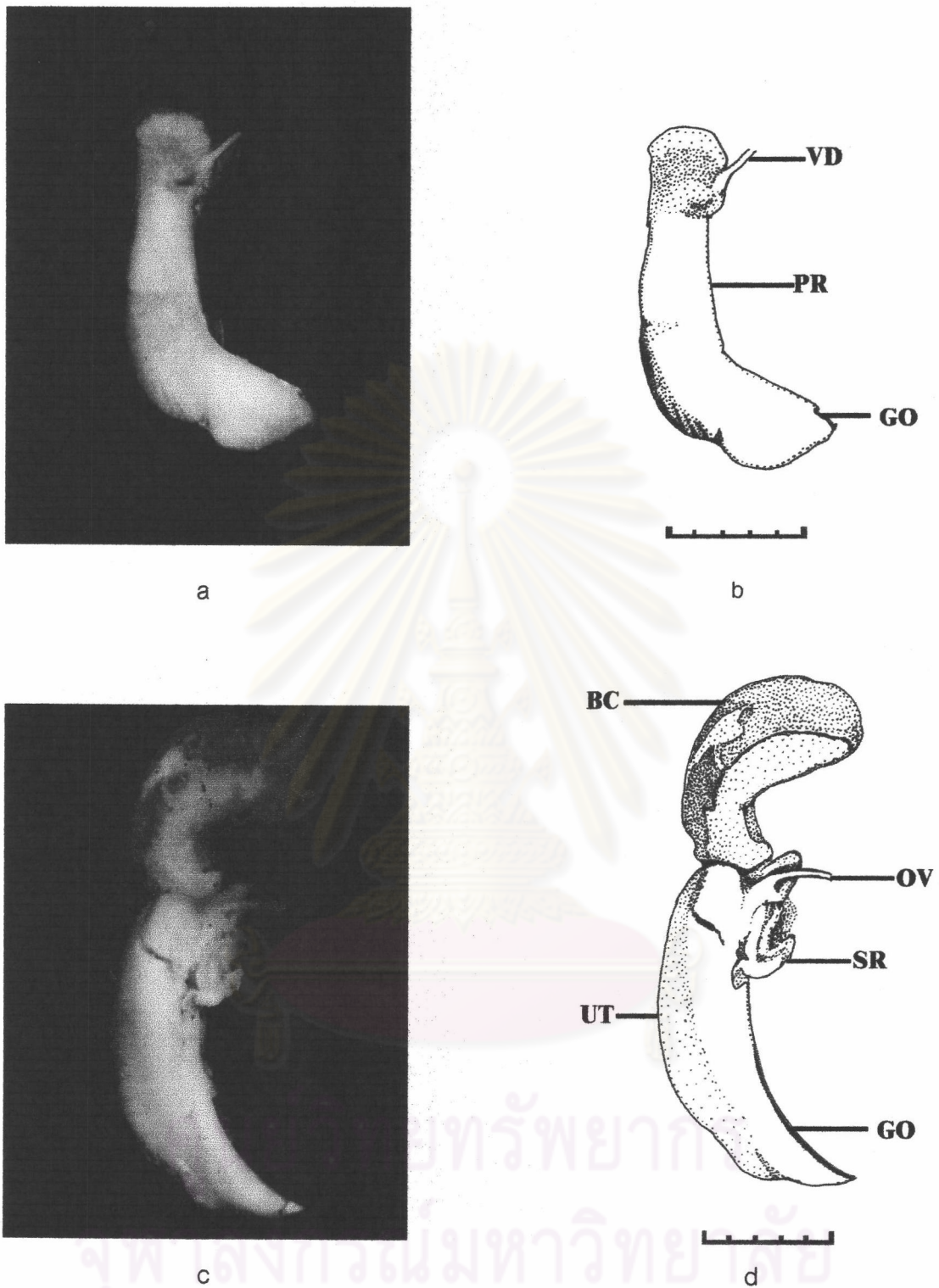


Figure 4.3 Reproductive organs of *Pterocyclus asiphon*; a) photographed and b) drawing of prostate gland, vas deferens, and genital opening; c) photographed and d) drawing of bursa copulatrix, uterus, seminal receptacle, oviduct, and genital opening (vagina slit) (scale bar = 5 mm.).

***Rhiostoma chupingense* Tomlin, 1938**

1938 *Rhiostoma chupingense*, Tomlin. J. of Conch. 21 (3) : 73-75, pl.2. fig. 1-2 (Bukit Chuping; Perlis : Malaysia)

1999 *Rhiostoma chupingense*, Hemmen *et al.* La Conchiglia. Supplement 292 : 26 p., fig. 18.1-18.3 (Chuping hill; Perlis : Malaysia)

2001 *Rhiostoma chupingense*, Patamakanthin. Of Sea and Shore. 23, 4 : 222-223, Fig. B1-B2, C1-C3.(Perlis : Malaysia and Songkhla : Thailand)

Shell : The shape is proboscis with 5 rounded whorl, solid, widely umbilicate, and flattened spire. Disconnected part of last whorl present for distance range 5.12-18.42 mm., turn in and downward, major diameter range 17.67-22.10 mm. and shell height range 11.70-20.53 mm. Shell surface smooth with regular growth lines. Periostracum mostly present thin diaphanous and shiny in pale yellow to brown in color. Dorsal side of shell mostly present uniform, ventral side present uniform, color is variable in light brown, brown, dark brown, dark blue or purple. Sub-peripheral band mostly present in faint or narrow dark brown band. Aperture circular, peristome mostly present thick and interrupt by apertural notch presentation on upper side. Air breathing tube absent but triangular projection present behind apertural notch. Blunt keel present from projection to suture

Operculum : Calcaroconeous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : The first half of trunk is black mottle on pale yellow background with fade down in an area near columella muscle. The second half of the body is visceral mass covered with thin transparent mantle layer.

Radula : Taenioglossate radula sheet contain 7 teeth in each row. Central tooth has 5 to 7 cusps, the head is more convex, the width is longer than the length, central cusp is larger than other cusps in linguiform, ridge connecting is stocky. Lateral teeth have 4 cusps, the third is very large in robust linguiform and other cusps are smaller in

robust serrate shape, basal plate likes a sickle with inner part is very short but outer part is very long, the third cusp is longer than inner part. Marginal teeth turn in, the first marginal teeth have 3 cusps, second cusp is large in pointed linguiform, other cusps are smaller than it in robust serrated shape. The second marginal teeth have 4 cusps, the first is serrate shape, the second in robust digitiform, the third is broad serrate shape, the fourth is largest in triangular shape.

Genital system :

Male :

Testis occupies entirely on early whorl except the uppermost part of visceral hump, bright orange in color.

Vas deferens runs forward from testis to prostate gland on the collumella side, thin, slender, and pale yellowish color.

Prostate gland is elongate fusiform, flattened, pale yellowish color, separated in two parts by thickness. The posterior part is one-thirds of the length, flattened in elongate ovate shape, vas deferens enters at the area lower than the middle of it, without seminal vesicle. Anterior part is thicker than posterior part, genital opening opens from the anterior end reach to the half of anterior part length.

Seminal groove extends from the prostate along the right side of the head to the tip of the penis.

Penis is digitiform, the base is robust and slightly taper at the tip. It is shorter than tentacle.

Female :

Ovary locates on the columella side of the early whorls, color is bright orange. The ovary consists of 6 glands, the fourth gland is single large knob, other glands are multilobate.

Oviduct is pale yellowish color.

Seminal receptacle is small digitiform projects from posterior of uterus, its length long over the posterior end, pale yellowish color.

Bursa copulatrix is ovate shape with dull or bright orange color on inner side, the length about one-thirds or one-fourths of uterus length, flattened. It opens into the outer side of uterus.

Uterus is lunate shape, plump, posterior end is round, anterior part slender than other parts and pointed at the end, color is pale yellow. Oviduct enters to uterus on inner side near the base of seminal receptacle. Vagina slit opens from the distal of anterior end reach to one-thirds of uterus length, its labial is thick and expand .

Habitat : *Rhiostoma chupingense* were collected from Khao Wang Thong, Nakhon Si Thammarat in leaf litter of limestone hill, which surrounding by evergreen forest.

Locality : Na Mueang Waterfall, Samui Island in the Gulf of Thailand; Khao Chok Chae, Tham Kha-min, limestone hill in Ban Na San and Don Sak, Surat Thani; Khao Wang Thong, Nakhon Si Thammarat; Khao Pu Khao Ya National Park, Phatthalung.

Distribution : Samui Island, in the Gulf of Thailand, Surat Thani, Nakhon Si Thammarat, Phatthalung, and Songkhla, Southern part of Thailand; Perlis, Malaysia.

Diagnosis : shell proboscis shape, periostracum sub-diaphanuous, air breathing tube absent, behind apertural projection keel blunt, apertural direction turn in, triangular short and blunt, the color of shell uniform and vary in light brown, brown, dark brown, dark blue or purple.

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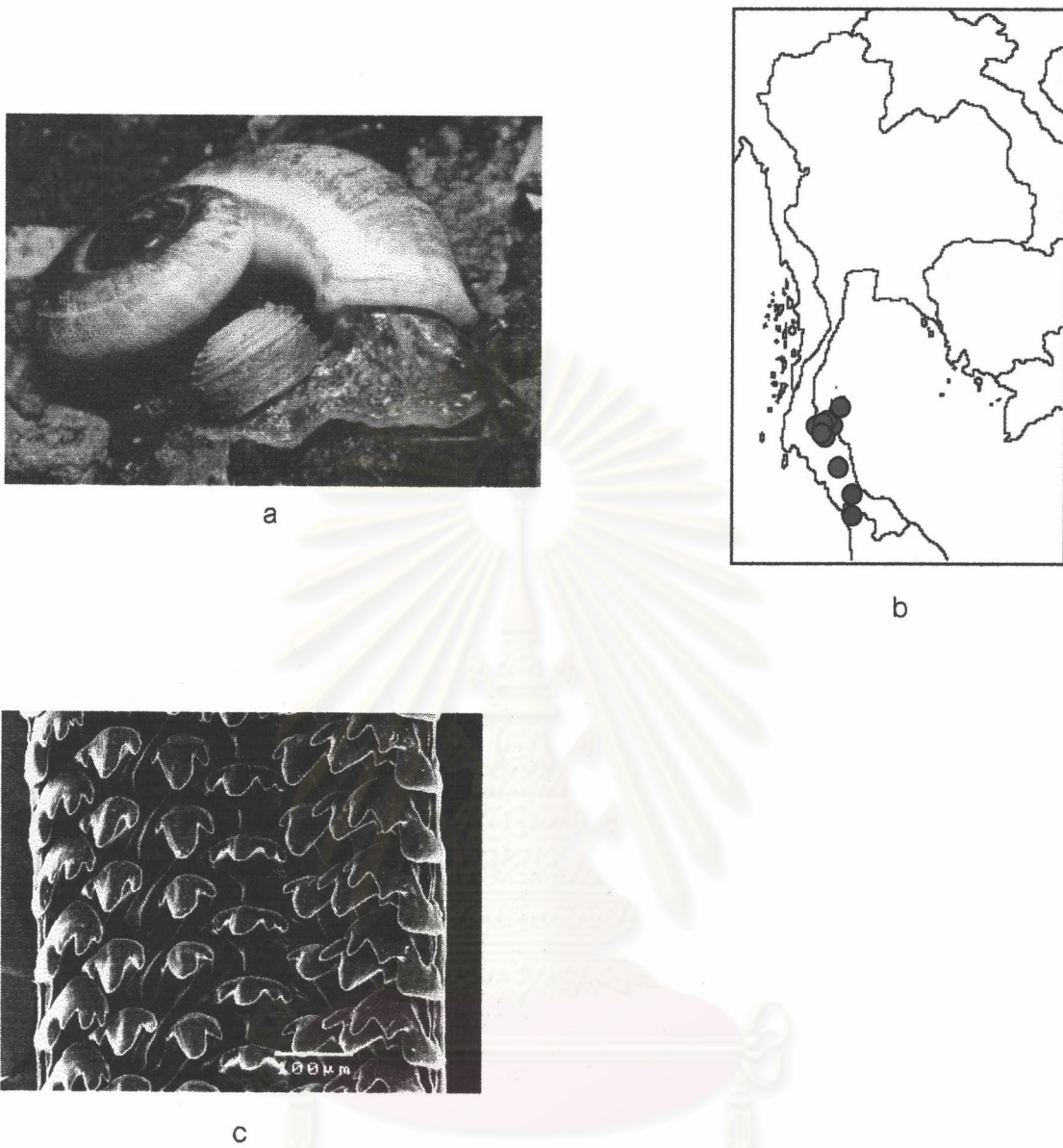


Figure 4.4 a) *Rhiostoma chupingense*; b) distribution; Samui Island; Surat Thani; Nakhon Si Thammarat; Phatthalung; Songkhla : Thailand and Perlis : Malaysia. (● collected from the present study, ● literature review); c) radula sheet

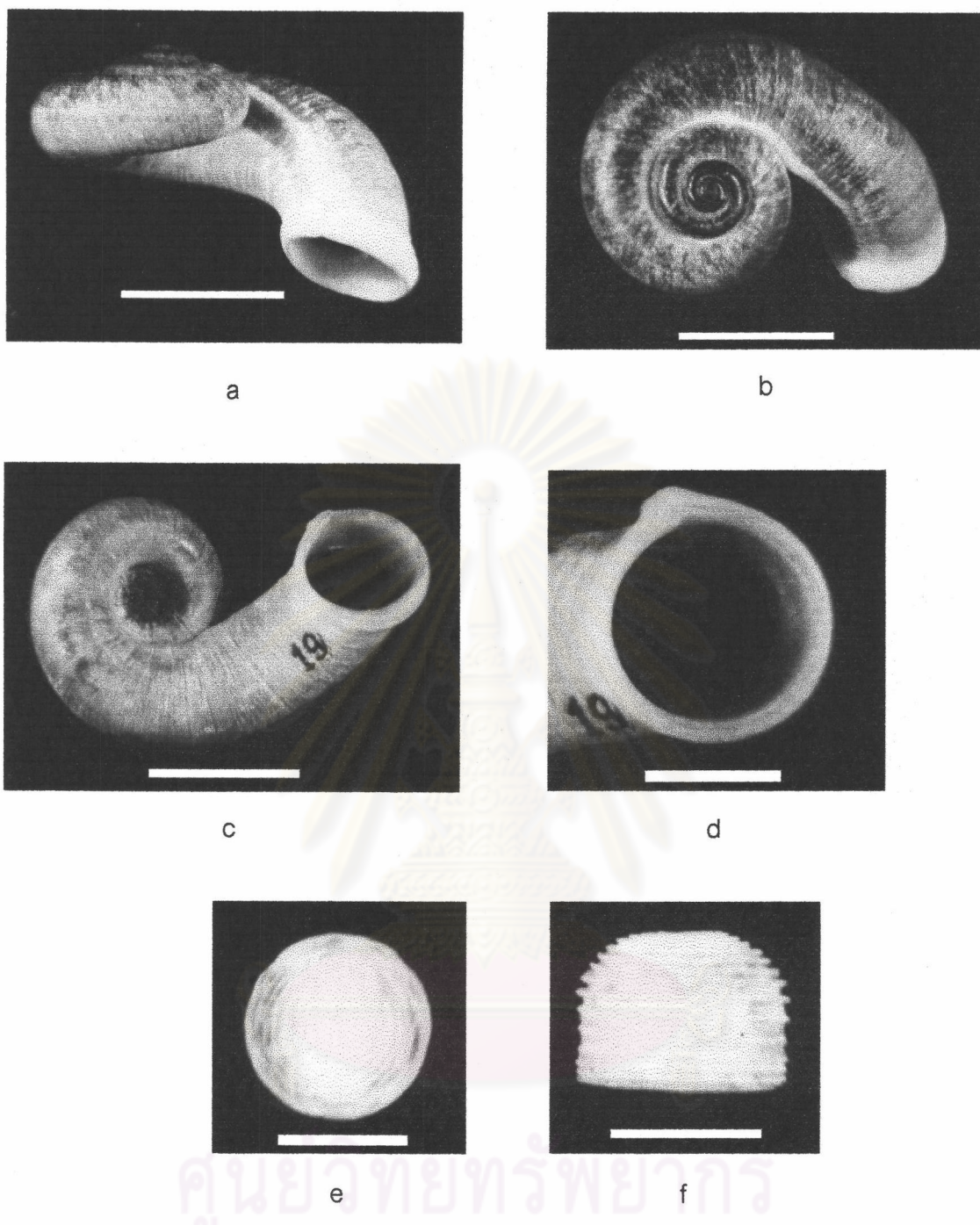


Figure 4.5 *Rhiostoma chupingense*; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; e) operculum at dorsal side; f) operculum at lateral side; (scale bars : a-c = 10 mm.; d-f = 5 mm.)

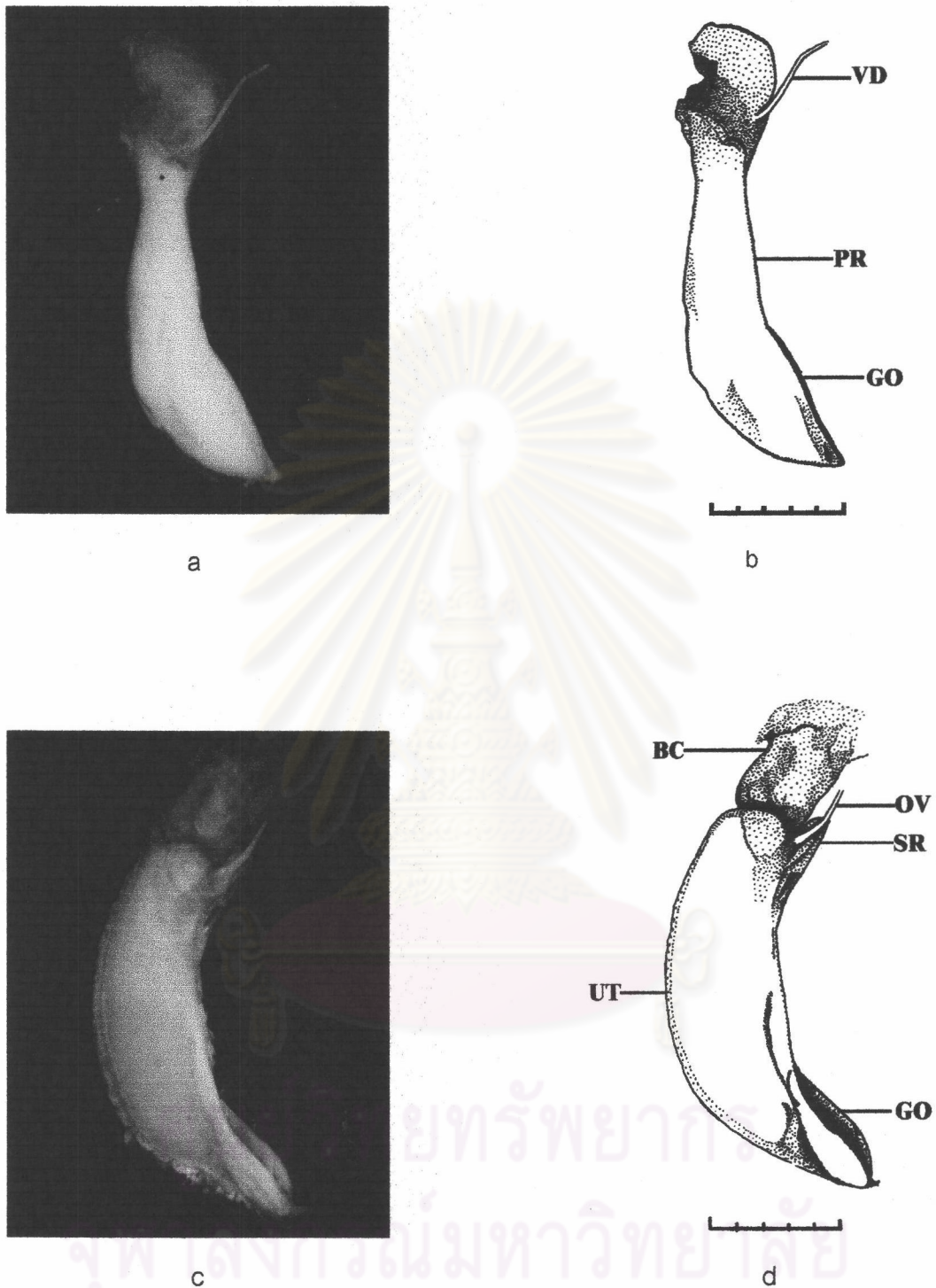


Figure 4.6 Reproductive organs of *Rhiostoma chupingense*; a) photographed and b) drawing of prostate gland, vas deferens, and genital opening; c) photographed and d) drawing of bursa copulatrix, uterus, seminal receptacle, oviduct, and genital opening (vagina slit) (scale bar = 5 mm.).

***Rhiostoma hainesi* Pfeiffer, 1862**

1949 *Rhiostoma tomlini*, Salisbury. Proc. Malac. Soc. Lond, 28(1) : 41-42, pl.3B fig. 3-4.

(Khao Sabap : Thailand)

1965 *Rhiostoma housei kirai*, Habe. Nature and Life in Southeast Asia, 4 : 111-128, pl.2,

fig.11 (Chanthaburi : Thailand)

1989 *Rhiostoma smithi*, Abbott. Compendium of Landshells, : 240 pp. (Khao Sabah :

Thailand)

1999 *Rhiostoma smithi*, Hemmen *et al.* La Conchiglia. Supplement 292 : 26 p., fig.

4-6 (Khao Sabap National Park; Chanthaburi : Thailand)

2001 *Rhiostoma smithi*, Patamakanthin. Of Sea and Shore. 23, 4 : 222-223, fig. M1-3

(Khao Sabap; Chanthaburi : Thailand)

Shell : The shape is proboscis with 5 rounded whorl, solid, widely umbilicate, and slightly raise spire. Disconnected part of last whorl for distance about 10.79-29.16 mm., turn in and downward, major diameter range 19.01-26.98 mm. and shell height range 18.47-33.64 mm. Shell surface smooth with regular growth lines. Periostracum is thick opaque and dull, reddish brown to dark brown color. Dorsal side of shell present uniform or variegate, ventral side mostly present uniform. Sub-peripheral band mostly present in dark brown band. Aperture circular, most of peristome broadly expand, which the outer lip expand more than other sides, the upper side interrupt by apertural notch presentation. Air breathing tube sometimes present in short incomplete tube or long complete tube, but mostly present in triangular projection behind apertural notch. Blunt keel present from projection to suture.

Operculum : Calcaroconeous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : The first half of trunk is black mottle on pale yellow background. The second half of the body is visceral mass covered with thin transparent mantle layer.

Radula : Taenioglossate radula sheet contain 7 teeth in each row. Central tooth has 5 cusps, the head is more convex, the width is longer than the length, ridge connecting is slender. Lateral teeth have 4 cusps, the third cusp is largest in linguiform, the first and the second cusps are robust digitiform, the fourth cusp is small serrate shape, inner part of basal plate is very short but outer part is very long. Marginal teeth turn in, the first marginal teeth have 3 cusps, the second cusp is largest in pointed linguiform, the first cusp is robust digitiform, the third cusp is serrate shape. The second marginal teeth have 4 cusps, the first cusp is digitiform, the second cusp is linguiform, the third cusp is serrate shape, the fourth cusp is largest in triangular shape.

Genital system :

Male :

Testis occupies entirely on the early whorls except the uppermost part of visceral hump, dull orange in color.

Vas deferens is robust, pale yellow or pale orange color.

Prostate gland is robust fusiform, plump, pale yellowish color, separated in two parts by thickness. The posterior part is one-fourths of the length in ovate form, flattened, pale yellowish color, vas deferens enters at the base of posterior end, without seminal vesicle. Anterior part is thicker than posterior part, genital opening opens from the distal of anterior end reach to one-thirds or half of anterior part length.

Seminal groove extends from the prostate along the side of the head to the tip of the penis.

Penis is digitiform, slender, pointed at the tip. It is shorter than tentacle.

Female :

Ovary is invisible from specimen.

Oviduct is pale yellowish color.

Seminal receptacle is small digitiform projects from posterior of uterus, its length long over the posterior end of uterus, pale orange color.

Bursa copulatrix is lunate shape with bright or dull orange color on inner side, the length about half of uterus length, plump. It opens into the outer side of uterus.

Uterus is lunate shape, very plump, color is pale yellow, posterior end is round, numerous of tiny white ovate piece present under the membrane, anterior part slender than other parts and pointed at the end. Oviduct enters to uterus on inner side at the base of seminal receptacle. Vagina slit opens from the distal of anterior end reach to half of uterus length, it has thick and expand labial.

Habitat : *Rhiostoma hainesi* were found on the ground of evergreen forest around the granite mountain of Khao Sabap in the rainy day.

Locality : Khao sabap (Namtok Phlio National Park) and Khao Soi Dao Wildlife Sanctuary, Chanthaburi; Khao Chamao-Khao Wong National Park, Rayong.

Distribution : Chanthaburi and Rayong, Eastern of Thailand; Cambodia.

Diagnosis : Differs from all other species of *Rhiostoma* by broadly expand lip.



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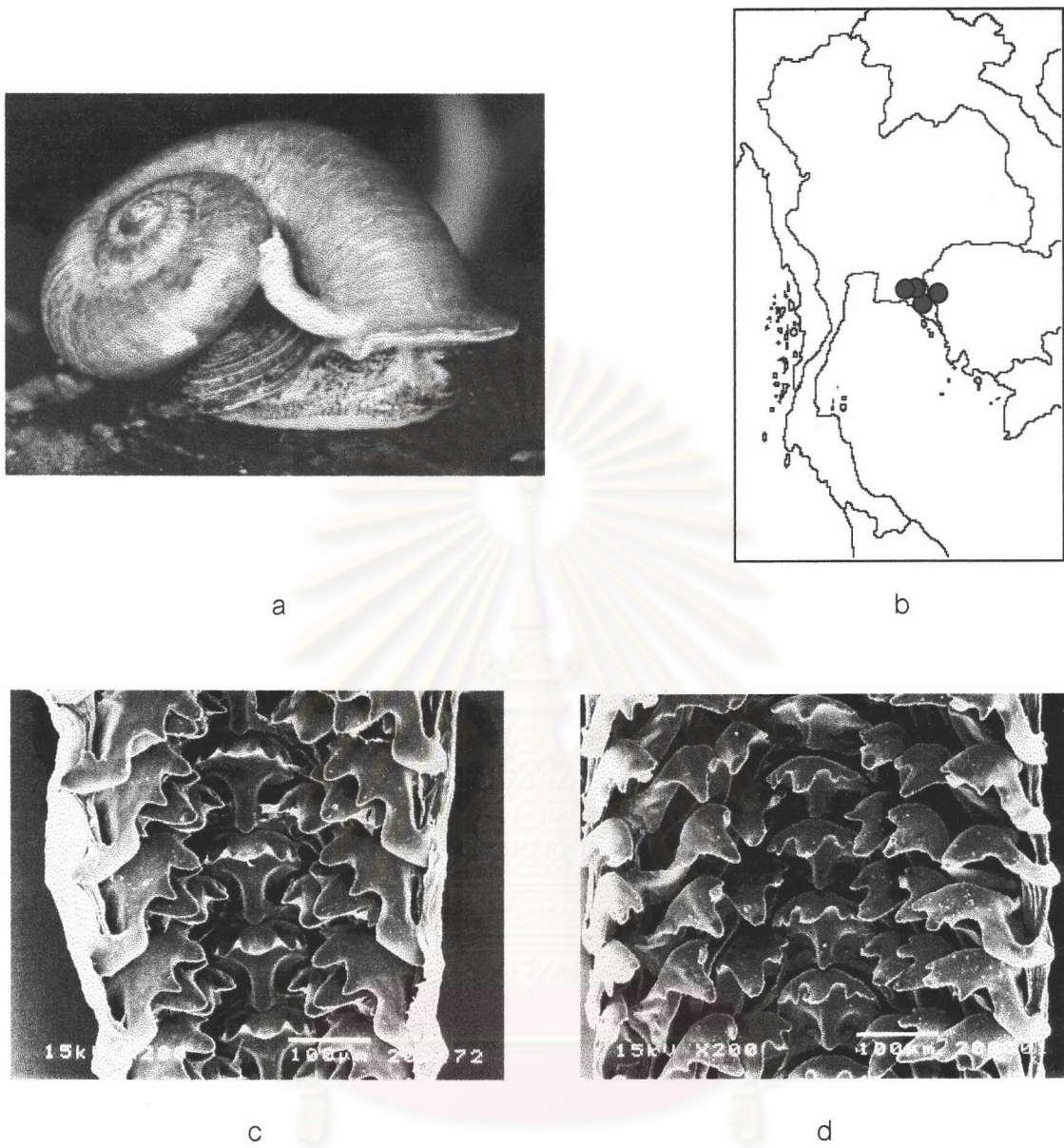


Figure 4.7 a) *Rhiostoma hainesi*; b) distribution; Chanthaburi; Rayong : Thailand and Cambodia. (● collected from the present study, ● literature review); c) and d) radula sheet

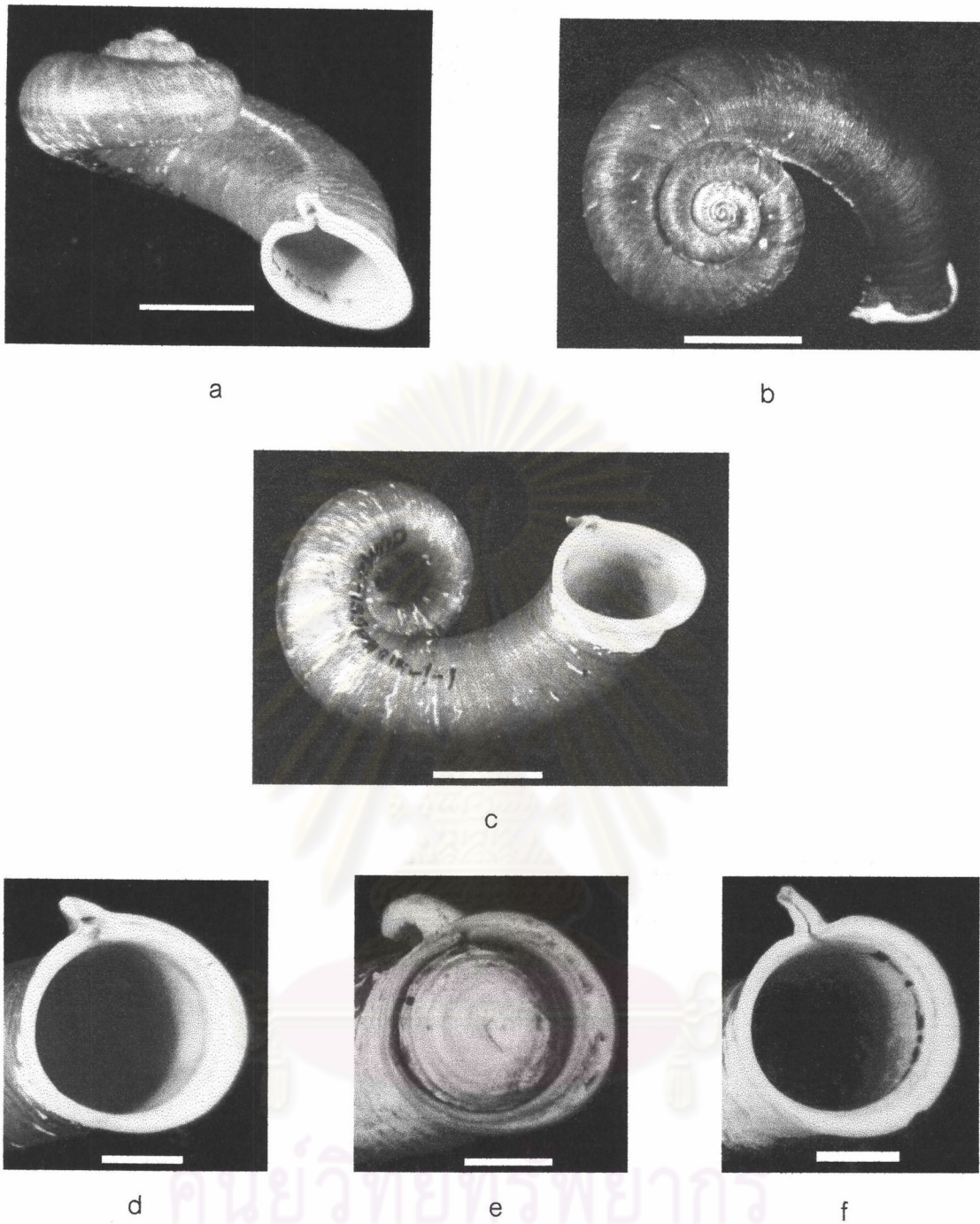


Figure 4.8 *Rhioptoma hainesi*; a) apertural side; b) dorsal side; c) umbilical side; d)-f) enlarged aperture with d) triangular projection; e) long complete tube; f) short incomplete tube; (scale bars : a-c = 10 mm.; d-f = 5 mm.)

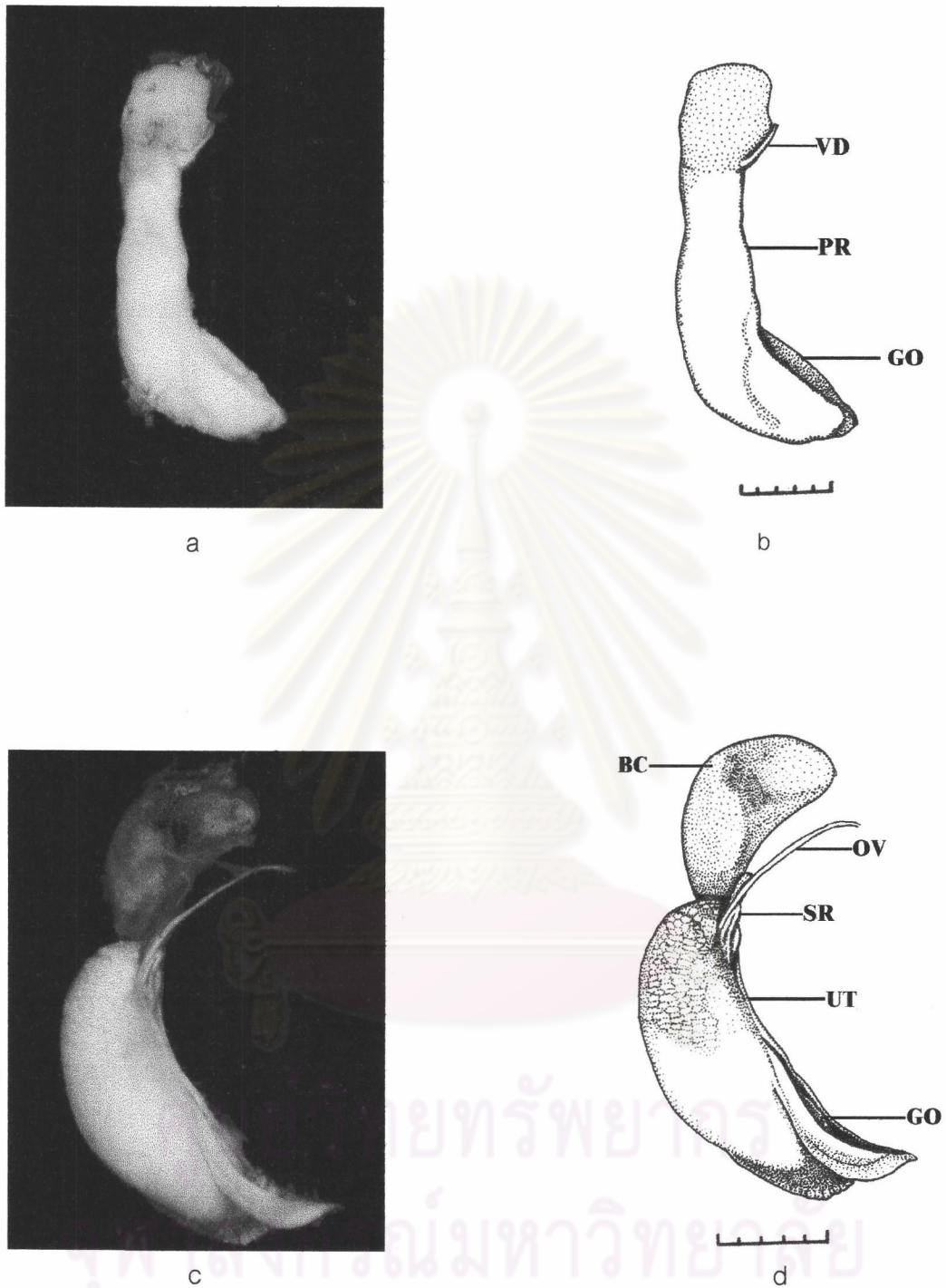


Figure 4.9 Reproductive organs of *Rhiostoma hainesi*; a) photographed and b) drawing of prostate gland, vas deferens, and genital opening; c) photographed and d) drawing of bursa copulatrix, uterus, seminal receptacle, oviduct, and genital opening (vagina slit) (scale bar = 5 mm.).

***Rhiostoma housei* (Haines, 1855)**

- 1894 *Rhiostoma housei*, Moellendorff. Proc. Zool. Soc. Lond., 146-156. (Samui Islands : Gulf of Thailand)
- 1902 *Rhiostoma dalyi*, Blanford. Proc. Malac. Soc. Lond., 5 : 34-35, fig.1 (Phitsanulok : Thailand)
- 1903 *Rhiostoma dalyi*, Blanford. Proc. Malac. Soc. Lond., 5 : 274-284. (Phitsanulok : Thailand)
- 1965 *Rhinostoma housei*, Habe. Nature and Life in Southeast Asia, 4 : 111-128, pl.2, fig.10 (Phukae Botanical Garden; Sara Buri : Thailand)
- 1966 *Rhiostoma dalyi*, Solem. Spolia zool. Mus. Haun., 24 : 110 pp. (Chieng Dao : Thailand)
- 1966 *Rhiostoma housei*, Solem. Spolia zool. Mus. Haun., 24 : 110 pp. (Chieng Dao : Thailand)
- 1989 *Rhiostoma housei*, Abbott. Compendium of Landshells, :240 pp. (Samui Islands : Gulf of Thailand)

Shell : The shell is sub-discoidal shape with 5 rounded whorl, solid, widely umbilicate, and flatted spire. Disconnected part of last whorls present for distance range 4.66-14.20 mm., turn in and downward, major diameter range 20.59-27.66 mm. and shell height range 13.34-20.70 mm. Shell surface smooth with regular growth lines. Periostracum is thin diaphanous and shiny in pale yellowish color. Dorsal side of shell mostly present variegate form with brown zigzag pattern on white background, ventral side mostly present uniform in white color. Sub-peripheral band mostly present in one faint or dark brown band. Aperture circular, peristome is thick and mostly interrupt, apertural notch mostly present. Air breathing tube mostly present complete tube which robust in shape and bent backward to the junction between disconnected part and previous whorl. Sharp keel mostly present from projection to suture.

Operculum : Calcarocorneous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : The first half of trunk is brown to dark-brown or black mottle on pale yellow background with fade down in an area near mantle cavity. The second half of the body is visceral mass covered with thin transparent mantle layer.

Radula : Taenioglossate radula sheet contain 7 teeth in each row. Central tooth has 5 cusps, central cusp is very broad with 4 lateral cusp in robust serrate shape, the head is slightly convex, the width is longer than the length, ridge connecting is stocky. Lateral teeth have 4 cusps, the third cusp is largest in robust linguiform and other cusps are smaller than it in robust serrate shape, inner part of basal plate is very short but outer part is very long. Marginal teeth turn in, the first marginal teeth have 3 cusps, the second cusp is largest linguiform and other cusps are smaller than it in robust serrated shape. The second marginal teeth have 4 cusps, the first cusp is digitiform, the second cusp is elongate linguiform, the third is serrate shape, the fourth is largest in triangular shape.

Genital system :

Male :

Testis occupies entirely on the early whorls, except the uppermost part of visceral hump, orange or brown in color.

Vas deferens runs forward from testis to prostate gland on the collumella side, thin, slender, and pale yellowish color.

Prostate gland is L shape, plump, pale yellowish color, separates in two parts by thickness. The posterior part is one-fourths of the length, flattened in ovate shape, vas deferens enters at the base of it, without seminal vesicle. Anterior part is thicker than posterior part, genital opening opens from the anterior end reach to the bent of L shape about one-thirds of anterior part length.

Seminal groove extends from the prostate along the side of the head to the tip of the penis.

Penis is digitiform, tapering at the tip. It is shorter than tentacle.

Female :

Ovary locates on the columella side of the early whorls. Color is bright orange.

Oviduct is pale yellowish color.

Seminal receptacle is digitiform projects from posterior of uterus, its length not over the posterior end of uterus, pale yellowish color.

Bursa copulatrix is elongate rectangle shape in pale orange color, the length about half of uterus length, flattened. It opens into the outer side of uterus.

Uterus is lunate shape, slender, posterior end is round, anterior end is pointed, color is pale yellow. Oviduct enters to uterus on inner side near the base of seminal receptacle. Vagina slit opens from the distal of anterior end reach to half of uterus, its labial is simple.

Habitat : *Rhiostoma housei* were collected from Khao Luk Chang and Wat Thepphitakpunnaram, Nakhon Ratchasima; Doi Phu Nang National Park, Phayao; They live in leaf litter on limestone hill, which surrounding by dry evergreen forest.

Locality : Doi Phu Nang National Park, Phayao; Limestone hill in Kang Khoi, Sara Buri; Phu Khiao Wildlife Sanctuary, Chaiyaphum; Khao Luk Chang and Wat Thepphitakpunnaram, Nakhon Ratchasima; Limestone hill in Ban Bueng, Chon Buri; Khao Lom Muak, Prachuap Khiri Khan.

Distribution : Samui Islands, in the Gulf of Thailand, Chiang Mai, Phayao, Phitsanulok, Sara Buri, Chaiyaphum, Nakhon Ratchasima, and Chon Buri; Thailand.

Diagnosis : shell sub-discoidal shape, disconnected part of last whorl present, dorsal side of shell variegate, and complete air breathing tube present.

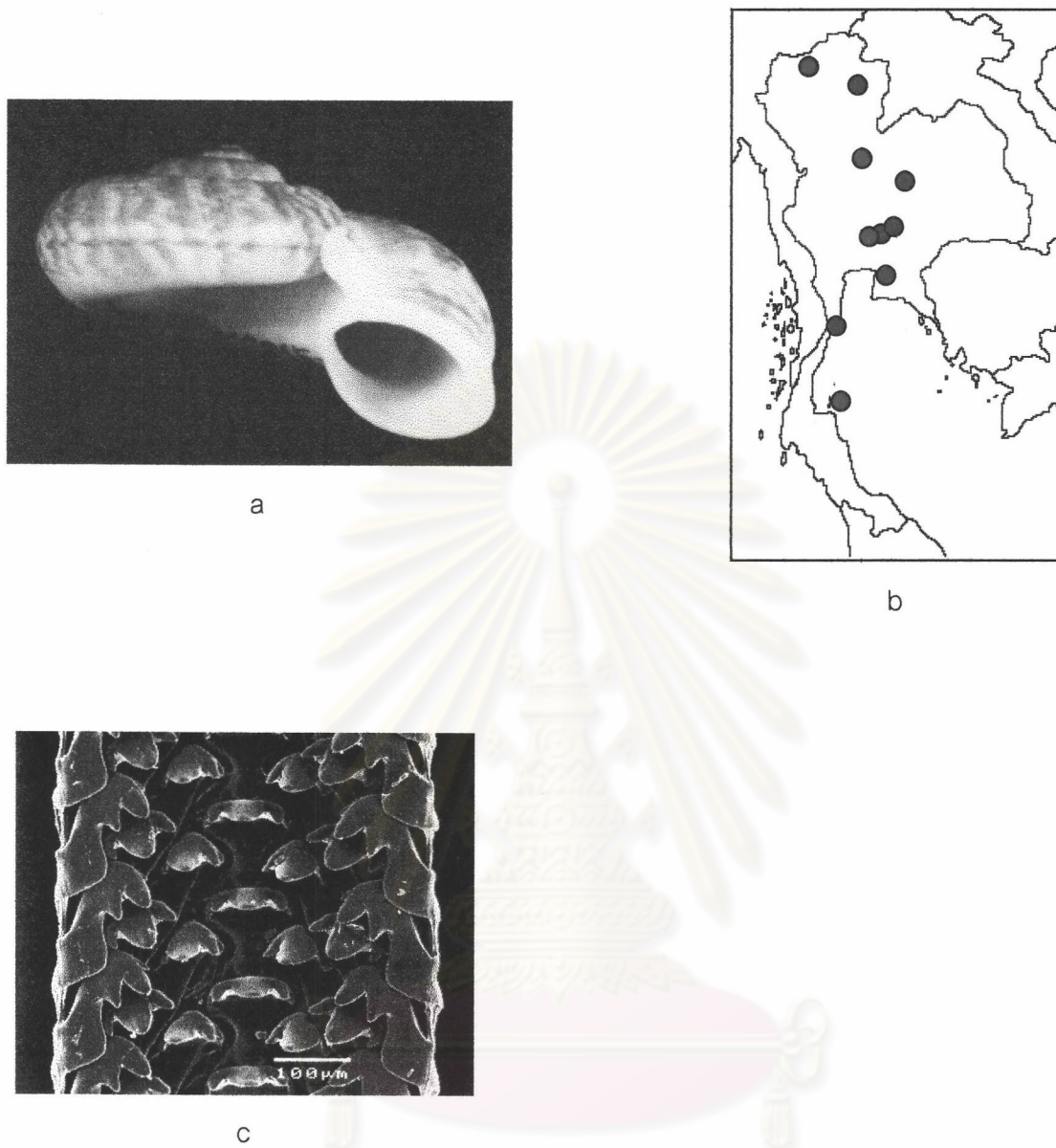


Figure 4.10 a) shell apertural side of *Rhiostoma housei*; b) distribution; Chiang Mai; Phayao; Phitsanulok; Sara Buri; Chaiyaphum; Nakhon Ratcha Sima; Chon Buri; Prachuap Khiri Khan; Samui Island : Thailand. (● collected from the present study, ● literature review); c) radula sheet

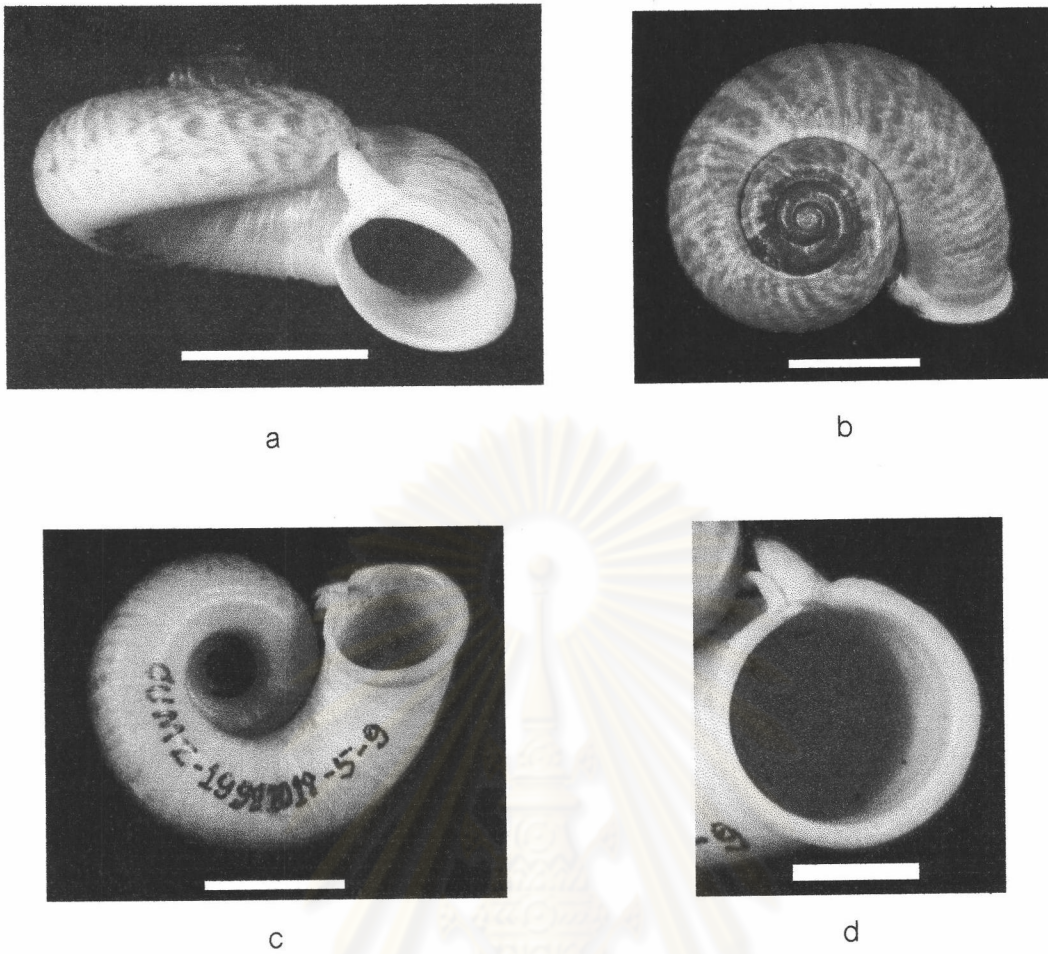


Figure 4.11 *Rhiostroma housei*; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; (scale bars : a-c = 10 mm.; d = 5 mm.)

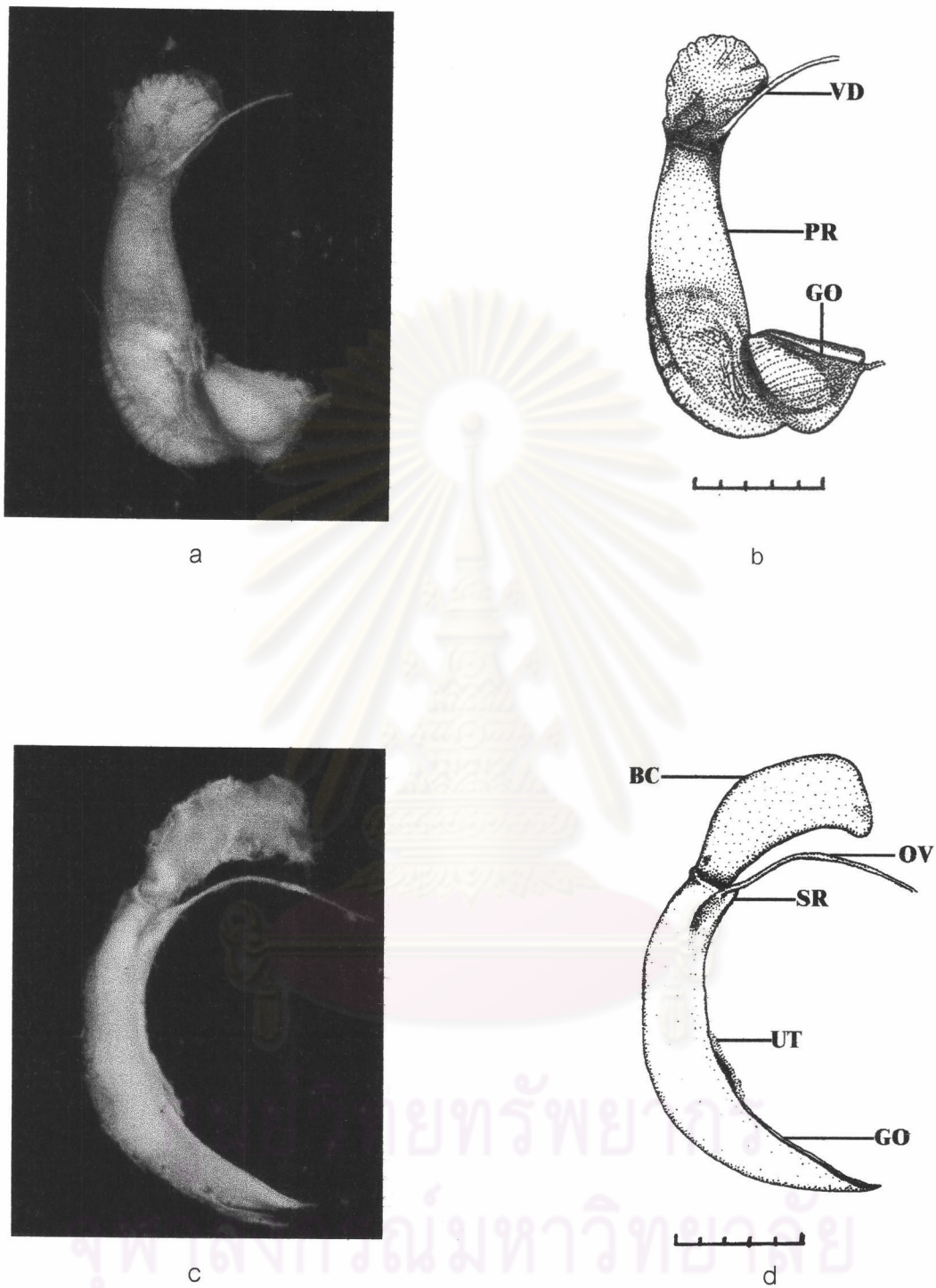


Figure 4.12 Reproductive organs of *Rhiostoma housei*; a) photographed and b) drawing of prostate gland, vas deferens, and genital opening; c) photographed and d) drawing of bursa copulatrix, uterus, seminal receptacle, oviduct, and genital opening (vagina slit) (scale bar = 5 mm.).

***Rhiostoma jalorensis* Sykes, 1903**

1903 *Rhiostoma jalorensis*, Sykes. Proc. Zool. Soc. Lond., 1 : 194-199, pl.20 (Biserat;

Jalor : Malaysia ?)

1949 *Rhiostoma jalorensis*, Salisbury. Proc. Malac. Soc. Lond., 28(1) : 41-42, pl.3B,

fig.1-2(Biserat; Jalor : Malaysia ?)

1999 *Rhiostoma cf.smithi*, Hemmen *et al.* La Conchiglia. Supplement 292 : 26 p., fig.

7-11, 19-20. (Temple Cave, Phang-nga; Aao Luek and Wat Tham Sua, Krabi : Thailand)

2001 *Rhiostoma smithi*, Patamakanthin. Of Sea and Shore. 23, 4 : 222-223, Fig.

F1-3, I1-I4, J1-3, L1-3. (Phang-nga and Tiger cave; Krabi : Southern of Thailand)

Shell : The shape is proboscis with 5 rounded whorl, solid, widely umbilicate, and flatted spire. Disconnected part of last whorl present for distance about 6.94-15.88 mm., turn in and downward, major diameter range 15.95-22.92 mm. and shell height range 11.25-19.38 mm. Shell surface smooth with regular growth lines. Periostracum is thin diaphanous and shiny in pale yellowish color. Dorsal and ventral side of shell mostly present uniform in light brown, brown or dark brown color, the case of variegate form with brown zigzag pattern are rare. Sub-peripheral band mostly present in faint or dark brown band. Aperture circular, peristome is thick and mostly interrupt by apertural notch presentation. Air breathing tube mostly present in long complete tube. Blunt keel mostly present from projection to suture.

Operculum : Calcaroconeous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : The first half of trunk is black with fade down in an area near collumella muscle. The second half of the body is visceral mass covered with thin transparent mantle layer.

Radula : Taenioglossate radula sheet contain 7 teeth in each row. Central tooth has 5 cusps, the head is more convex, the width is shorter than the length, central cusp

is linguiform larger than others, ridge connecting is slender. Lateral teeth have 4 cusps, the third cusp is largest in linguiform and other cusps are smaller than it in robust serrate shape, inner part of basal plate is very short but outer part is very long. Marginal teeth turn in, the first marginal teeth have 3 cusps, the second cusp is largest in linguiform and other cusps are robust serrated shape. The second marginal teeth have 4 cusps, the first and the third cusp are serrate, the second cusp is robust digitiform, the fourth is largest in triangular shape.

Genital system :

Male :

Testis occupies entirely on early whorl except the uppermost part of visceral hump, orange or brown in color.

Vas deferens is thin, slender, and pale yellowish color.

Prostate gland is elongate-fusiform, flattened, pale yellowish color. The posterior part is about one-fourths of the length, flattened in ovate shape, vas deferens enters lower than the middle of posterior part, without seminal vesicle. Anterior part is thicker than posterior part, genital opening opens from the anterior end reach to about two-fifths of anterior part length.

Seminal groove extends from the prostate along the right side of the head to the tip of the penis.

Penis is digitiform. It is shorter than tentacle.

Female :

Ovary locates on the columella side of the early whorls, color is bright orange with a few brown spot in each gland in some specimen. Number of gland unclear.

Oviduct is pale yellowish color.

Seminal receptacle is digitiform projects from posterior of uterus, its length long over the posterior end, pale yellow in color.

Bursa copulatrix is ovate shape with pale orange in color, the length is about half of uterus length, plumped or flattened. It opens into the outer side of uterus.

Uterus is lunate shape, plump, color is pale yellow, posterior end is round, anterior end is tapered and then pointed at the tip. Oviduct enters to uterus on inner side

at the base of seminal receptacle. Vagina slit opens from the distal of anterior end reach to one-thirds of uterus length, its labial is simple.

Habitat : *Rhiostoma jalorensis* were collected from the ground on the leaf litter surface, base of limestone hill at Wat Tham Suwannakhuha, which surrounding by evergreen forest.

Locality : Wat Tham Suwannakhuha, Ao Phang-nga National Park, Ko Phrao, Phang-nga; Khlong Sang Wildlife Sanctuary and Wat Na San, Surat Thani; Tham Chang Si and Wat Tham Suea, Krabi.

Distribution : Surat Thani, Phang-nga, Krabi, Southern Thailand; Jalor; Malaysia.

Diagnosis : Shell proboscis shape, periostracum sub-diaphanuous, complete air breathing tube present, and dorsal side of shell uniform.



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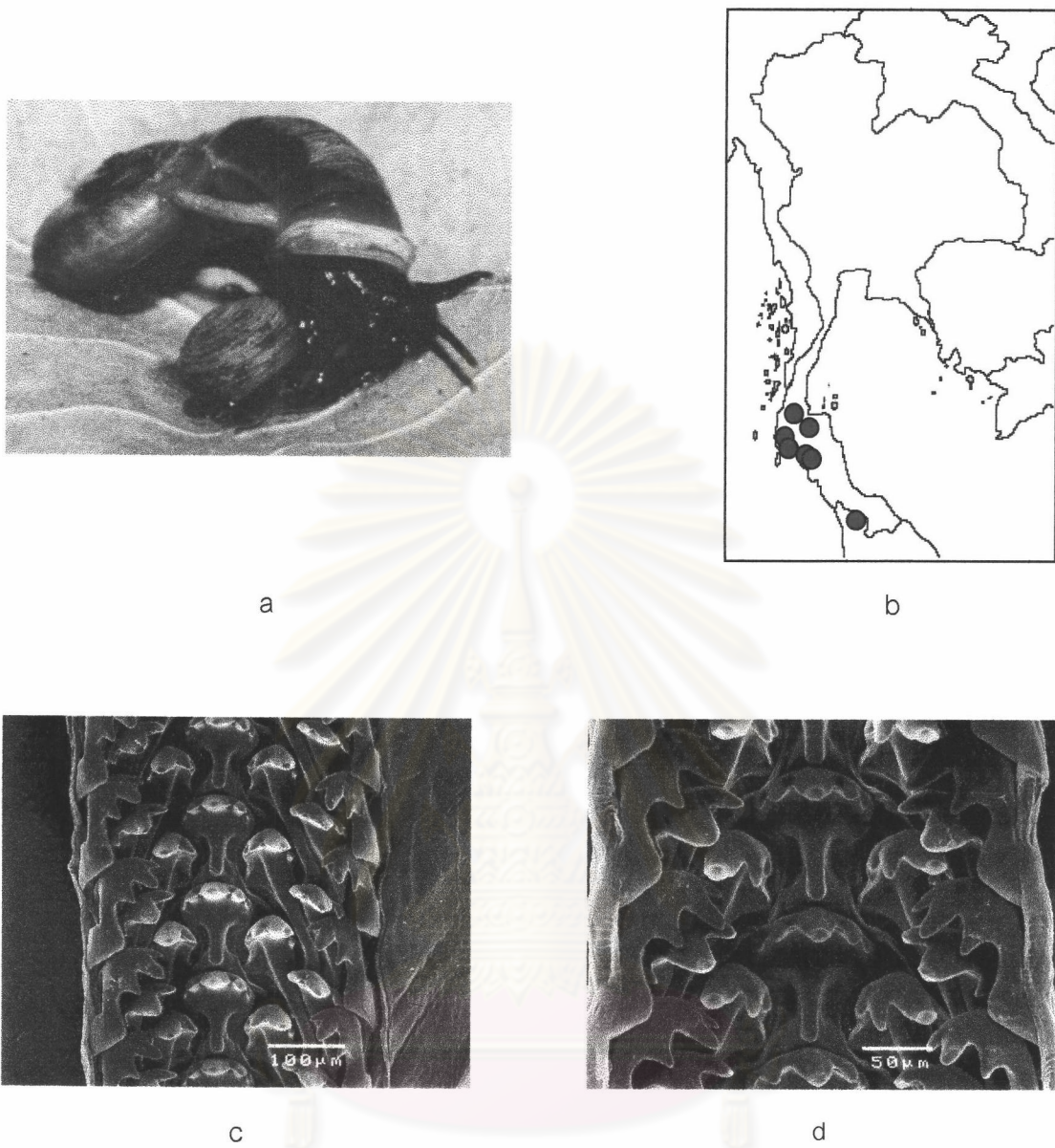


Figure 4.13 a) *Rhioostoma jalorensis*; b) distribution; Surat Thani; Phang-nga; Krabi : Thailand and Jalor : Malaysia. (●collected from the present study,●literature review); c) radula sheet; d) enlarged radula sheet

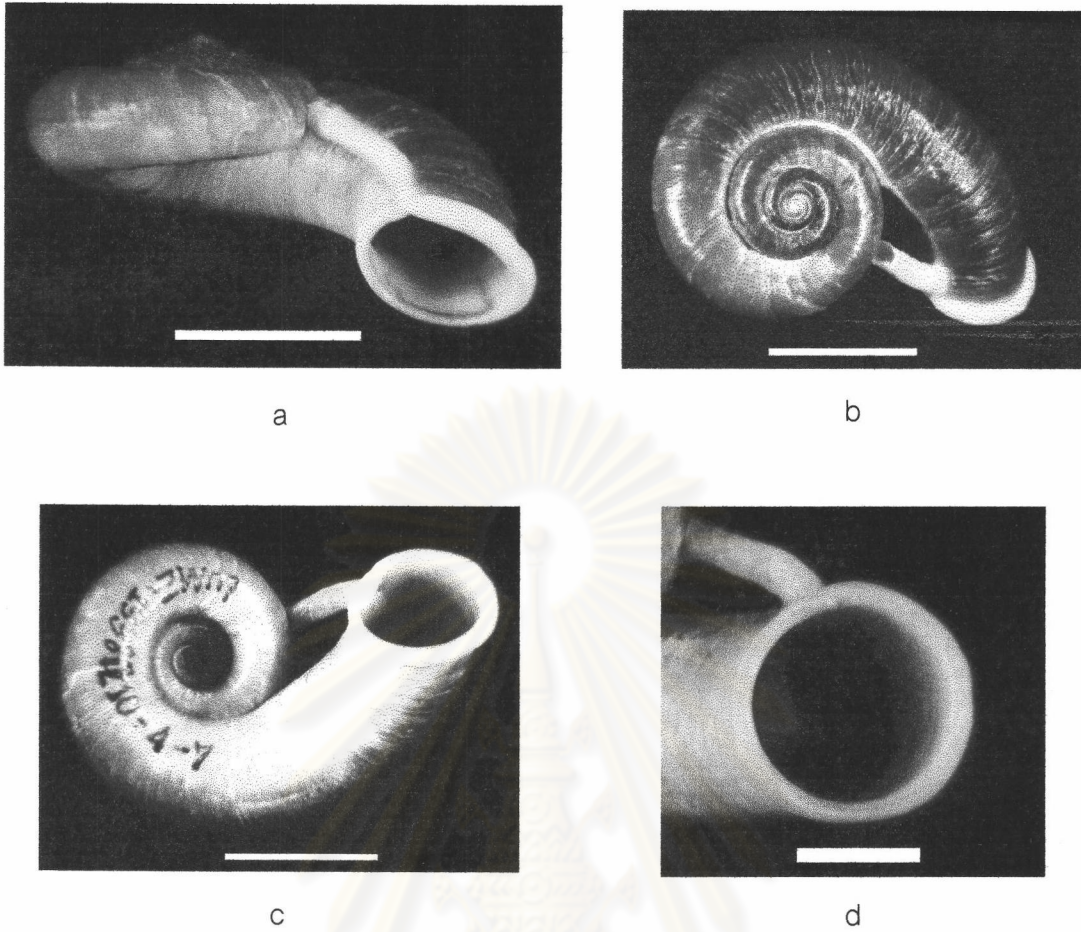


Figure 4.14 *Rhiostroma jalorensis*; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; (scale bars : a-c = 10 mm.; d = 5 mm.)

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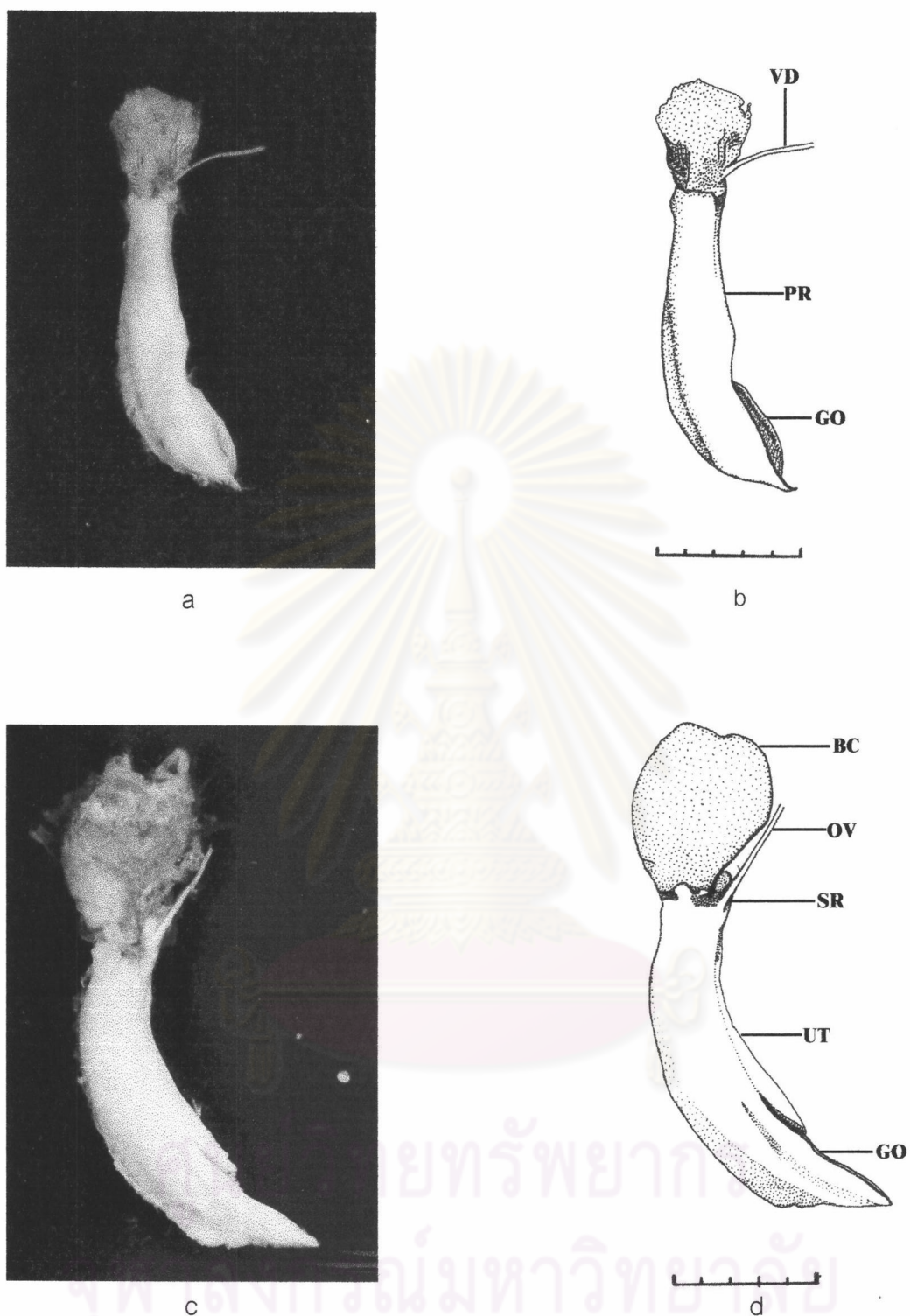


Figure 4.15 Reproductive organs of *Rhiostoma jalorensis*; a) photographed and b) drawing of prostate gland, vas deferens, and genital opening; c) photographed and d) drawing of bursa copulatrix, uterus, seminal receptacle, oviduct, and genital opening (vagina slit) (scale bar = 5 mm.).

***Rhiostoma samuiense* Tomlin, 1931**

1931 *Rhiostoma samuiense*, Tomlin. Proc. Malac. Soc. Lond. 19 : 227-228, pl.26. (Samui Island : Gulf of Thailand)

1999 *Rhiostoma samuiense*, Hemmen *et al.* La Conchiglia. Supplement 292 : 26 p., fig. 17 (Samui Island : Gulf of Thailand)

2001 *Rhiostoma samuiense*, Patamakanthin. Of Sea and Shore. 23, 4 : 222-223, Fig. D1-D3 (Samui Island : Gulf of Thailand)

Shell : The shape is proboscis with 5 rounded whorl, solid, widely umbilicate, and flatted spire. Disconnected part of last whorl present for distance about 4.04-10.98 mm., turn in and downward, major diameter range 15.64-17.75 mm. and shell height range 10.06-14.02 mm. Shell surface smooth with regular growth lines. Periostracum is thick opaque and dull reddish-brown to brown in color. Dorsal side and ventral side of shell are uniform with white color. Sub-peripheral band absent or present with dark brown band. Aperture circular, peristome is thick, continuous or interrupt by apertural notch presentation on upper side. Air breathing tube absent but triangular projection present behind apertural notch. Blunt keel present from projection to suture.

Operculum : Calcaroconeous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : The first half of trunk is black mottle on pale yellow background. The second half of the body is visceral mass covered with thin transparent mantle layer.

Radula : Taenioglossate radula sheet contain 7 teeth in each row. Central tooth has 5-6 cusps, the head is more convex, the width is shorter than the length, central cusp is linguiform larger than lateral cusps, ridge connecting width is stocky. Lateral teeth have 4 cusp, the third cusp is largest in linguiform and other cusps are smaller than it in robust serrate shape, basal plate separate two parts likes a sickle, inner part is very short but outer part is very long. Marginal teeth turn in, the first marginal teeth have 3 cusps, the second cusp is large in linguiform, the first is robust serrated shape, the

third is serrate shape. The second marginal teeth have 4 cusps, the first and the third cusp are serrate shape, the second is pointed linguiform, and the fourth is largest in triangular shape.

Genital system :

Male :

Testis occupies entirely on the early whorls except the uppermost part of visceral hump, dull orange in color.

Vas deferens is thin, slender, and pale yellowish color.

Prostate gland is elongate-fusiform, flattened, pale yellowish color, separated in two parts by thickness. The posterior part is one-fourths of the length, thin ovate form, vas deferens enters at the middle of it, without seminal vesicle. Anterior part is thicker than posterior part, genital opening opens from the anterior end reach to the half of anterior part length.

Seminal groove extends from the prostate and along the side of the nape to the tip of the penis.

Penis is digitiform, stocky, the base is robust and slightly taper at the tip.

Female :

Ovary locates on the columella side of the early whorls, color is bright orange. The ovary consists of 6 glands, the fourth gland is single small knob, the sixth gland is single digitiform, other glands are multilobate.

Oviduct is pale yellowish color.

Seminal receptacle is small digitiform which projects from posterior of uterus, its length long over the posterior end of uterus, pale yellowish color.

Bursa copulatrix is convoluted ovate shape in inner side, its length about half of uterus length, flattened. It opens into the outer side of uterus. The wall is very thin in black mottle on orange color background.

Uterus is rapier shape, slender, posterior end is round and slightly taper to anterior end, color is pale yellow. Oviduct enters to uterus on inner side at the base of seminal receptacle. Vagina slit opens inclined outer side from the distal of anterior end reach to one-thirds of uterus, its labial is thin and simple.

Habitat : *Rhiostoma samuiense* were found under leaf litter near the cascade in evergreen forest, the rock looks like granite.

Locality : Na Mueang and Hin Lat Waterfall on Samui Island, in the Gulf of Thailand.

Distribution : Samui Island, in the Gulf of Thailand.

Diagnosis : Shell proboscis shape, periostracum opaque, lip thicken.



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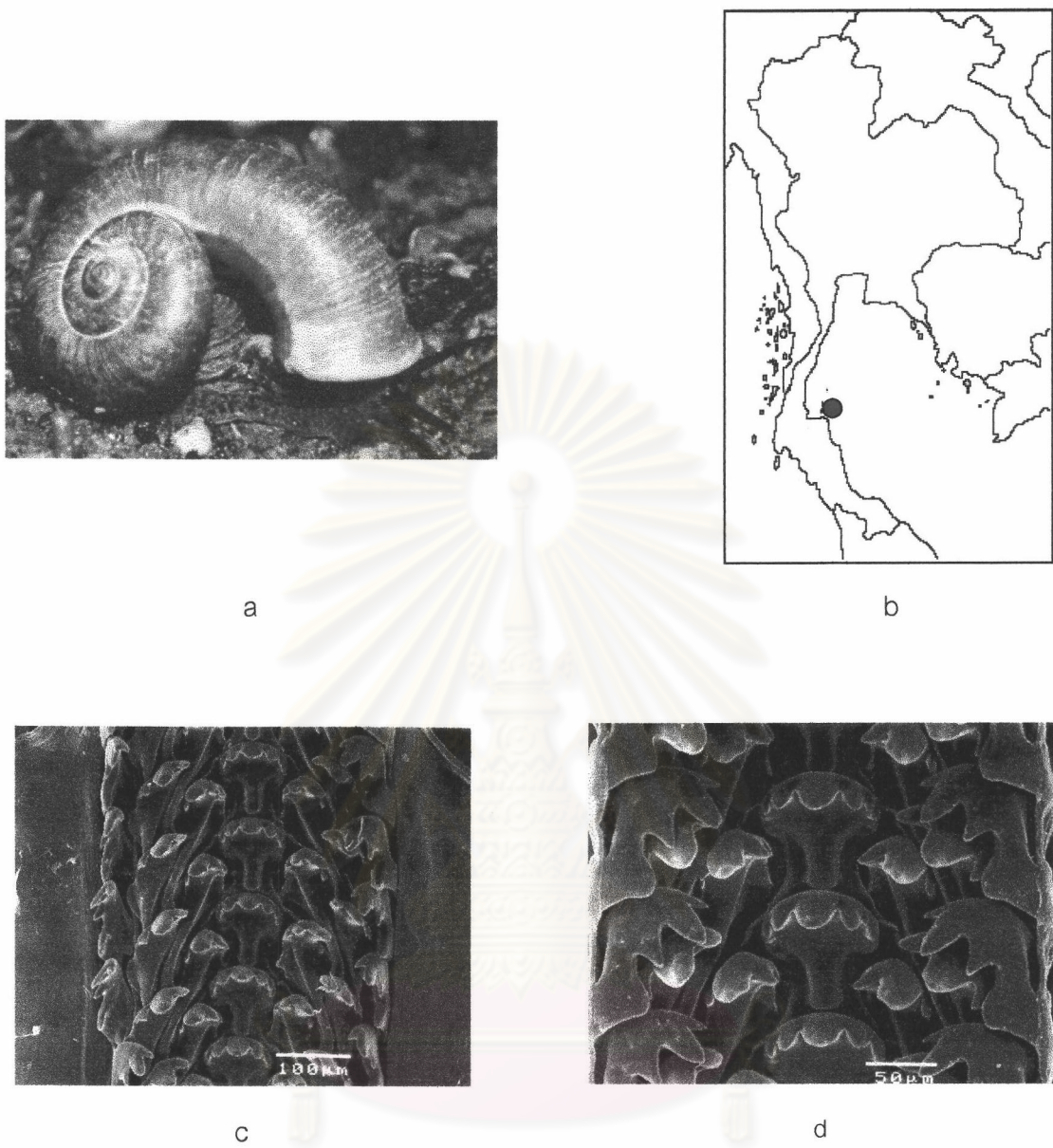


Figure 4.16 a) *Rhiosstoma samuiense*; b) distribution; Samui Island : Gulf of Thailand.

(● collected from the present study); c) radula sheet; d) enlarged radula sheet

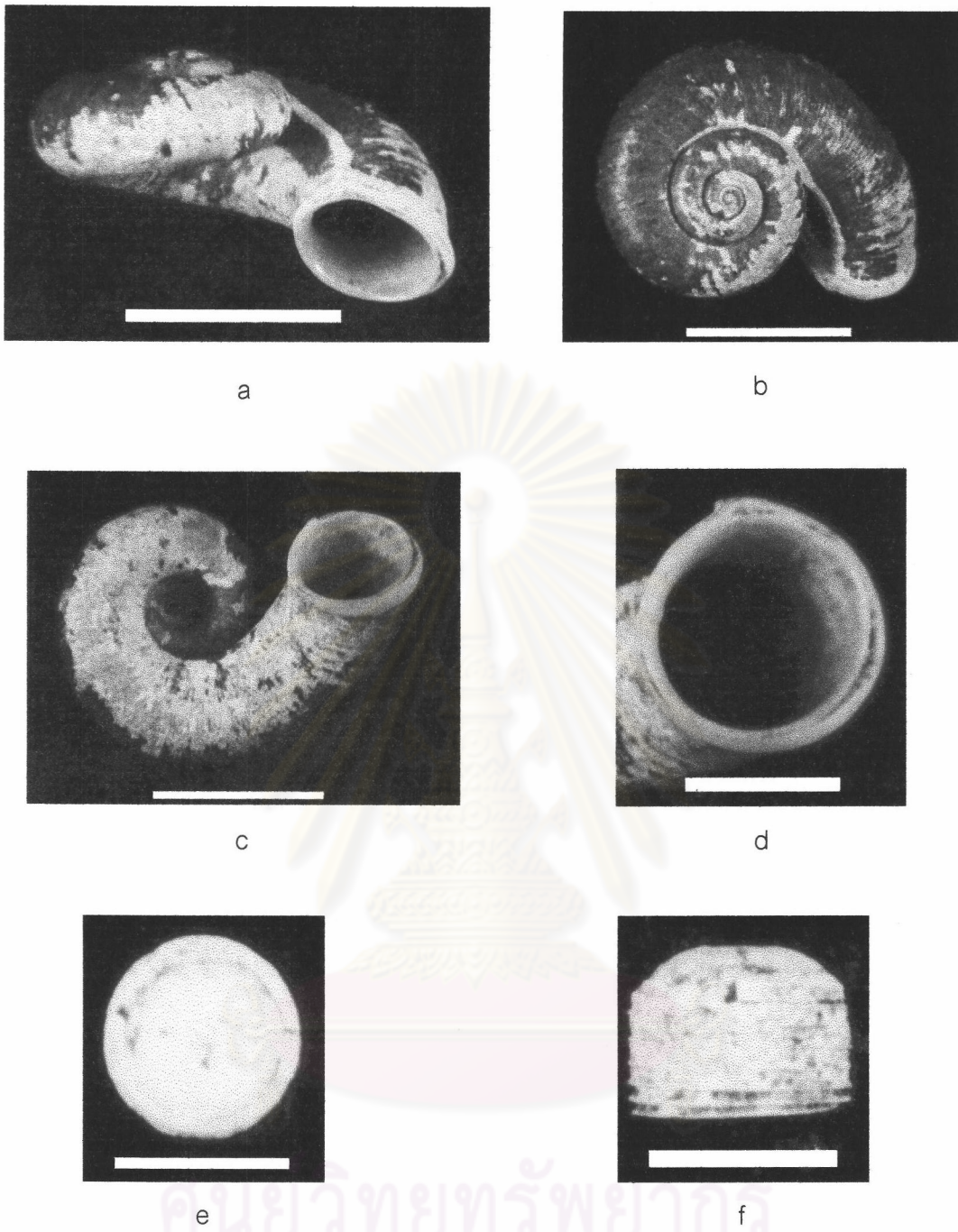


Figure 4.17 *Rhiosstoma samuiense*; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; e) operculum at dorsal side; f) operculum at lateral side; (scale bars : a-c = 10 mm.; d-f = 5 mm.)

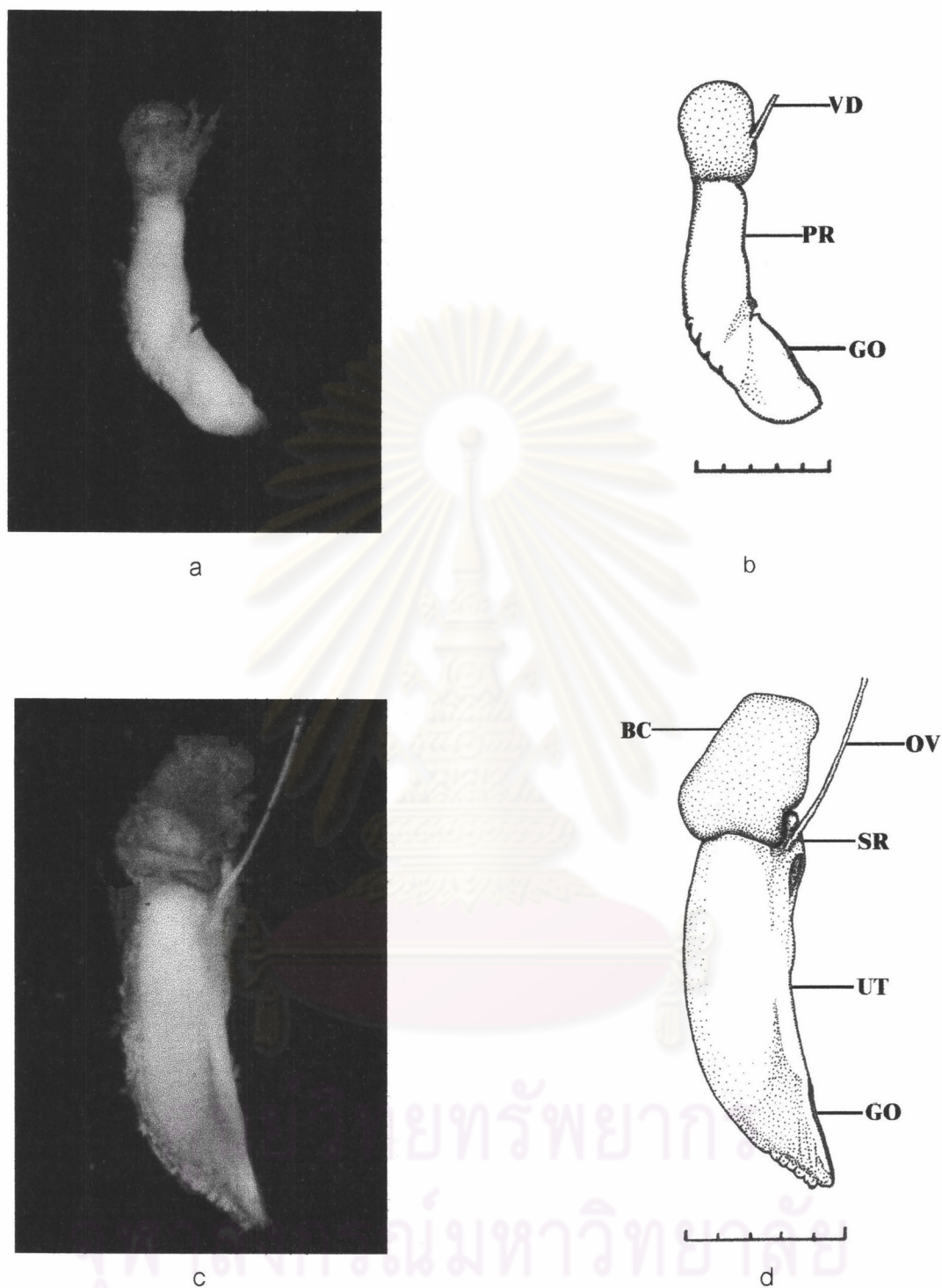


Figure 4.18 Reproductive organs of *Rhiostoma samuiense*; a) photographed and b) drawing of prostate gland, vas deferens, and genital opening; c) photographed and d) drawing of bursa copulatrix, uterus, seminal receptacle, oviduct, and genital opening (vagina slit) (scale bar = 5 mm.).

***Rhiostoma* sp.1**

Shell : The shape mostly proboscis shape with 5 rounded whorl, solid, widely umbilicate, and flat spire. Disconnected part of last whorl present for distance range 6.55-23.22 mm., turn in and downward, major diameter range 15.25-20.70 mm. and shell height range 10.63-21.26 mm. Shell surface smooth with regular growth lines. Periostracum is thin diaphanous and shiny in pale yellowish color. Dorsal side mostly present variegate form in dark brown zigzag pattern, ventral side present in uniform or variegate. Sub-peripheral band present in dark brown band. Aperture circular, thick peristome interrupt by apertural notch presentation. Air breathing tube mostly present in long complete tube. Sharp keel present from projection to suture, sometime present in blunt keel.

Operculum : Calcaroconeous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : The first half of trunk is dark-brown to black mottle on pale yellow background. The second half of the body is visceral mass covered with thin transparent mantle layer.

Radula : Taenioglossate radula sheet contain 7 teeth in each row. Central tooth has 5 cusps in linguiform, central cusp is larger than others, the head is convex, the width is longer than the length, ridge connecting is stocky. Lateral teeth have 4 cusps, the third cusp is largest in linguiform, the first and the fourth cusp are serrate shape, the second cusp is robust digitiform, inner basal part is very short but outer part is very long. Marginal teeth turn in, the first marginal teeth have 3 cusps, the second cusp is largest in pointed linguiform, the first cusp is digitiform, the third cusp is serrate shape. The second marginal teeth have 4 cusps, the first cusp is small digitiform, the second cusp is pointed linguiform, the third cusp is serrate shape, and the fourth cusp is largest in triangular shape.

Genital system :

Male :

Testis occupies entirely on the early whorls, except the uppermost part of visceral hump, dull or bright orange in color.

Vas deferens is slender, and pale yellowish color.

Prostate gland is stocky fusiform, plump, pale orange in color, separates in two parts by thickness. The posterior part is one-thirds of the length, flattened, color is orange, vas deferens enters lower than the middle of posterior part, without seminal vesicle. Anterior part is thicker than posterior part, genital opening opens from the anterior end reach to half of anterior part length.

Seminal groove extends from the prostate along the side of the head to the tip of the penis.

Penis is digitiform, slightly tapered and pointed at the tip. It is longer than tentacle.

Female :

Ovary locates on the columella side of the early whorls. Color is pale orange. It has many glands, but unclear in number.

Oviduct is pale yellowish color.

Seminal receptacle is robust digitiform projects from posterior of uterus, its length long over the posterior end of uterus, pale yellowish color.

Bursa copulatrix is sickle shape in bright orange, the length is more than half of uterus length, flattened. It opens to the outer side of uterus.

Uterus is lunate shape, very plump, posterior end is angle, anterior end is slightly taper, color is pale yellow. Oviduct enters to uterus on inner side higher than the base of seminal receptacle. Vagina slit opens from the distal of anterior end reach to one-thirds of uterus length, Its labial is thick and expand.

Habitat : *Rhiostoma* sp.1 were found from Tham Pla, Chiang Rai. They live in leaf litter of limestone hill.

Locality : Tham Pang Kham, Tham Pha Mon, and limestone hill in Pang Ma Pha, Mae Hong Son; Tham Prichinda in Doi Inthanon National Park, limestone hill near Chai Prakan and near Chiang Dao, Tham Mueang On, Chiang Mai; Tham Mae Suai, Tham pla, and Tham Pha Chom, Chiang Rai; Tham Pha Tup, Nan.

Distribution : Mae Hong Son, Chiang Mai, Chiang Rai, and Nan, Northern of Thailand.

Diagnosis : Shell proboscis shape, periostracum sub-diaphanuous, complete air breathing tube present, dorsal side of shell variegate in zigzag pattern.



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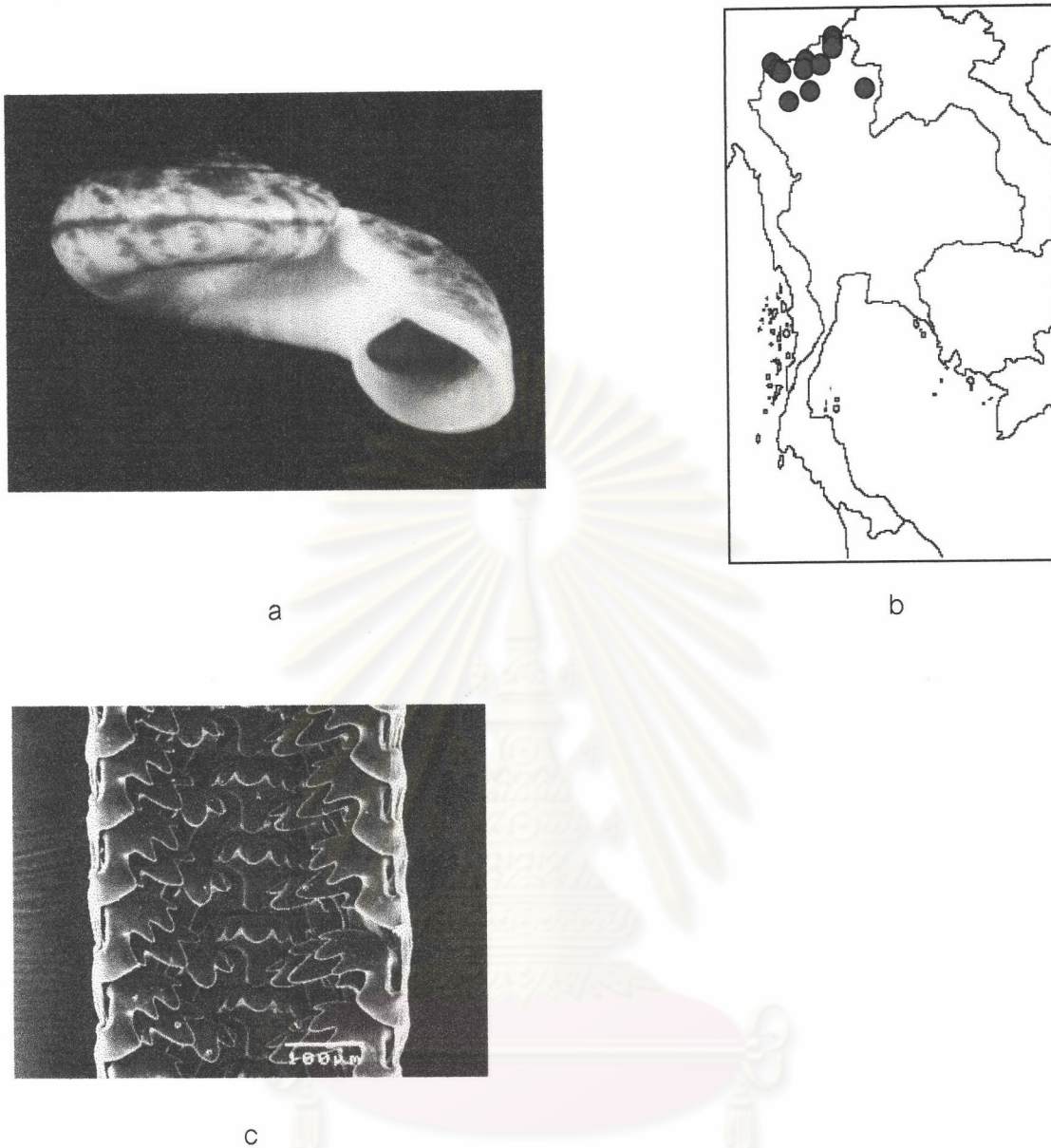


Figure 4.19 a) shell apertural side of *Rhiostoma* sp.1; b) distribution; Mae Hong Son; Chiang Mai; Chiang Rai; Nan : Thailand. (● collected from the present study); c) radula sheet

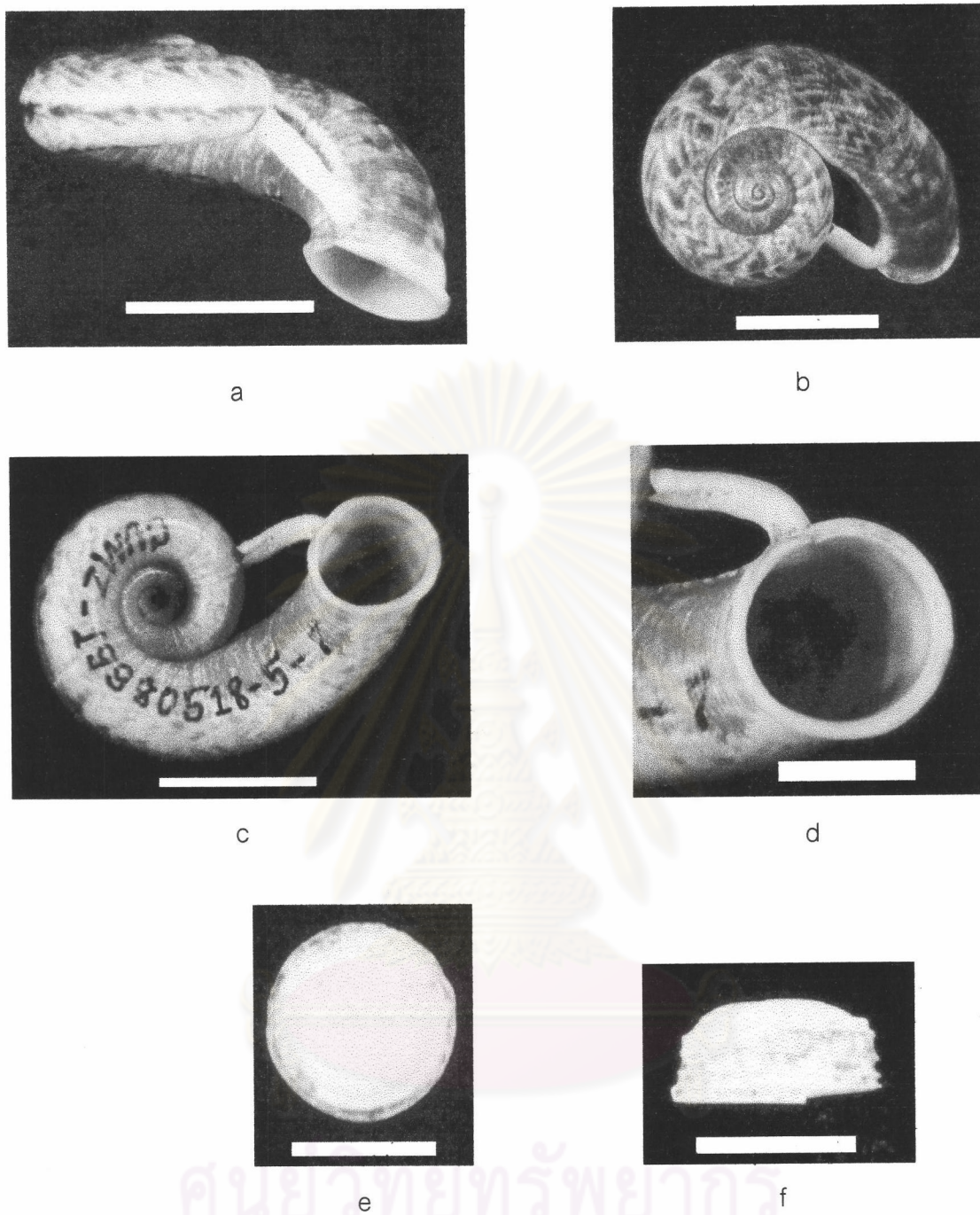


Figure 4.20 *Rhiostoma* sp.1; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; e) operculum at dorsal side; f) operculum at lateral side; (scale bars : a-c = 10 mm.; d-f = 5 mm.)

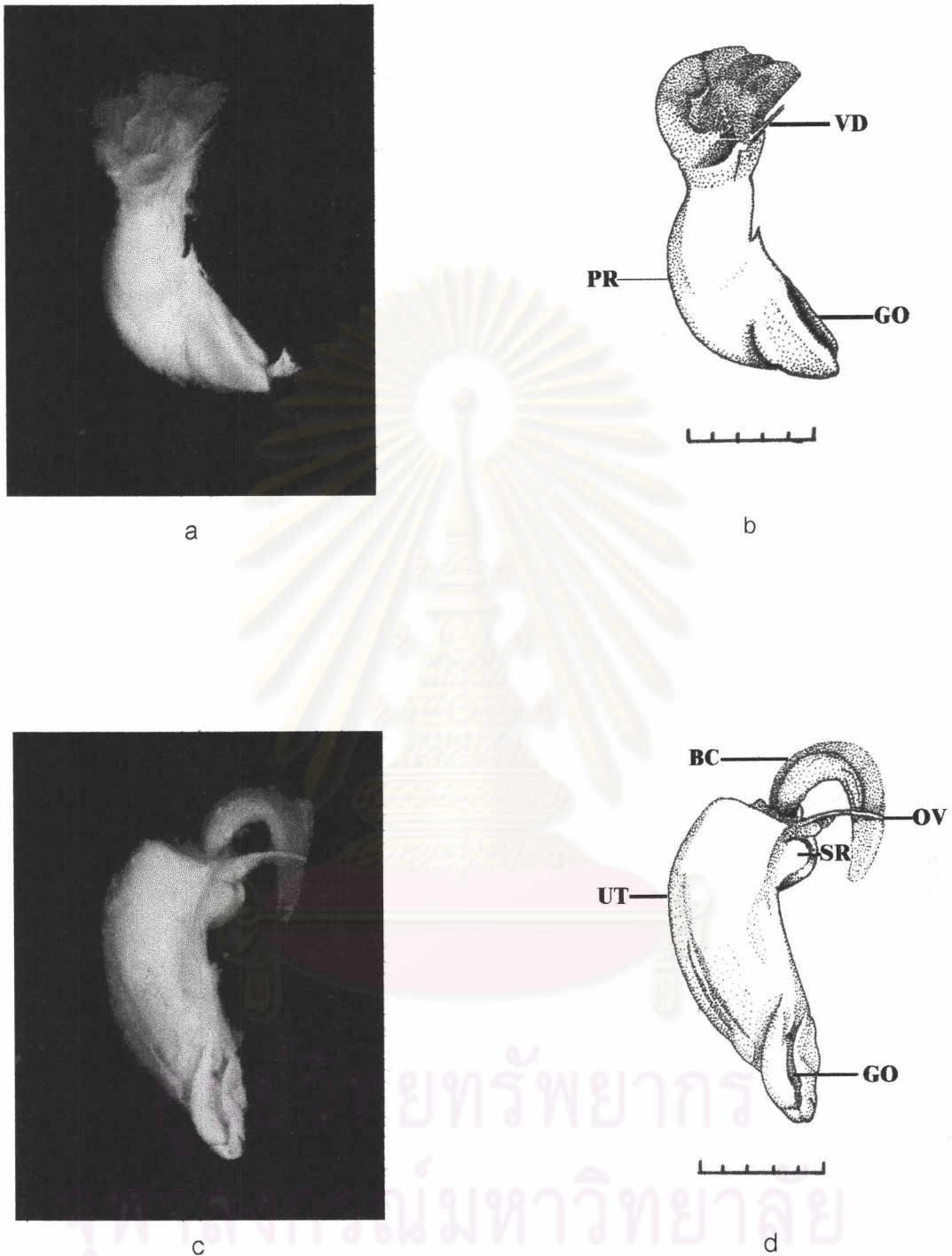


Figure 4.21 Reproductive organs of *Rhlostoma* sp.1; a) photographed and b) drawing of prostate gland, vas deferens, and genital opening; c) photographed and d) drawing of bursa copulatrix, uterus, seminal receptacle, oviduct, and genital opening (vagina slit) (scale bar = 5 mm.).

Rhiostoma sp.2

Shell : The shape is sub-discoidal with rounded 5 whorl, solid, widely umbilicate, and flattened spire. Disconnected part of last whorl absent or present, the present one has maximum distance 6.98 mm., last whorl coiling or turn in, major diameter range 20.26-24.25 mm. and shell height range 11.23-15.79 mm. Shell surface smooth with regular growth lines. Periostracum is thin diaphanous and shiny. Dorsal side of shell present variegate form with brown zigzag pattern on white background, ventral side mostly present uniform with white color. Sub-peripheral band mostly present dark brown band. Aperture circular, peristome is thick and interrupt by apertural notch presentation. Air breathing tube mostly present incomplete tube, which sometime attach to previous whorl. Keel absent or present blunt keel in shell that disconnected part of last whorl present.

Operculum : Calcaroconeous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : The first half of trunk is black with fade down in an area near the tentacle and collumella muscle with pale yellowish mottle. The second half of the body is visceral mass covered with thin transparent mantle layer.

Radula : Taenioglossate radula sheet contain 7 teeth in each row. Central tooth has 5-7 cusps, central cusp is linguiform with other cusps in serrate shape, the head is convex, the width is longer than the length, ridge connecting is slender. Lateral teeth have 4 cusps in serrate shape, the third cusp is largest and the fourth cusp is smallest, inner basal part is very short but outer part is very long. Marginal teeth turn in, the first marginal teeth have 3 cusps, the first cusp is digitiform, the second cusp is largest in robust serrate shape, the third cusp is smallest in serrate shape. The second marginal teeth have 4 cusps, the first cusp is usually present papilliform in some teeth, the second and the third cusp are serrate shape, and the fourth cusp is largest in triangular shape.

Genital system :**Male :**

Testis locates on the early whorls, poor information about it because the lost of early whorl.

Vas deferens is pale yellowish color.

Prostate gland is stocky fusiform, pale orange in color, separated in two parts by thickness. The posterior part is one-thirds of the length, flattened in rhomboid shape, vas deferens enters near the base of it, without seminal vesicle. Anterior part is plump, genital opening opens from the anterior end reach to half of anterior part length.

Seminal groove extends from the prostate along the side of the head to the tip of the penis.

Penis is robust digitiform, tapering at the tip. It is longer than tentacle.

Female :

Ovary locates on the columella side of the early whorls. Other information unknown because uppermost part lose.

Oviduct is pale yellowish color.

Seminal receptacle is small digitiform projects from posterior part of uterus, its length long over the posterior end of uterus, pale brown in color.

Bursa copulatrix is lunate shape with brown in color, the length about one-fifths of uterus length, flattened. It opens to the outer side of uterus.

Uterus is elongate sword shape, very flattened, posterior end is angle, anterior end is slightly taper, color is pale brown. Oviduct enters to uterus on inner side at the base of seminal receptacle. Vagina slit opens from the distal of anterior end reach to two-eighths to three- eighths of uterus length, its labial is simple.

Habitat : *Rhiostoma* sp.2 were found from Khao Noi, Nakhon Sawan. They live in leaf litter of limestone hill.

Locality : Khao Noi, Nakhon Sawan.

Distribution : Nakhon Sawan, Central of Thailand.

Diagnosis : Shell sub-discoidal shape, disconnected part of last whorl present, dorsal side of shell variegate, air breathing tube mostly present incomplete tube.



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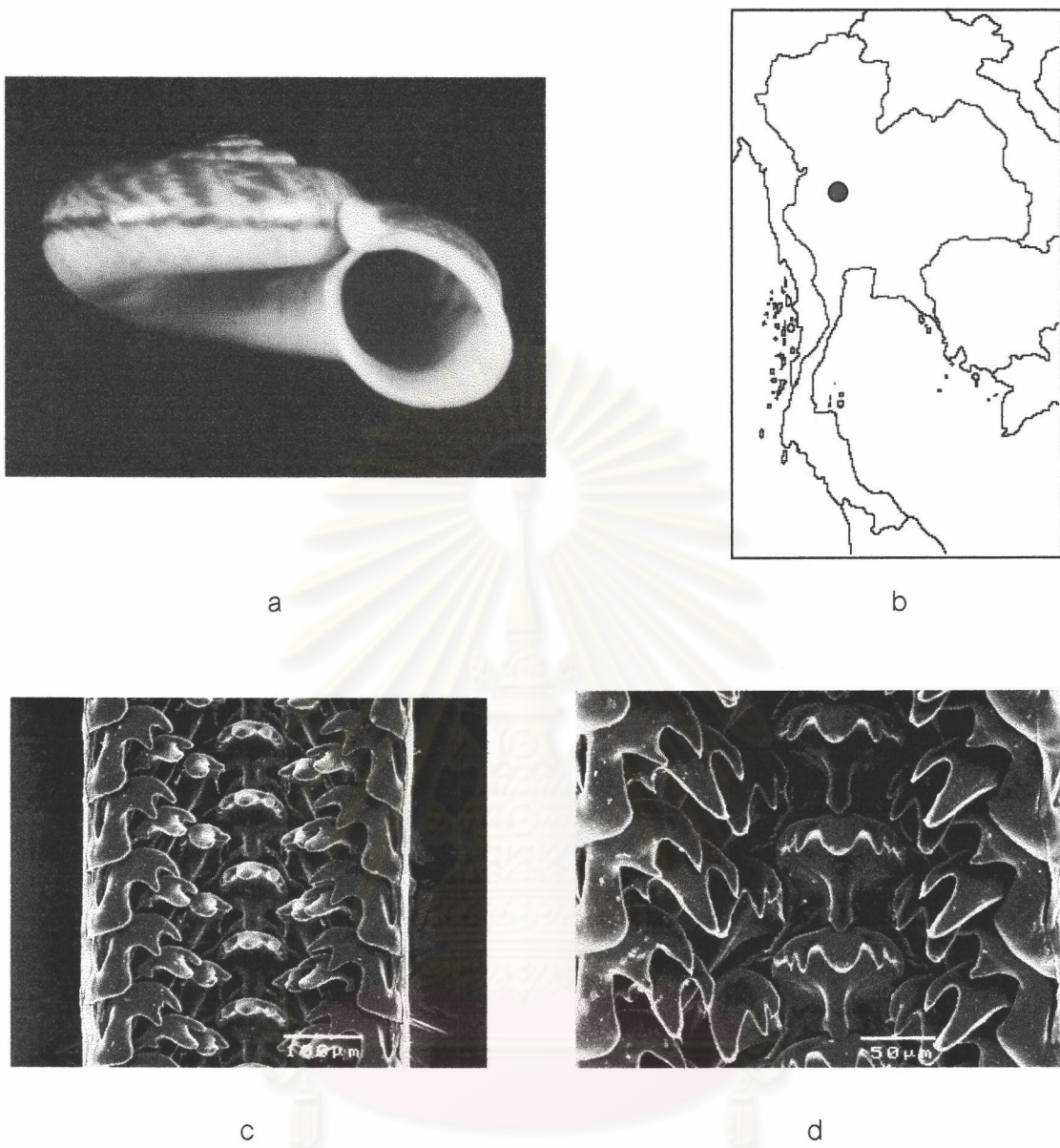


Figure 4.22 a) shell apertural side of *Rhiostoma* sp.2; b) distribution; Nakhon Sawan : Thailand; (● collected from the present study); c) radula sheet; d) enlarged radula sheet

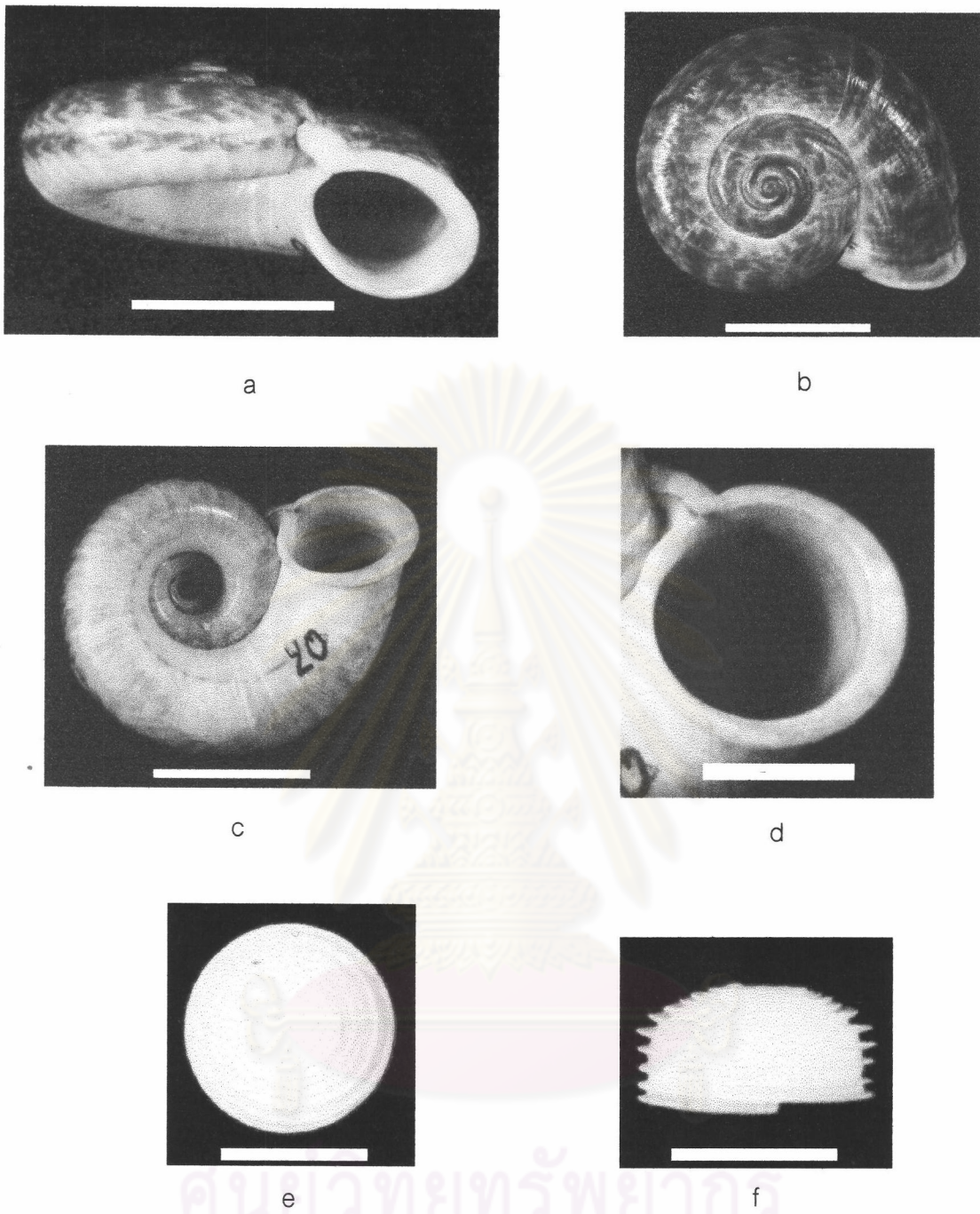


Figure 4.23 *Rhiostoma* sp.2; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; e) operculum at dorsal side; f) operculum at lateral side; (scale bars : a-c = 10 mm.; d-f = 5 mm.)

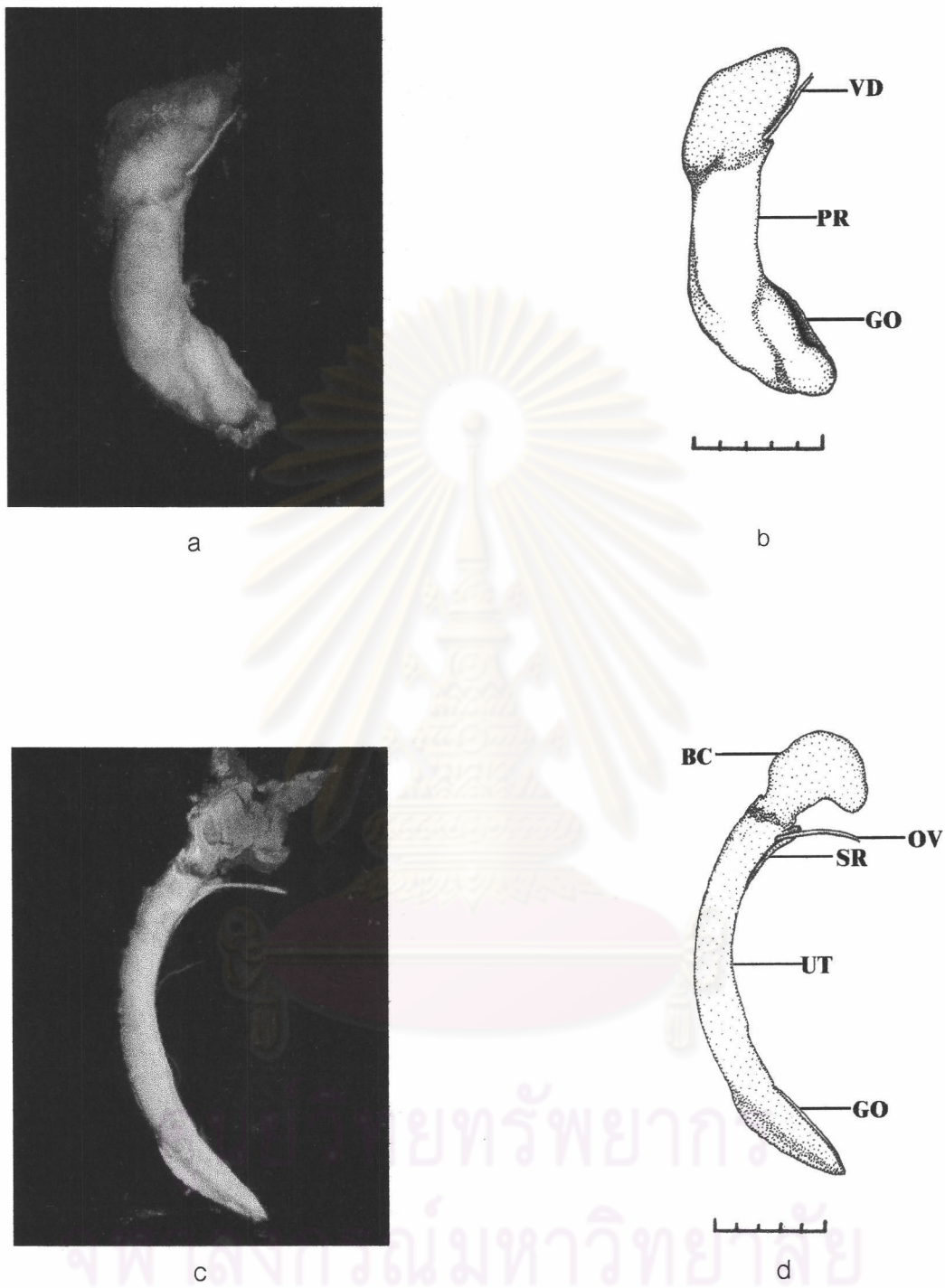


Figure 4.24 Reproductive organs of *Rhiostoma* sp.2; a) photographed and b) drawing of prostate gland, vas deferens, and genital opening; c) photographed and d) drawing of bursa copulatrix, uterus, seminal receptacle, oviduct, and genital opening (vagina slit) (scale bar = 5 mm.).

***Rhiostoma* sp.3**

Shell : The shape is sub-discoidal with rounded 5 whorl, solid, widely umbilicate, and flattened, Disconnected part of last whorl mostly absent, the present one is very rare has maximum distance 4.46 mm. last whorl coiling or turn in, major diameter range 21.98-26.46 mm. and shell height range 13.47-16.78 mm. Shell surface smooth with regular growth lines. Periostracum is thin diaphanous with pale brown in color. Dorsal side of shell present variegate form with dark brown mottle and zigzag pattern on white background, ventral side mostly present variegate form with dark brown zigzag pattern on white background. Sub-peripheral band mostly present one more dark brown band. Aperture circular, peristome is thick and interrupt, apertural notch mostly present. Air breathing tube mostly absent or present short projection which attach to penultimate whorl. Keel absent.

Operculum : Calcarocorneous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : The first half of trunk is black with fade down in dorsal and frontal area with white or pale yellowish mottle. The second half of the body is visceral mass covered with thin transparent mantle layer.

Radula : Taenioglossate radula sheet contain 7 teeth in each row. Central tooth has 5 cusps, the head is convex, the width is longer than the length, ridge connecting is stocky. Lateral teeth have 4 cusps, the third cusp is largest in linguiform and other cusps are smaller than it present in robust serrate shape, inner basal part is very short but outer part is very long. Marginal teeth turn in, the first marginal teeth have 3 cusps, the second cusp is largest in pointed linguiform, the first cusp is elongate linguiform, the third cusp is serrate shape. The second marginal teeth have 4 cusps, the first and the third cusp are serrate shape, which the first is shorter than the third, the second is pointed linguiform, and the fourth cusp is largest in triangular shape.

Genital system :**Male :**

Testis is no information because the lost of early whorl.

Vas deferens is no information because the lost of early whorl.

Prostate gland is no information because the lost of early whorl.

Seminal groove extends from the prostate along the side of the head to the tip of the penis.

Penis is stocky digitiform, tapering at the tip. It is shorter than tentacle.

Female :

Ovary locates on the columella side of the early whorls. Color is pale orange. It consist of 6 glands, all of them are unilobate.

Oviduct is pale yellowish color.

Seminal receptacle is slender digitiform projects from posterior part of uterus, its length long over the posterior end of uterus, pale yellowish color.

Bursa copulatrix is lunate shape with pale green-orange in color, the length is about half of uterus length.

Uterus is lunate shape, plump, color is pale yellow, posterior end is round, anterior end is pointed. Oviduct enters to uterus on inner side at the base of seminal receptacle. Vagina slit opens from the distal of anterior end reach to about half of uterus length, labial is thick and expand.

Habitat : *Rhiostoma* sp.3 were collected from limestone hill in Phu Khiao wildlife Sanctuary, Chaiyaphum.

Locality : Phu Khiao wildlife Sanctuary, Chaiyaphum.

Distribution : Chaiyaphum, North-eastern of Thailand.

Diagnosis : Shell sub-discoidal shape, disconnected part of last whorl absent, dorsal and ventral side of shell variegate.

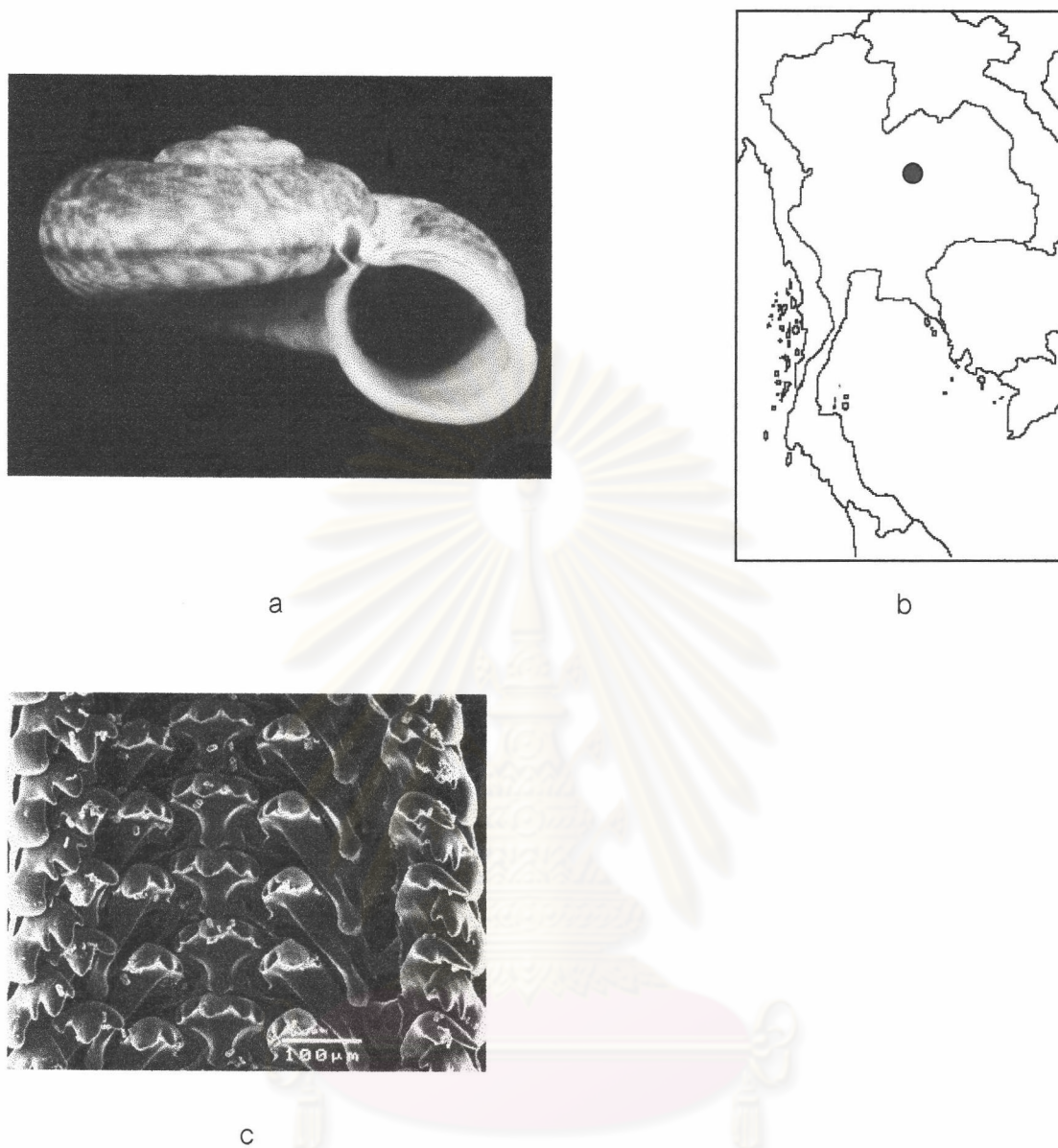


Figure 4.25 a) shell apertural side of *Rhiostoma* sp.3; b) distribution; Chaiyaphum : Thailand. (●collected from the present study); c) radula sheet

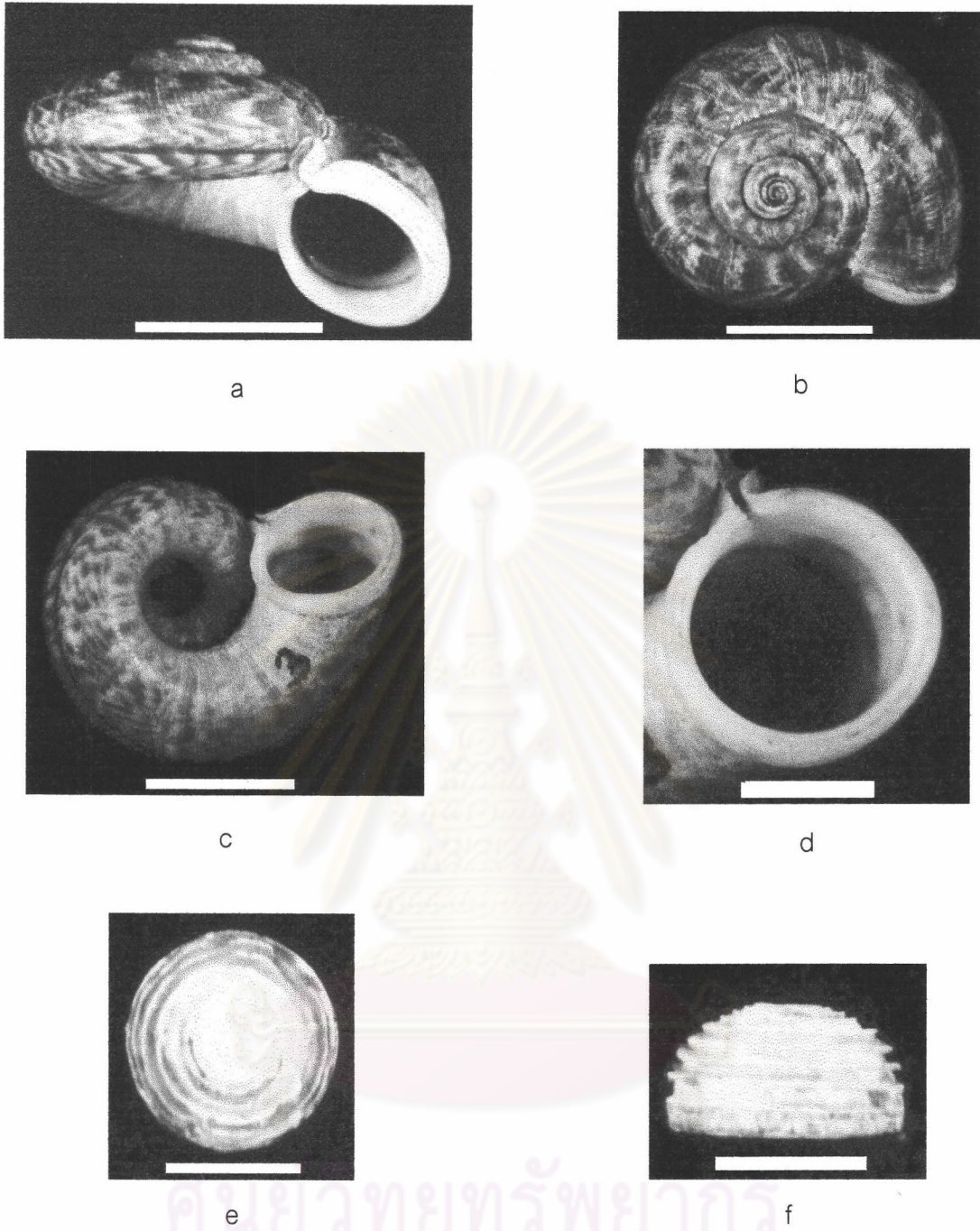
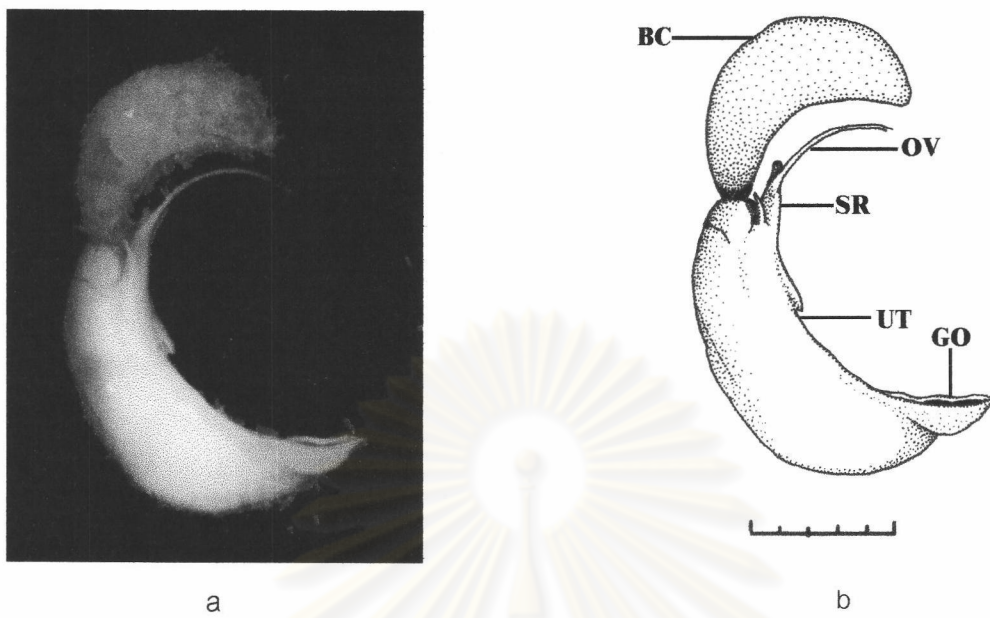


Figure 4.26 *Rhiostroma* sp.3; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; e) operculum at dorsal side; f) operculum at lateral side; (scale bars : a-c = 10 mm.; d-f = 5 mm.)



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Figure 4.27 Reproductive organs of *Rhlostoma* sp.3; a) photographed and b) drawing of bursa copulatrix, uterus, seminal receptacle, oviduct, and genital opening (vagina slit) (scale bar = 5 mm.).

Rhiostoma sp.4

Shell : The shape is sub-discoidal with rounded 5 whorl, solid, widely umbilicate, and flat spire. Disconnected part of last whorl usually present in maximum distance 6.87 mm. last whorl coiling or turn in, major diameter range 15.31-21.01 mm. and shell height range 8.98-13.72 mm. Shell surface smooth with regular growth lines. Periostracum is thin diaphanous and shiny. Dorsal side of shell mostly present uniform with light brown, brown, or dark brown in color, ventral side present uniform with white color or variegate by white color inside and light brown outside below sub-peripheral band. Sub-peripheral band mostly present one brown band. Aperture circular, peristome is thick and mostly interrupt, apertural notch mostly present. Air breathing tube usually absent. Sharp keel mostly present.

Operculum : Calcaroconeous, high cylindrical, outside convex, anti-clockwise multispiral,

Body : The first half of trunk is pale yellowish mottle on black background, the area near collumella muscle is pale yellowish color. The second half of the body is visceral mass covered with thin transparent mantle layer.

Radula : Taenioglossate radula sheet contain 7 teeth in each row. Central tooth has 5 cusps, central cusp like rectangle shape, inner lateral cusps are long robust serrate and outer lateral cusp are short robust serrate, the head is more convex, the width is longer than the length, ridge connecting is slender. Lateral teeth have 4 cusps, the third cusp is largest in elongate linguiform, the first and the second cusp are digitiform, the fourth cusp is small serrate shape, inner part of basal plate is very short but outer part is very long. Marginal teeth turn in, the first marginal teeth have 3 cusps, the second cusp is largest in linguiform, the first cusp is robust digitiform, the third cusp is serrate shape. The second marginal teeth have 4 cusps, the first cusp is smallest in digitiform, the second cusp is robust digitiform, the third cusp is serrate shape, and the fourth cusp is largest in triangular shape.

Genital system :**Male :**

Testis occupies entirely on the early whorls, dull orange in color.

Vas deferens is slender, pale yellowish color.

Prostate gland is elongate fusiform, slender, pale yellowish color, separated in two parts by thickness. The posterior part is one-fifths of the length, flattened, color is pale orange, vas deferens enters at the base of posterior part, without seminal vesicle. Anterior part is thicker than posterior part, genital opening opens from the anterior end reach to half of anterior part length.

Seminal groove extends from the prostate along the right side of the head to the tip of the penis.

Penis is digitiform, tapering at the tip. It is shorter than tentacle.

Female :

Ovary locates on the columella side of the early whorls.

Oviduct is pale yellowish color.

Seminal receptacle is digitiform projects from posterior part of uterus, its length long over the posterior end of uterus, but some specimen not over the posterior end, pale yellowish color.

Bursa copulatrix is elongate ovate shape, pointed at the tip, color is bright orange, the length is more than one-thirds of uterus length, flattened.

Uterus is lunate shape, plump, posterior end is angle, anterior end is slightly taper, It has numerous orange mottle under the membrane. Oviduct enters to uterus on inner side at the base of seminal receptacle. Vagina slit opens from the distal of anterior end reach to one-thirds of uterus length, its labial is simple.

Habitat : *Rhiostoma* sp.4 were found on the ground at the base of limestone hill near Wat Pluang Thong, Chon Buri.

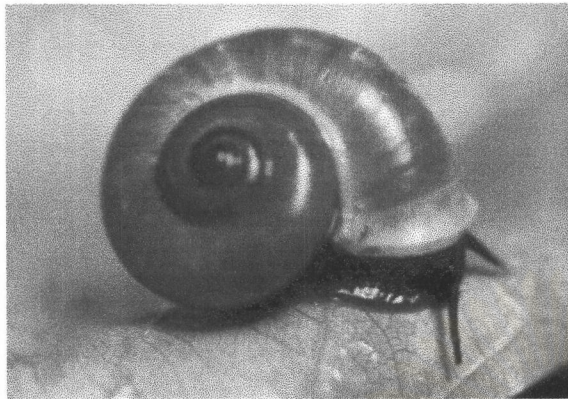
Locality : Limestone hill near Wat Pluang Thong, Chon Buri; Wat Tham Muang and Tham Pha Tha Phon, Pitsanulok; Khao Patthawi, Uthai Thani.

Distribution : Chon Buri, Pitsanulok, and Uthai Thani.

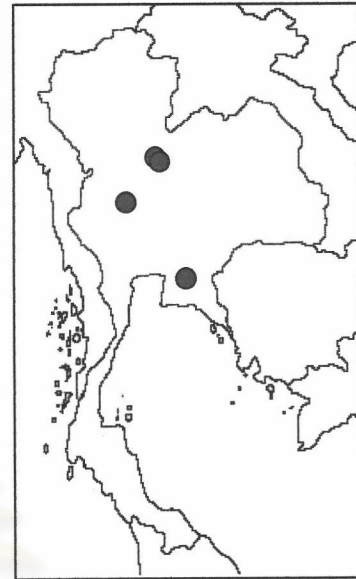
Diagnosis : Shell sub-discoidal shape, disconnected part of last whorl present, dorsal side of shell uniform in light brown, brown or dark brown in color, ventral side white color.



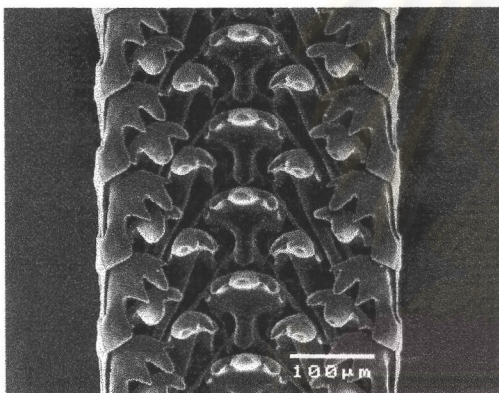
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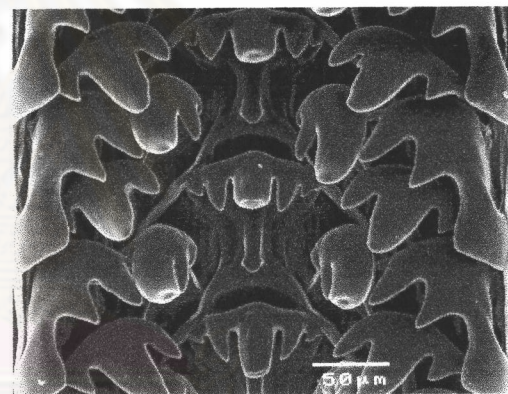
a



b



c



d

Figure 4.28 a) *Rhiostoma* sp.4; b) distribution; Phitsanulok; Chon Buri; Uthai Thani : Thailand. (● collected from the present study); c) radula sheet; d) enlarged radula sheet

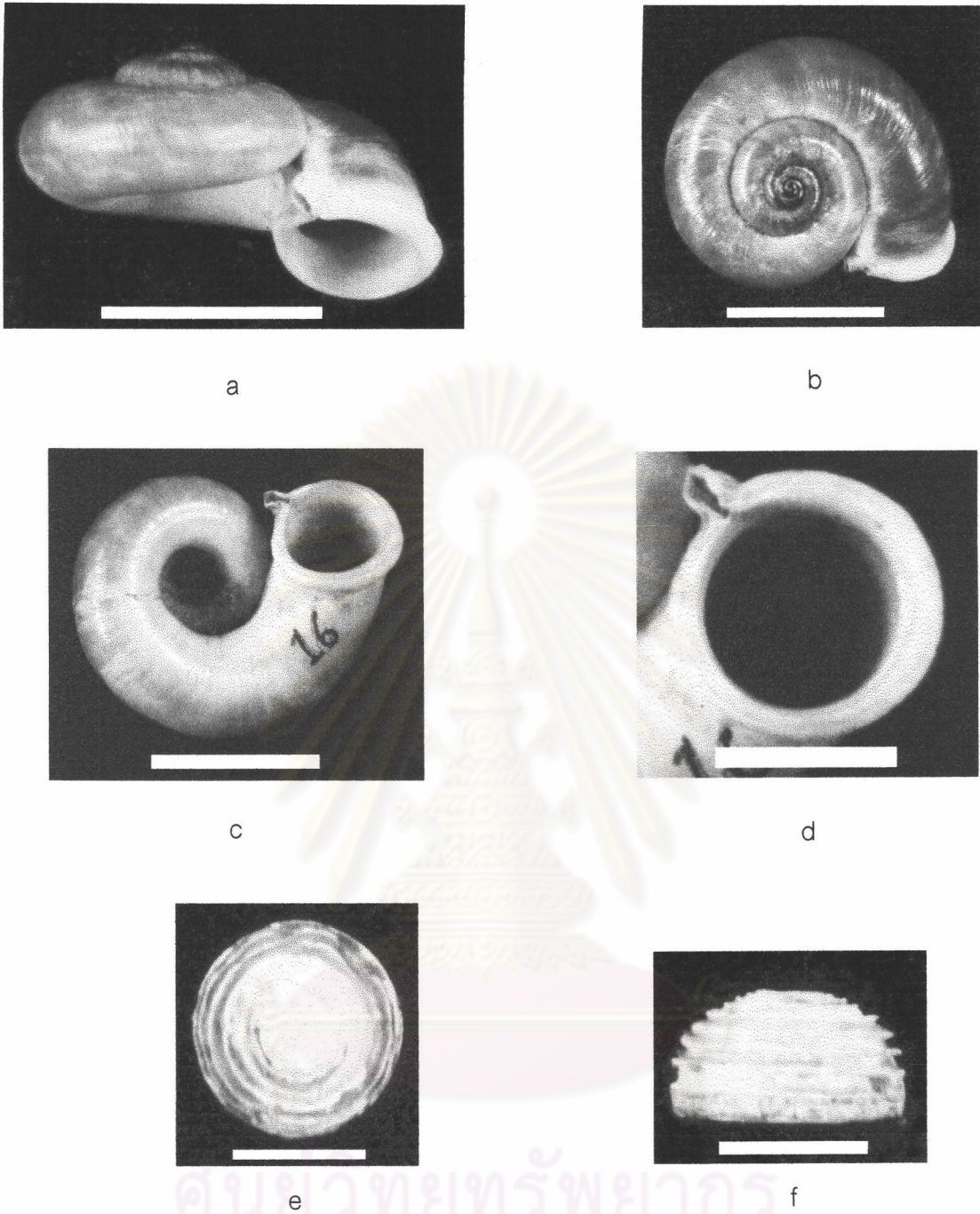


Figure 4.29 *Rhiostroma* sp.4; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; e) operculum at dorsal side; f) operculum at lateral side; (scale bars : a-c = 10 mm.; d-f = 5 mm.)

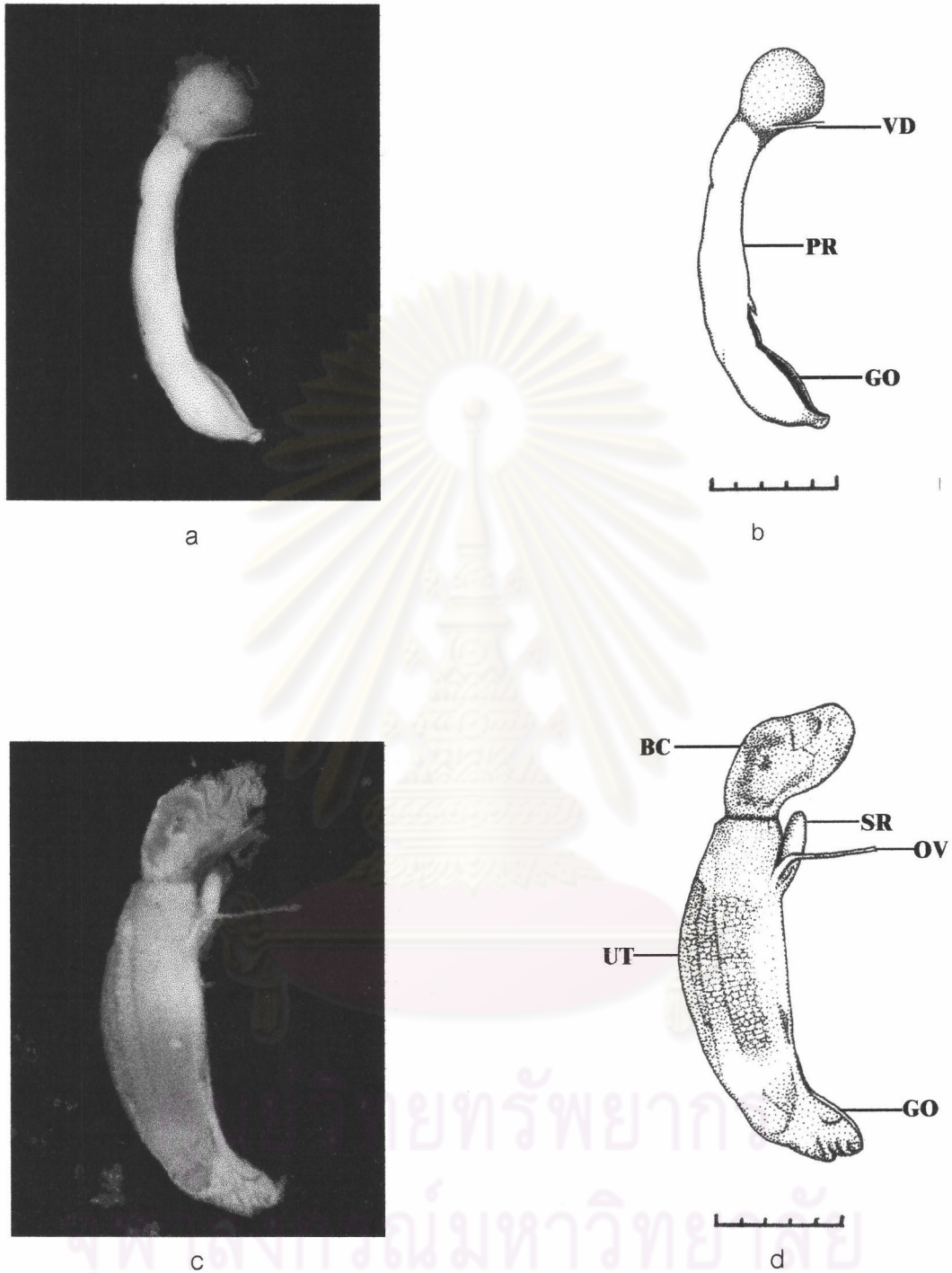


Figure 4.30 Reproductive organs of *Rhlostoma* sp.4; a) photographed and b) drawing of prostate gland, vas deferens, and genital opening; c) photographed and d) drawing of bursa copulatrix, uterus, seminal receptacle, oviduct, and genital opening (vagina slit) (scale bar = 5 mm.).

Rhiostoma sp.5

Shell : The shape is proboscis with rounded 4 whorl, solid, widely umbilicate, and flat spire. Disconnected part of last whorl present for distance range 10.33-27.34 mm., mostly turndown, major diameter range 16.78-19.86 mm. and shell height range 13.74-27.13 mm. Shell surface smooth with regular growth lines. Periostracum is thin diaphanous and shiny in pale brown color. Dorsal side of shells are uniform or variegate, color is variable in brown, dark brown, or purple with a faint brown zigzag on some shell. Sub-peripheral band absent or present in faint brown band. Aperture circular, peristome is thick, continuous or interrupt, apertural notch mostly present. Air breathing tube absent, triangular projection present. Blunt keel present.

Operculum : Calcaroconeous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : Not seen (only empty shell were found)

Habitat : shell of *Rhiostoma* sp.5 were found from limestone hill names Khao Phanom Wang, Surat Thani.

Locality : Khao Phanom Wang, Surat Thani.

Distribution : Surat Thani, Southern of Thailand.

Diagnosis : Differs from all other species of *Rhiostoma* in apertural direction turn down. Its coloration closely related to *R. chupingense*.

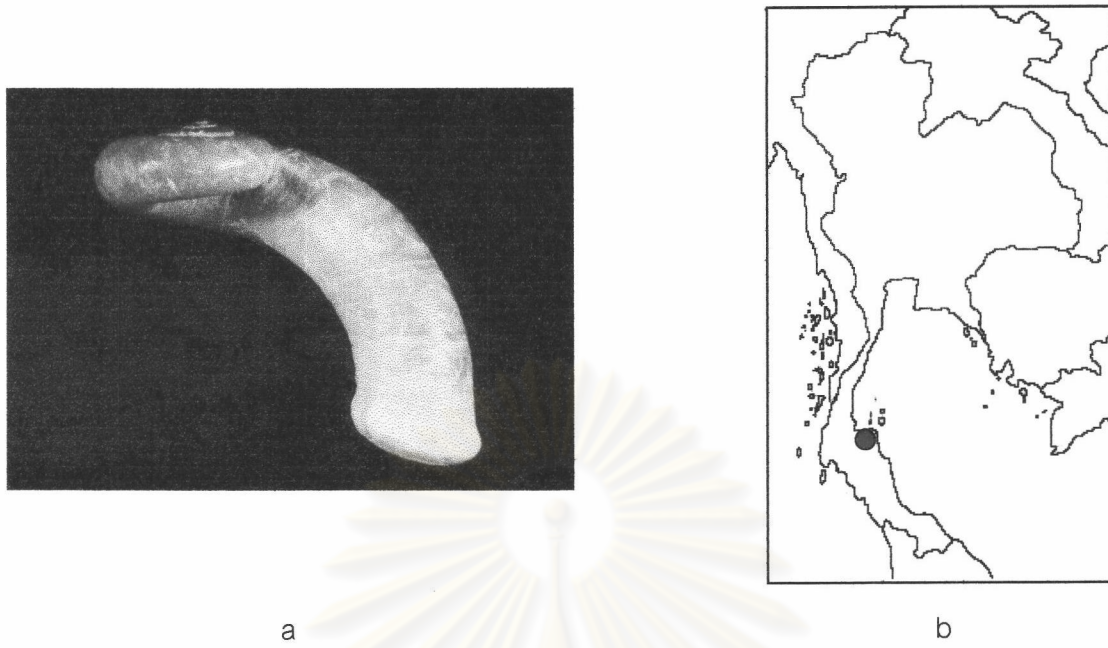


Figure 4.31 a) shell apertural side of *Rhiostroma* sp.5; b) distribution; Surat Thani : Thailand. (●collected from the present study)

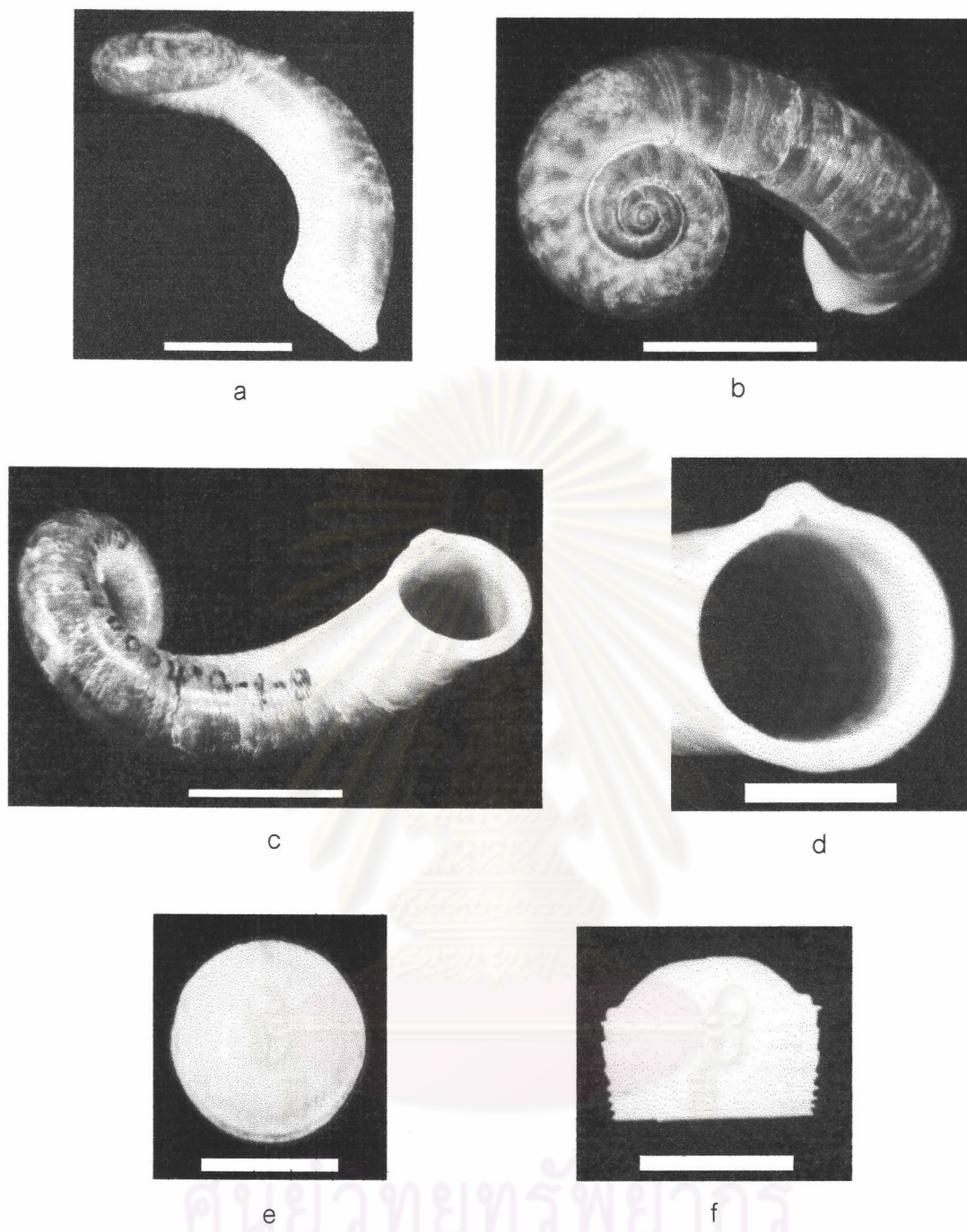


Figure 4.32 *Rhioptoma* sp.5; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; e) operculum at dorsal side; f) operculum at lateral side; (scale bars : a-c = 10 mm.; d-f = 5 mm.)

***Rhiostoma* sp.6**

Shell : The shape is proboscis with rounded 5 whorl, solid, widely umbilicate, and flat spire. Disconnected part of last whorl present for distance range 8.20-17.01 mm., turn in and downward, major diameter range 16.54-22.47 mm. and shell height range 12.62-21.10 mm. Shell surface smooth with regular growth lines. Periostracum is thin diaphanous and shiny in pale yellow to brown color. Dorsal side of shells is uniform or variegate with brown zigzag pattern or color vary in light brown or brown by growth line, ventral side mostly present uniform. Sub-peripheral band absent or present in brown band. Aperture circular, peristome is thick, mostly interrupt, apertural notch mostly present. Air breathing tube absent but present towering triangular projection. Very sharp keel mostly present.

Operculum : Calcaroconeous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : The first half of trunk is dark brown to black mottle on pale yellowish background. The second half of the body is visceral mass covered by thin transparent mantle layer.

Radula : Taenioglossate radula sheet contain 7 teeth in each row. Central tooth has 5 cusps, the head is more convex, the width is longer than the length, ridge connecting is slender. Lateral teeth have 4 cusps, the third cusp is largest in linguiform, the first and the second cusp are robust digitiform, the fourth cusp is small serrate shape, inner part of basal plate is very short but outer part is very long. Marginal teeth turn in, the first marginal teeth have 3 cusps, the second cusp is largest in linguiform, the first cusp is digitiform, the third cusp is serrate shape. The second marginal teeth have 4 cusps, the first cusp is very small digitiform, the second cusp is robust digitiform, the third cusp is serrate shape, and the fourth cusp is largest in triangular shape.

Genital system :**Male :**

Not seen (only female were found)

Female :

Ovary locates on the columella side of the early whorls. Color is bright orange.

Consists of 6 multilobate gland.

Oviduct is pale yellowish color.

Seminal receptacle is small digitiform projects from posterior of uterus, its length not over the posterior end of uterus, dull orange in color.

Bursa copulatrix is ovate shape, with pale yellow or pale orange in color, the length about one-thirds of uterus length, flattened. It opens into the outer side of uterus.

Uterus is lunate shape, very plump, color is pale yellow, posterior end is round, anterior end is slightly taper, numerous of tiny white ovate piece present under the membrane. Oviduct enters to uterus on inner side at the base of seminal receptacle. Vagina slit opens from the distal of anterior end reach to one-fourths of uterus length, its labial is simple.

Habitat : *Rhiostoma* sp.6 were collected from leaf litter of limestone hill name Khao Cha-ang-on, Chon Buri.

Locality : Khao Cha-ang-on, Chon Buri.

Distribution : Chon Buri, Eastern of Thailand.

Diagnosis : Shell proboscis shape, periostracum sub-diaphanuous, air breathing tube absent, and behind apertural projection keel very sharp.

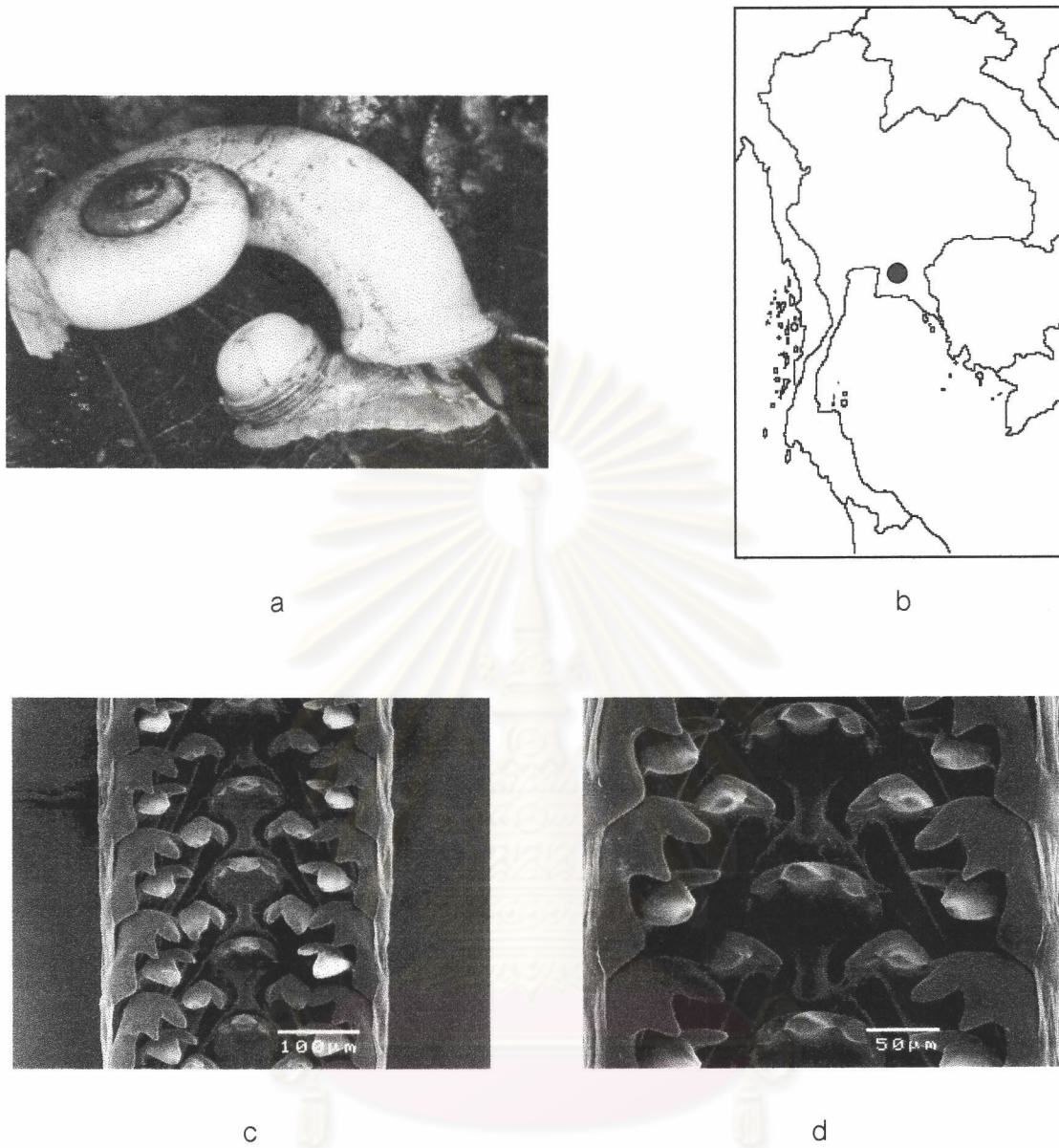


Figure 4.33 a) *Rhiostoma* sp.6; b) distribution; Chon Buri : Thailand. (● collected from the present study); c) radula sheet; d) enlarged radula sheet

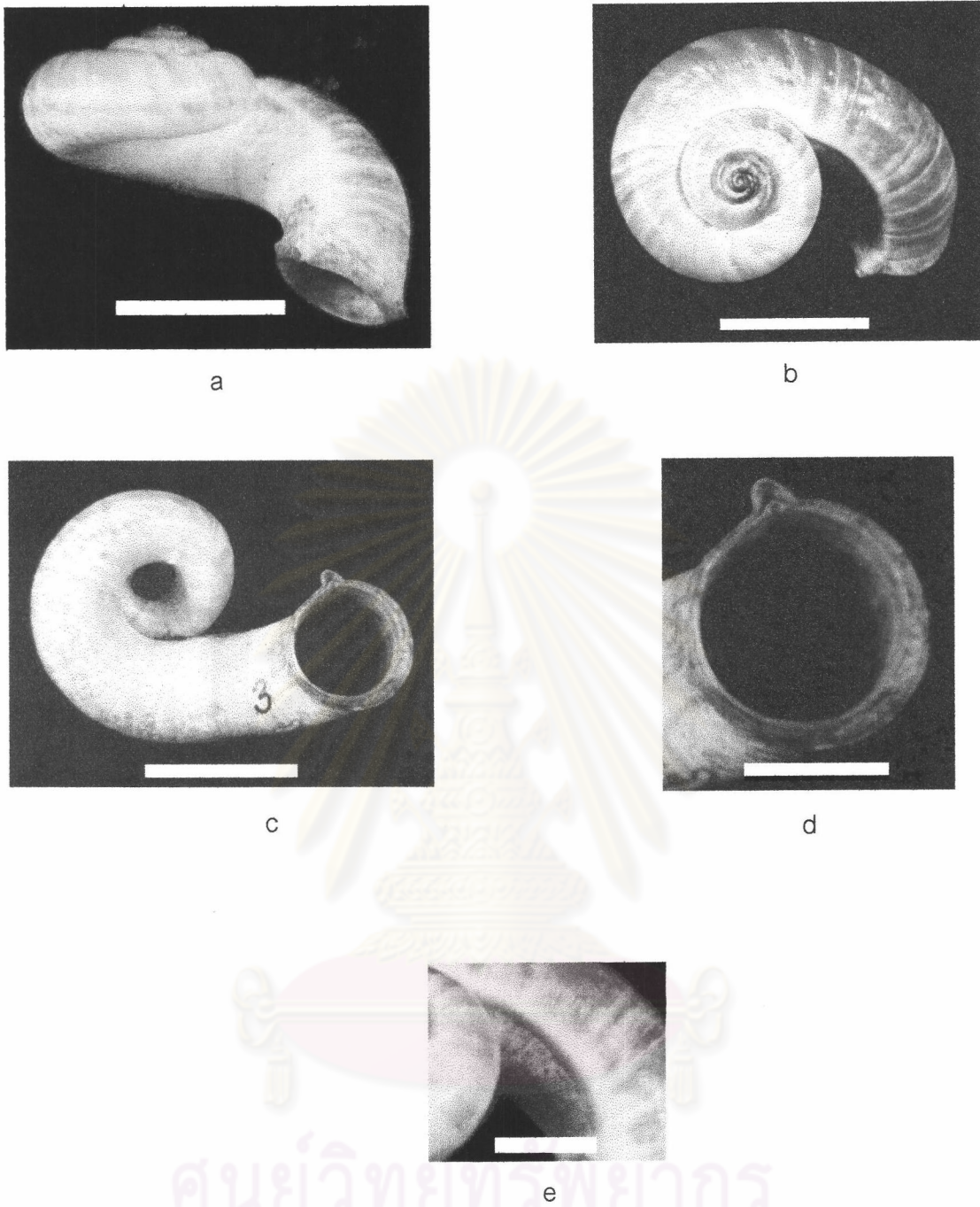
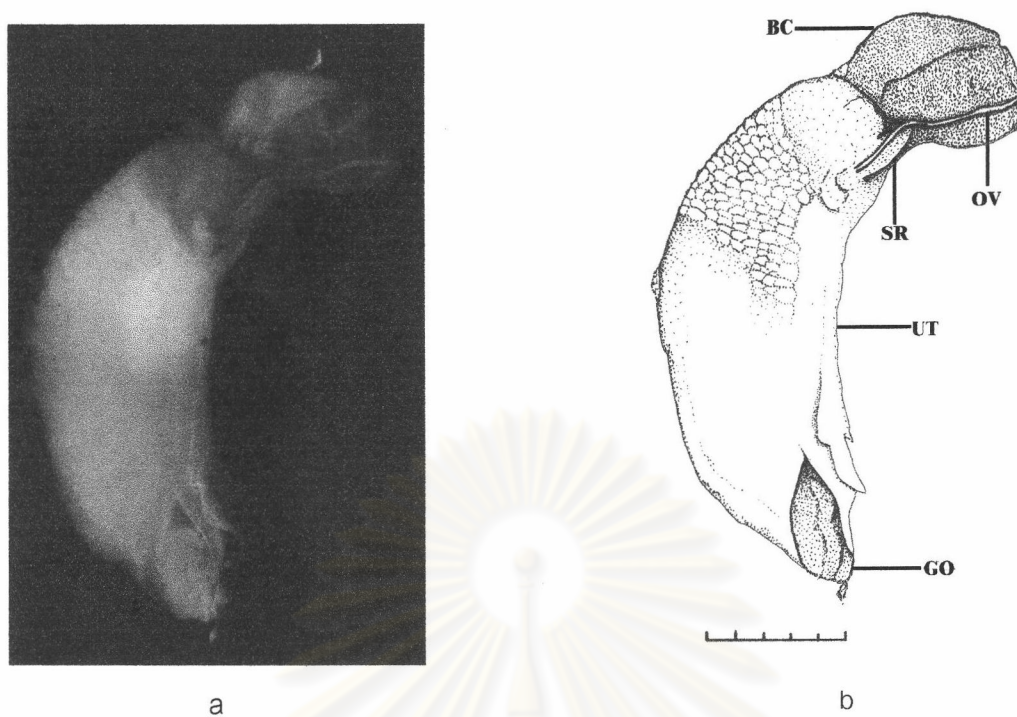


Figure 4.34 *Rhiostroma* sp.6; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; e) behind apertural projection keel; (scale bars : a-c = 10 mm.; d-e = 5 mm.)



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Figure 4.35 Reproductive organs of *Rhlostoma* sp.6; a) photographed and b) drawing of bursa copulatrix, uterus, seminal receptacle, oviduct, and genital opening (vagina slit) (scale bar = 5 mm.).

***Rhiostoma* sp.7**

Shell : The shape is sub-discoidal with rounded 5 whorl, solid, widely umbilicate, and flatted spire. Disconnected part of last whorl absent or present in maximum distance 4.93 mm., last whorl coiling or turn in, major diameter range 18.25-22.02 mm. and shell height range 10.73-14.62 mm. Shell surface smooth with regular growth lines. Periostracum is thin diaphanous and rather shiny. Dorsal and ventral side of shell present uniform with white, pale brown or pale purple in color. Sub-peripheral band absent or present in brown band. Aperture circular, most of peristome is thick, continuous or interrupt, apertural notch mostly present. Air breathing tube absent but present triangular projection on upper peristome. Keel present blunt or sharp in shell that disconnected part of last whorl present.

Operculum : Calcarocorneous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : Not seen (only empty shell were found)

Habitat : Shell of *Rhiostoma* sp.7 were found from the ground of limestone island.

Locality : Ko Wua Ta Lap in Mu Ko Ang Thong National Park, in the Gulf of Thailand.

Distribution : Wua Ta Lap Island; in the Gulf of Thailand.

Diagnosis : Shell sub-discoidal shape, disconnected part of last whorl present, monotonous shell color.

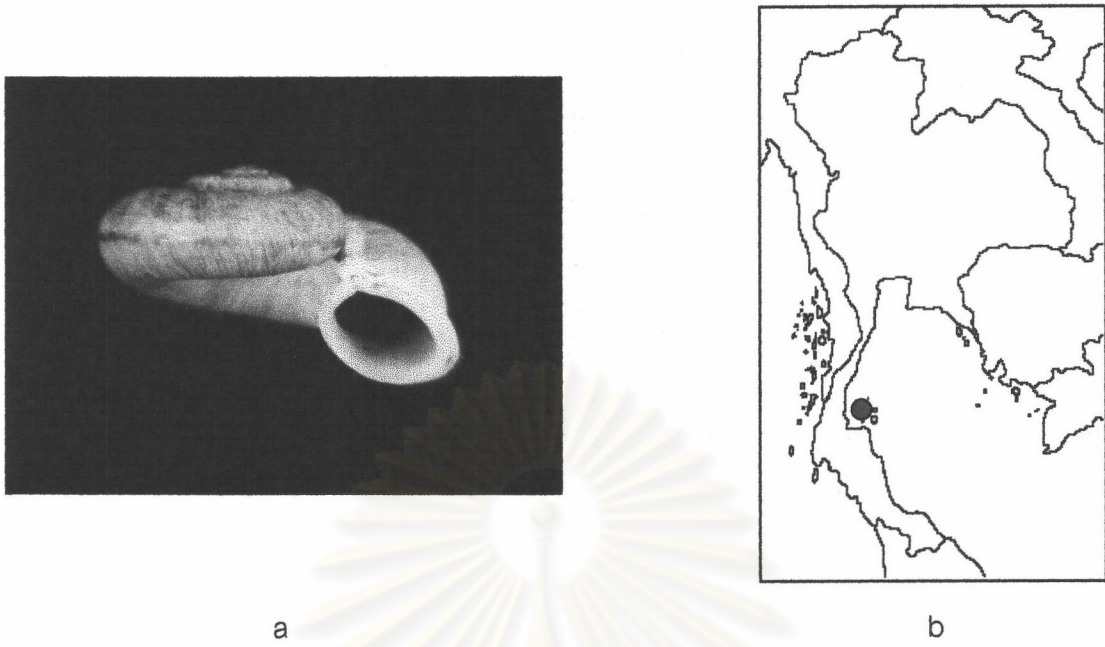


Figure 4.36 a) shell apertural side of *Rhiostroma* sp.7; b) distribution; Wua Ta Lap Island : Gulf of Thailand. (● collected from the present study)

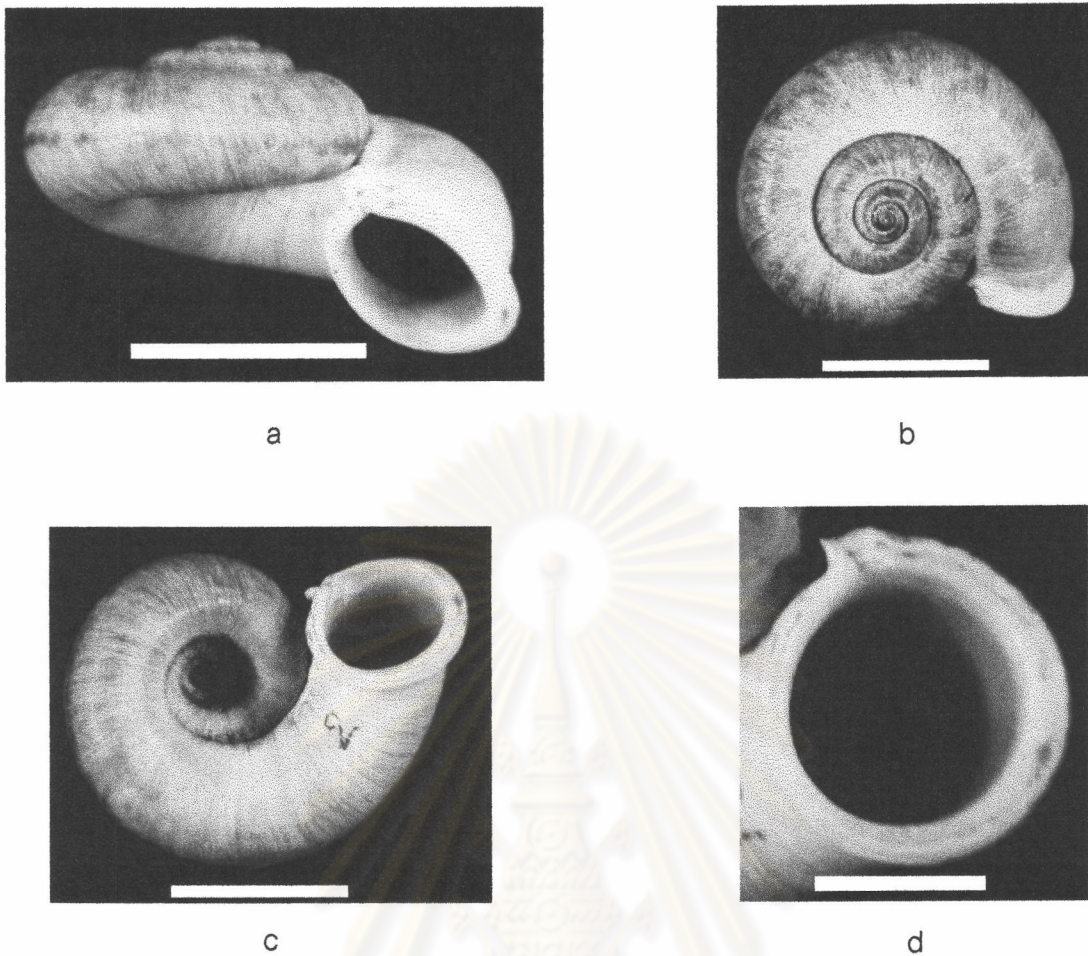


Figure 4.37 *Rhiostroma* sp.7; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; (scale bars : a-c = 10 mm.; d = 5 mm.)

Rhiostoma sp.8

Shell : The shape is sub-discoidal with rounded 5 whorl, solid, widely umbilicate, and flat spire. Disconnected part of last whorl absent or present in maximum distance 7.21 mm., last whorl coiling or turn in, major diameter range 19.64-24.68 mm. and shell height range 11.11-16.44 mm. Shell surface smooth with regular growth lines. Periostracum uninformed because the shell is very erode. Dorsal side of shell present variegate form with brown zigzag pattern on white background, ventral side present uniform in white color. Sub-peripheral band present in brown band. Aperture circular, peristome is thick and interrupt, apertural notch mostly present. Air breathing tube mostly absent but present triangular or tube-like projection. Blunt keel mostly present in shell that disconnected part of last whorl present.

Operculum : Calcaroconeous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : Not seen (only empty shell were found)

Habitat : Shell of *Rhiostoma* sp.8 were found from limestone hills on sacrificing stone and under leaf litter on the ground.

Localities : Khao Samokhon and Khao Ti Hin, Lop Buri.

Distribution : Lop Buri, Central of Thailand.

Diagnosis : Shell sub-discoidal shape, disconnected part of last whorl present, dorsal side of shell variegate, air breathing tube absent.

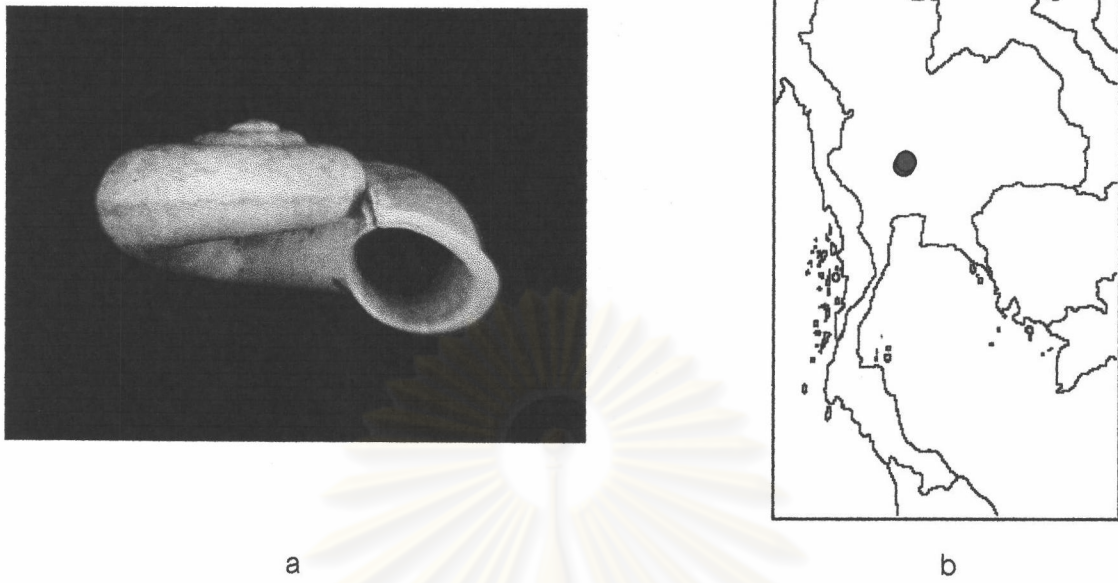


Figure 4.38 a) shell apertural side of *Rhiostroma* sp.8; b) distribution; Lop Buri : Thailand. (● collected from the present study)

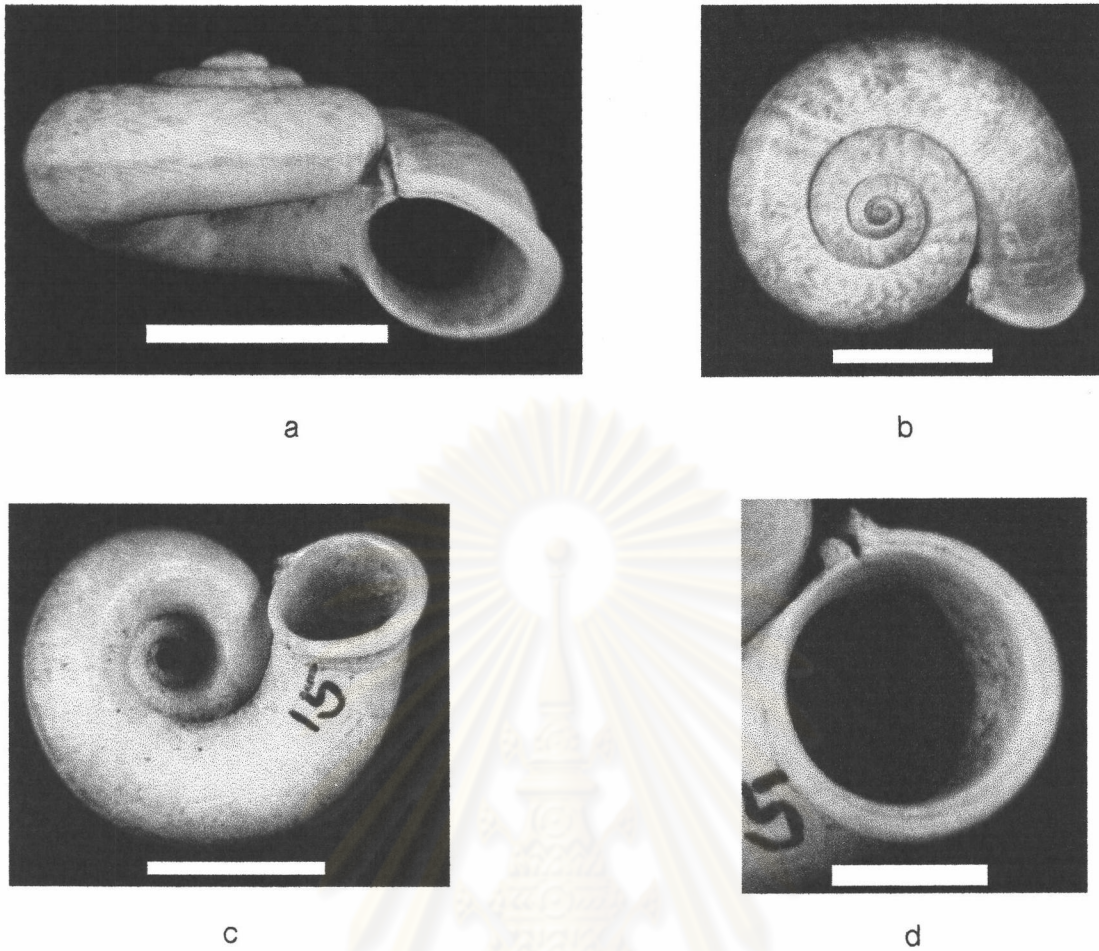


Figure 4.39 *Rhiostroma* sp.8; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; (scale bars : a-c = 10 mm.; d = 5 mm.)

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Rhiostoma sp.9

Shell : The shape is proboscis with rounded 5 whorl, solid, widely umbilicate, and flatted spire. Disconnected part of last whorl present for distance range 6.06-17.11 mm., turn in and downward, major diameter range 16.65-22.49 mm. and shell height range 13.04-19.92 mm. Shell surface smooth with regular growth lines. Periostracum is thin diaphanous in pale yellow or brown in color. Dorsal side of shells are uniform or variegate with brown zigzag pattern on white background, ventral side mostly present uniform. Sub-peripheral band present in dark brown band. Aperture circular, peristome mostly present thick and interrupt, apertural notch mostly present. Air breathing tube mostly absent, triangular projection and blunt keel mostly present.

Operculum : Calcaroconeous, high cylindrical, outside convex, anti-clockwise multispiral.

Body : Not seen (only decaying snails were found)

Radula : Taenioglossate radula sheet contain 7 teeth in each row. Central tooth has 5 cusps, central cusp is pointed linguiform and other cusps are robust serrate shape, the head is convex, the width is longer than the length, ridge connecting is slender. Lateral teeth have 4 cusps, the third cusp is largest in elongate linguiform, the first and the second cusps are digitiform, the fourth cusp is serrate shape, inner basal part is very short but outer part is very long. Marginal teeth turn in, the first marginal teeth have 3 cusps, the second cusp is largest in pointed linguiform, the first cusp is robust digitiform, the third cusp is serrate shape. The second marginal teeth have 4 cusps, the first cusp is digitiform, the second cusp is elongate linguiform, the third cusp is serrate shape, and the fourth cusp is largest in triangular shape.

Habitat : *Rhiostoma* sp.9 were found from Khao Cha-kan under leaf litter at base of limestone hills.

Locality : Khao Wong, Rayong; Khao Cha-kan and Khao Siwa, Sa Kaeo.

Distribution : Rayong and Sa Kaeo; Eastern of Thailand.

Diagnosis : Shell proboscis shape, periostracum sub-diaphanuous, air breathing tube absent, behind apertural projection keel blunt, apertural direction turn in, triangular projection long and sharp.



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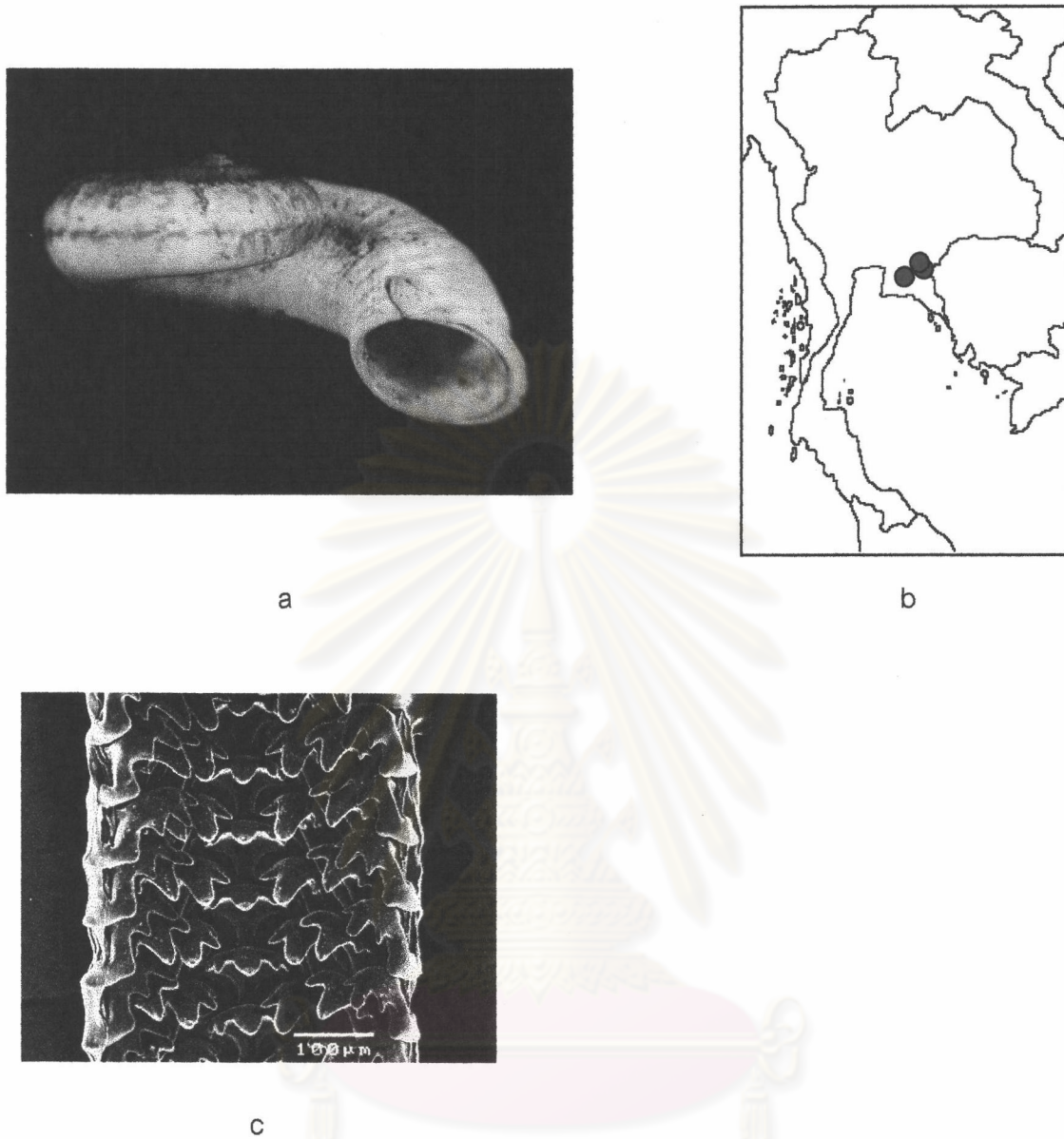


Figure 4.40 a) shell apertural side of *Rhiostoma* sp.9; b) distribution; Rayong; Sa Kaeo : Thailand. (● collected from the present study); c) radula sheet

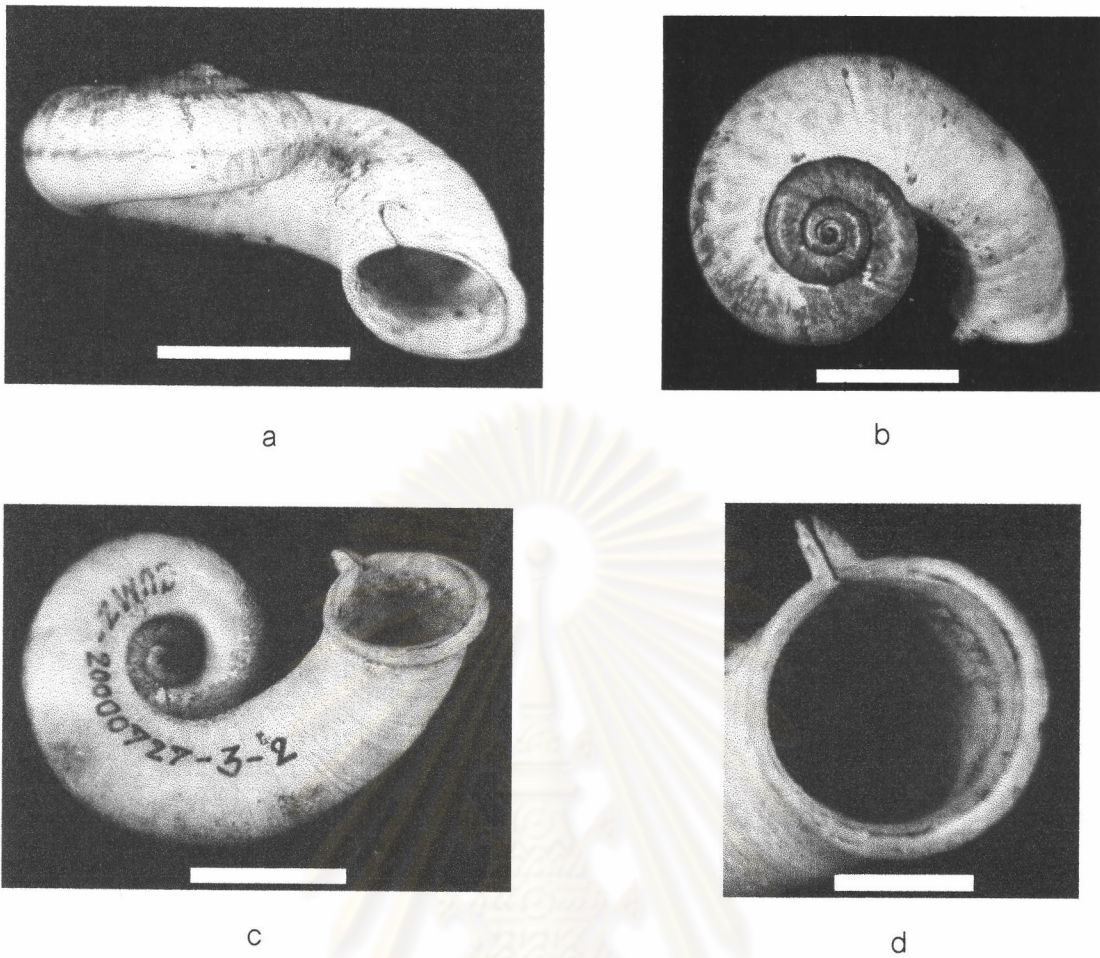


Figure 4.41 *Rhiosstoma* sp.9; a) apertural side; b) dorsal side; c) umbilical side; d) enlarged aperture; (scale bars : a-c = 10 mm.; d = 5 mm.)

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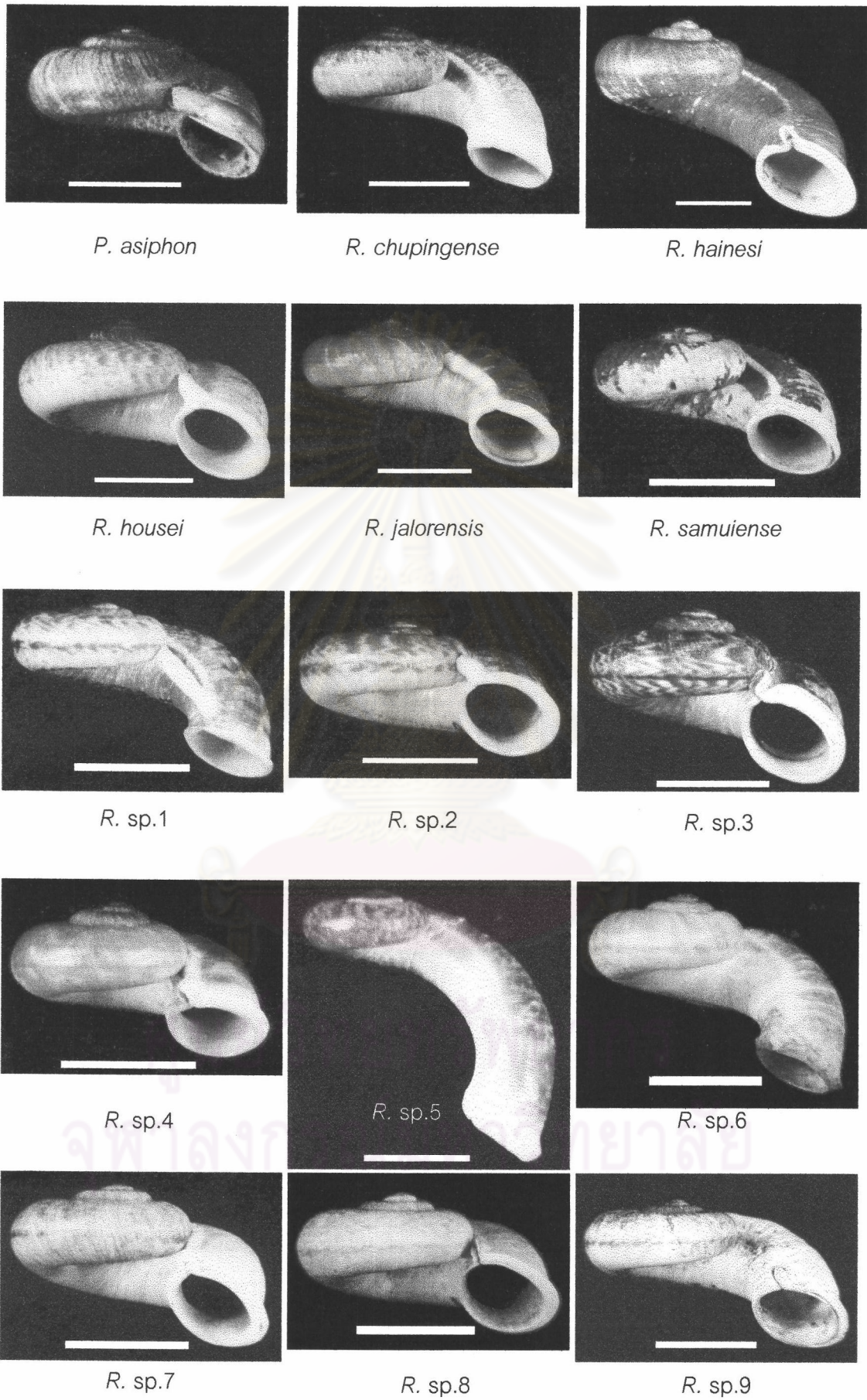


Figure 4.42 Shells at apertural side of 15 Thai rhiostomid snails (scale bars = 10 mm.)

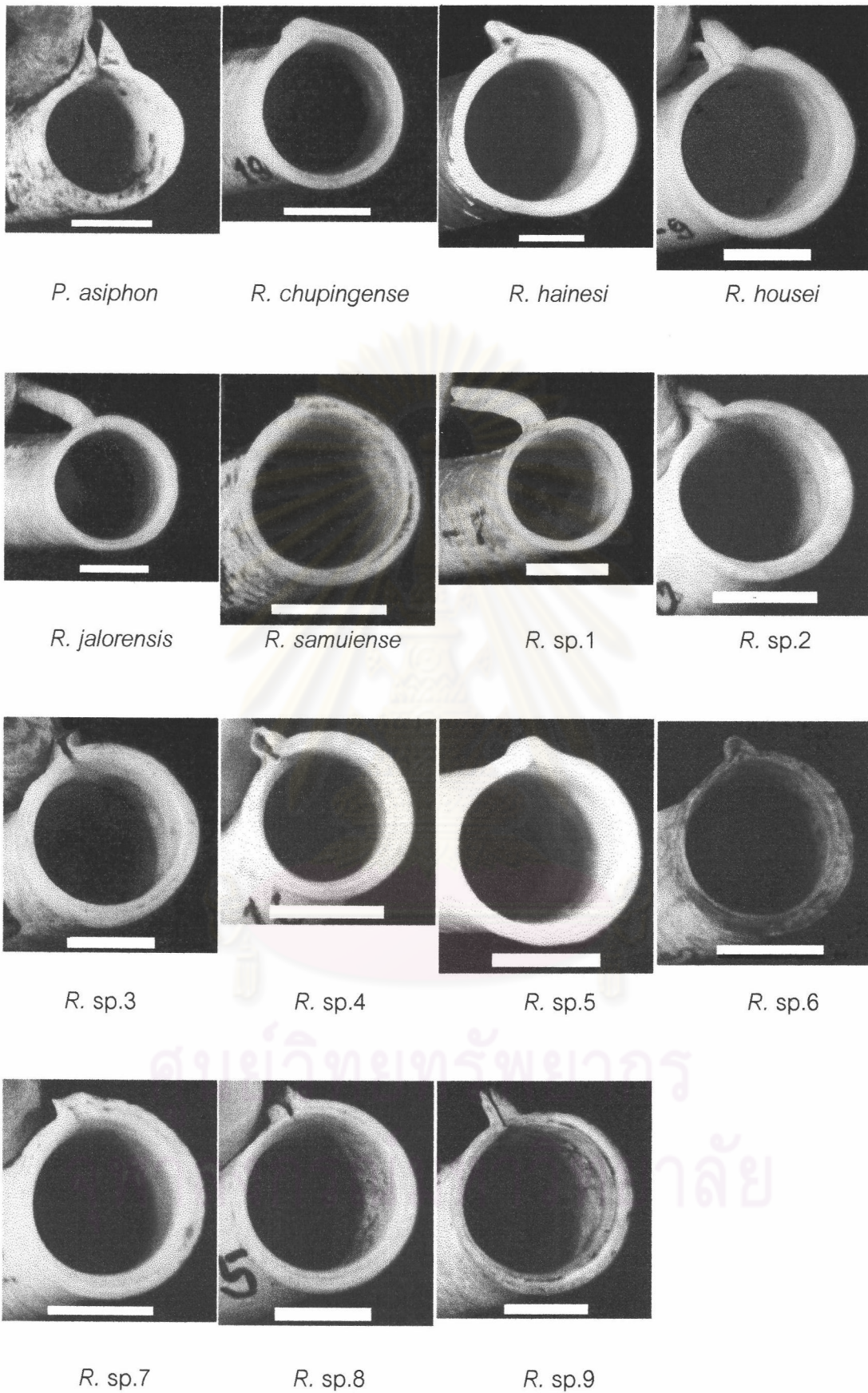


Figure 4.43 Apertures of 15 Thai rhiostomid snails (scale bars = 5 mm.)

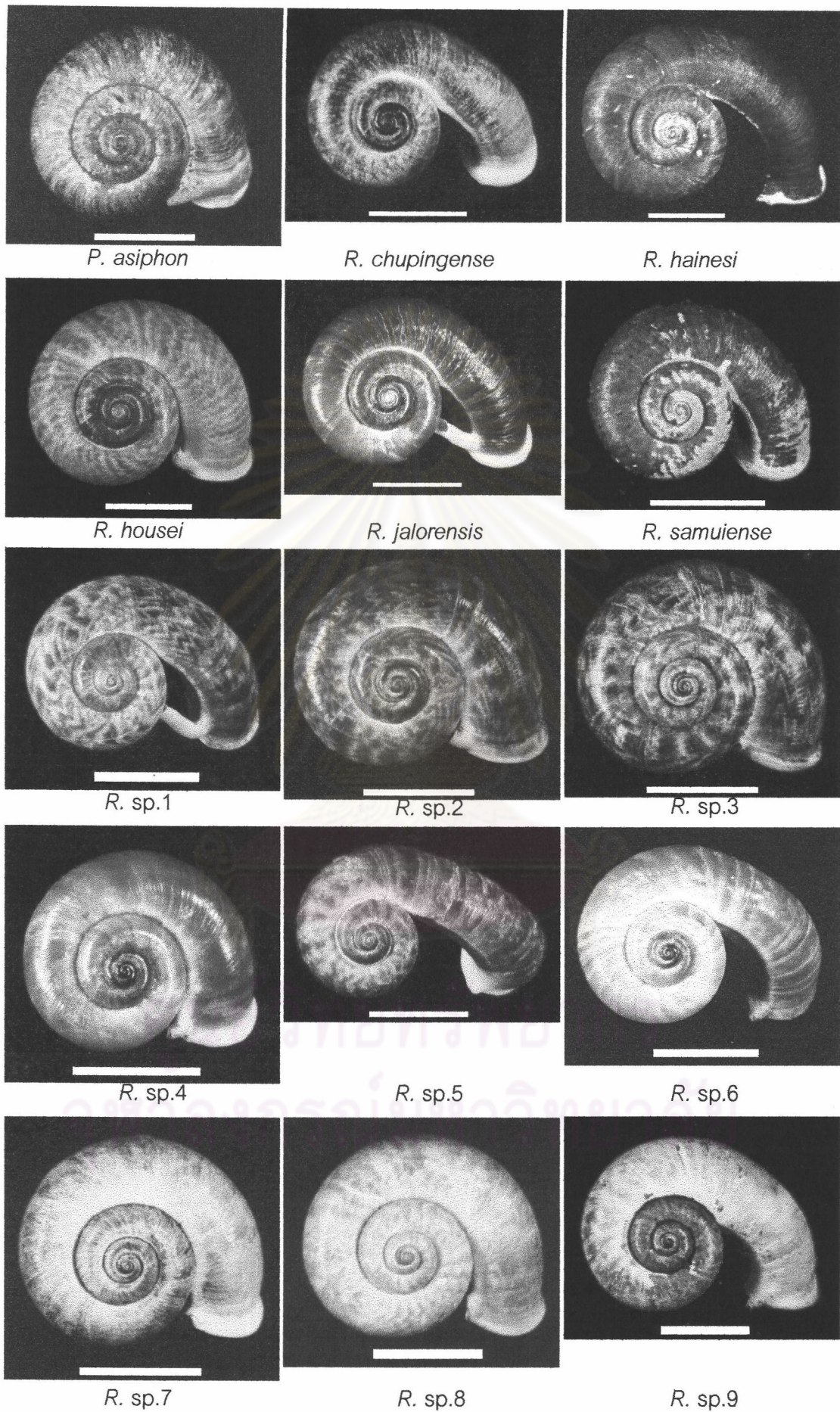


Figure 4.44 Shells at dorsal side of 15 Thai rhiostomid snails (scale bars = 10 mm.)

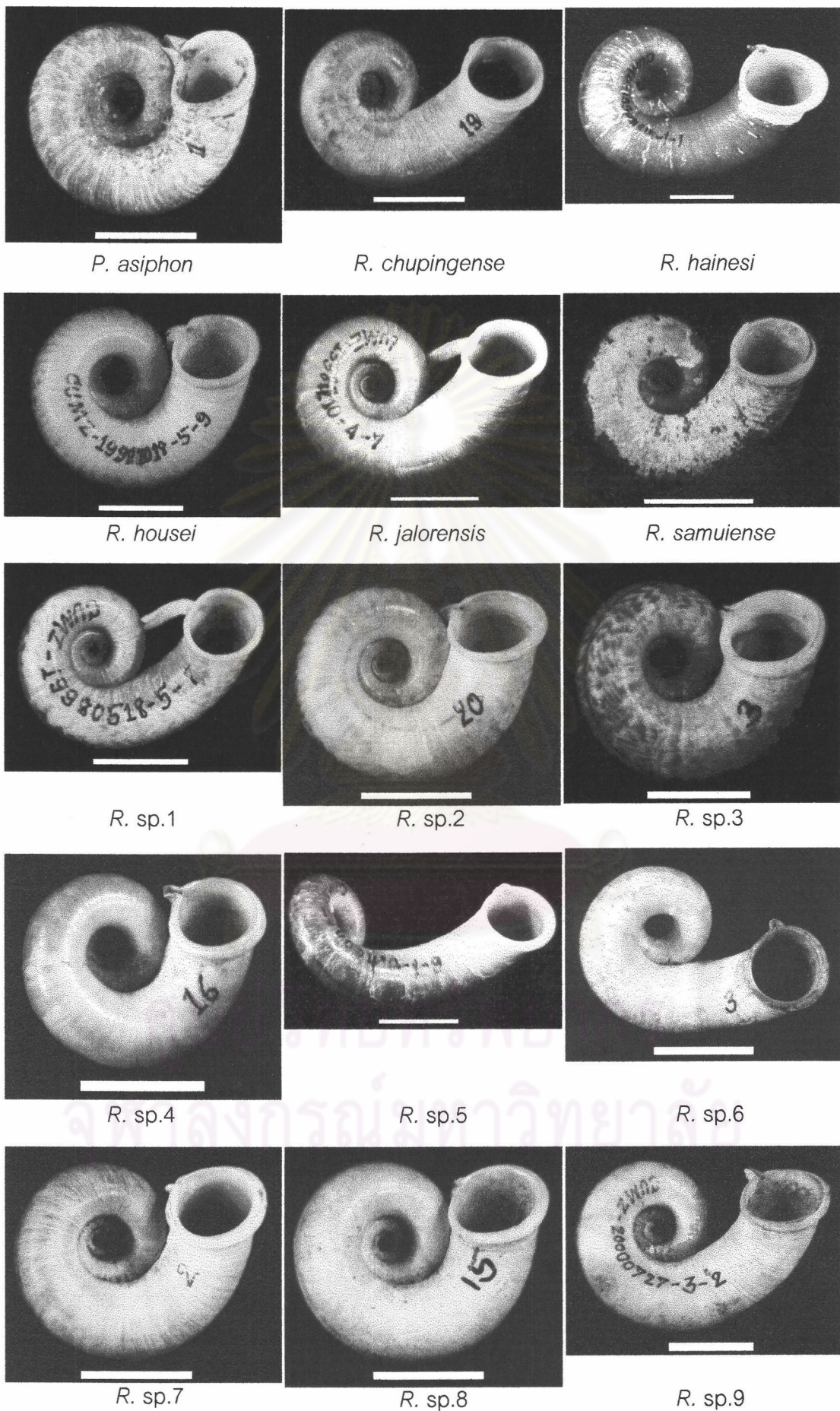


Figure 4.45 Shells at umbilical side of 15 Thai rhiostomid snails (scale bars = 10 mm.)

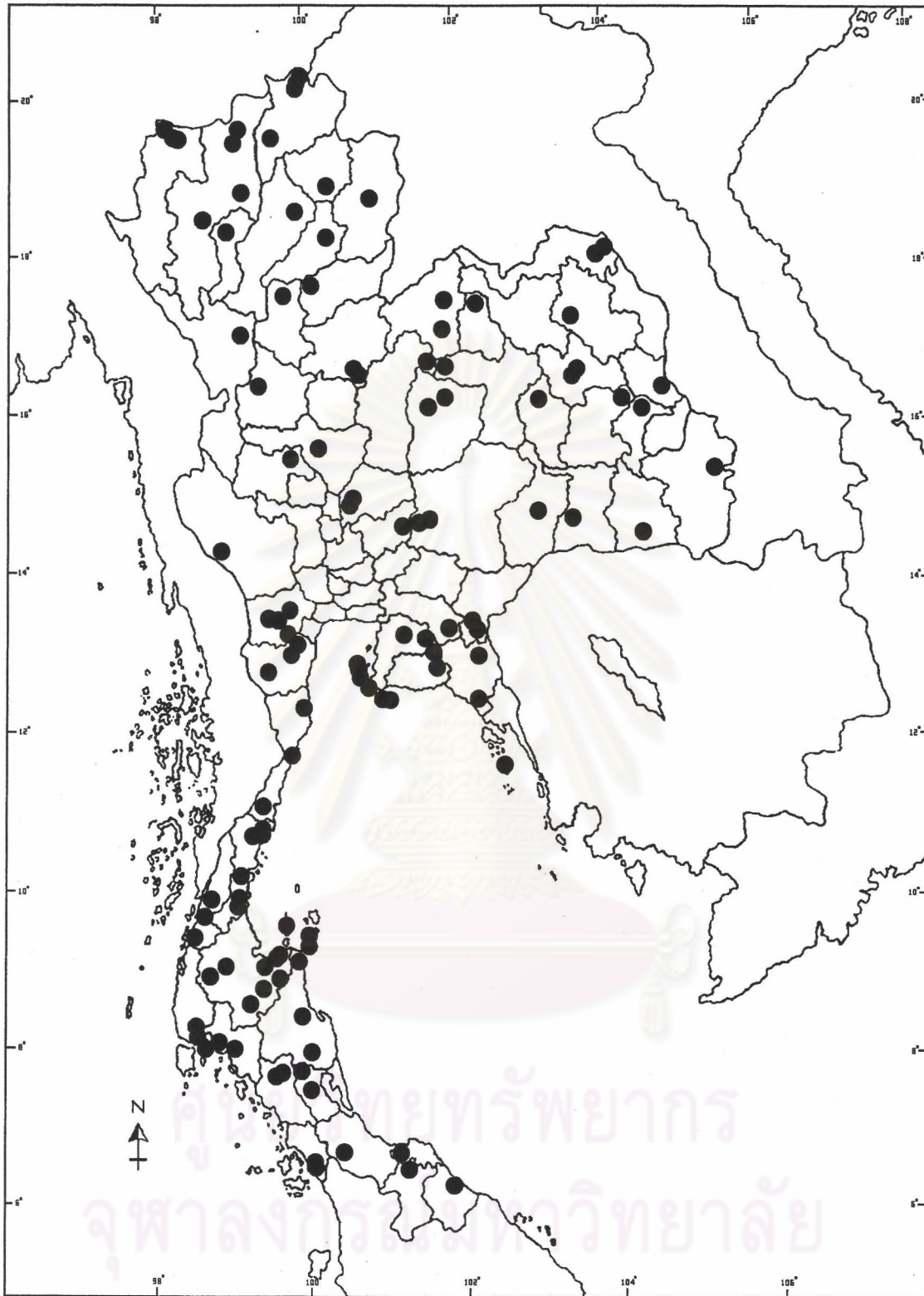


Figure 4.46 Map showing the collected site (●) of the present study

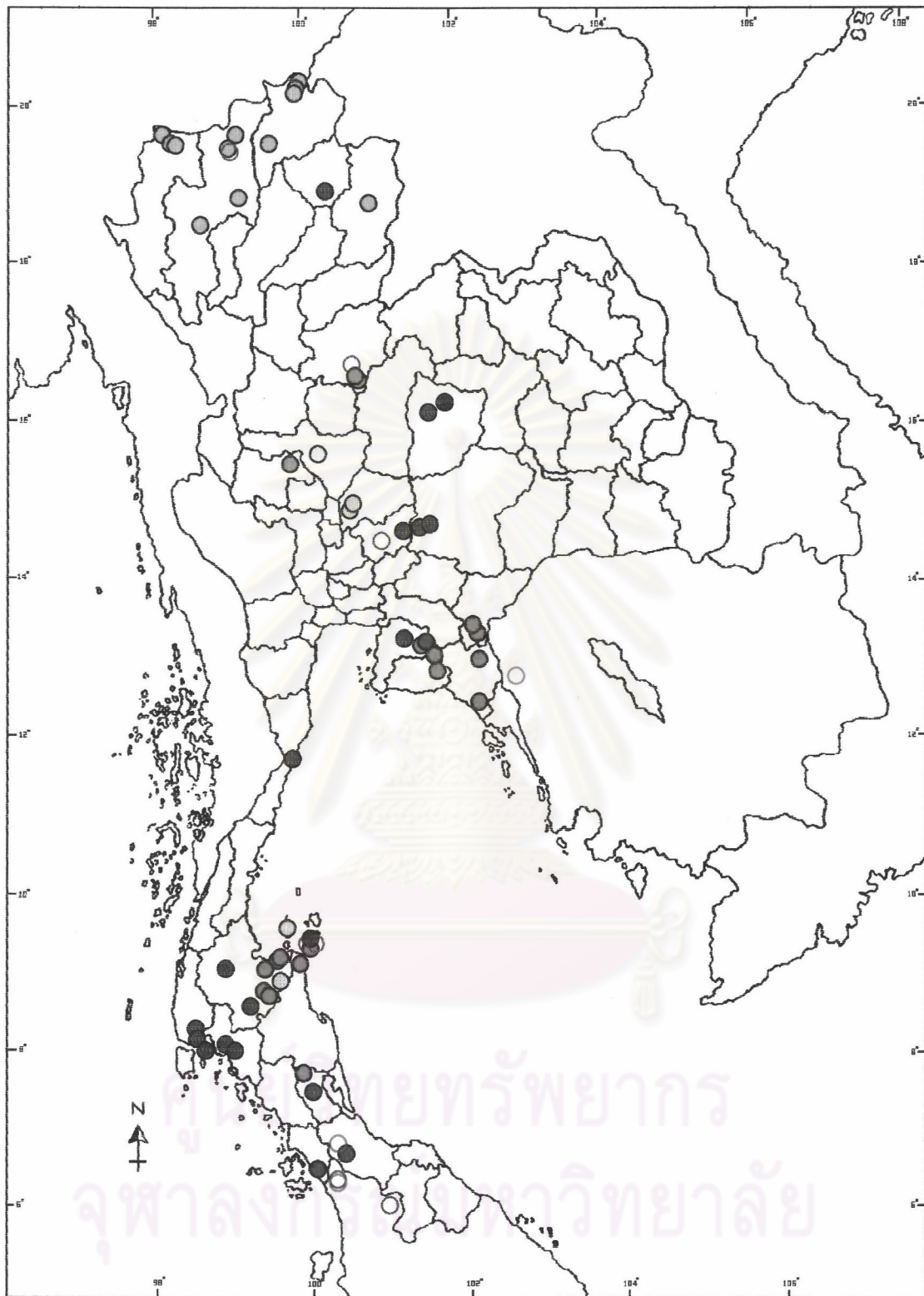


Figure 4.47 Distribution map of Thai riostomid snails

Localities in the present study

- *P. asiphon* ● *R. chupingense* ● *R. hainesi* ● *R. housei* ● *R. jalorensis* ● *R. samuiense*
 ● *R. sp.1* ○ *R. sp.2* ● *R. sp.3* ● *R. sp.4* ● *R. sp.5* ● *R. sp.6* ● *R. sp.7*
 ○ *R. sp.8* ● *R. sp.9*

Localities in literatures

- *P. asiphon* ○ *R. chupingense* ○ *R. hainesi* ○ *R. housei* ○ *R. jalorensis*

Table 4.2 Numbers of shell with shell characteristics variation of 15 Thai rhiostomid snails

Characters	Variation	as	ch	ho	ja	sa	ha	sp1	sp2	sp3	sp4	sp5	sp6	sp7	sp8	sp9
Shell shape	Sub-discoidal	7	-	190	-	-	-	5	100	100	229	-	-	25	41	-
	Proboscis	-	86	-	181	16	68	48	-	-	1	33	29	-	-	39
Periostracum	Sub-diaphanuous	3	23	75	78	-	-	24	98	91	135	6	12	10	-	4
	Opaque	-	3	1	-	11	48	-	-	-	-	-	-	-	-	-
	Periostracum erode	4	60	114	103	5	20	29	2	9	95	27	17	15	41	35
Dorsal side color form	Uniform	3	58	1	96	13	43	3	-	-	124	12	13	14	-	13
	Variagate	3	5	158	12	-	14	42	100	100	25	11	4	-	8	18
	Shell erode	1	23	31	73	3	11	8	-	-	81	10	12	11	33	8
Ventral side color form	Uniform	7	76	146	101	14	56	16	97	1	86	27	26	15	2	22
	Variagate	-	-	10	4	-	1	29	3	99	63	-	3	-	-	5
	Shell erode	-	10	34	76	2	11	8	-	-	81	6	-	10	39	12
Disconnected part of last whorl	Absent	7	-	1	-	-	-	-	49	98	56	-	-	6	10	-
	Present	-	86	189	181	16	68	53	51	2	174	33	29	19	31	39
Apertural direction	Turn in	7	86	190	181	16	68	53	100	100	230	6	29	25	41	39
	Turn down	-	-	-	-	-	-	-	-	-	-	27	-	-	-	-
Total specimens		7	86	190	181	16	68	53	100	100	230	33	29	25	41	39

Table 4.2 Numbers of shell with shell characteristics variation of 15 Thai riostomid snails (continue)

Characters	Variation	as	ch	ho	ja	sa	ha	sp1	sp2	sp3	sp4	sp5	sp6	sp7	sp8	sp9
Apertural notch	Absent	-	16	2	5	-	-	-	-	6	12	6	2	1	1	1
	Present	7	70	187	175	16	68	53	100	94	210	26	27	23	40	38
	Shell broken	-	-	1	1	-	-	-	-	-	8	1	-	1	-	-
Air breathing tube	Absent	4	86	11	2	16	55	7	17	98	174	33	29	25	40	35
	Present	3	-	177	176	-	13	46	83	2	56	-	-	-	1	4
	Tube broken	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-
Behind apertural projection keel	Blunt	-	84	23	178	16	92	16	51	2	23	33	1	13	24	38
	Sharp	-	2	162	3	-	1	37	-	-	137	-	28	5	1	1
	Disconnected part of last whorl absent	7	-	5	-	-	-	-	49	98	67	-	-	7	16	-
Peristome	Thicken	7	81	189	181	16	10	52	100	100	230	33	29	24	41	31
	Broadly expand	-	3	-	-	-	53	-	-	-	-	-	-	1	-	8
	Intermediate	-	2	1	-	-	5	1	-	-	-	-	-	-	-	-
Swell ridge behind peristome	Absent	-	86	190	181	16	68	53	100	100	230	33	29	25	41	39
	Present	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total specimens		7	86	190	181	16	68	53	100	100	230	33	29	25	41	39

Shell morphological key to species of Thai Rhiostomid snails.

1. A. Shell sub-discoidal shape.....2
B. Shell proboscis shape.....8
2. A. Disconnected part of last whorl absent.....3
B. Disconnected part of last whorl present.....4
3. A. Swell ridge behind peristome absent.....*Rhiostoma* sp.3
B. Swell ridge behind peristome present.....*Pterocyclus asiphon*
4. A. Dorsal side of shell uniform.....5
B. Dorsal side of shell variegate.....6
5. A. Monotonous shell color.....*Rhiostoma* sp.7
B. Dorsal side of shell brown and ventral side white color.....*Rhiostoma* sp.4
6. A. Air breathing tube absent.....*Rhiostoma* sp.8
B. Air breathing tube present.....7
7. A. Air breathing tube incomplete.....*Rhiostoma* sp.2
B. Air breathing tube complete.....*Rhiostoma housei*
8. A. Periostracum sub-diaphanuous.....9
B. Periostracum opaque.....14
9. A. Air breathing tube absent.....10
B. Air breathing tube present.....13
10. A. Behind apertural projection keel blunt.....11
B. Behind apertural projection keel sharp.....*Rhiostoma* sp.6
11. A. Apertural direction turn in.....12
B. Apertural direction turn down.....*Rhiostoma* sp.5
12. A. Triangular projection short and blunt.....*Rhiostoma chupingense*
B. Triangular projection long and sharp.....*Rhiostoma* sp.9
13. A. Dorsal side of shell uniform.....*Rhiostoma jalorensis*
B. Dorsal side of shell variegate.....*Rhiostoma* sp.1
14. A. Shell robust and peristome broadly expand.....*Rhiostoma hainesi*
B. Shell slender and peristome thicken.....*Rhiostoma samuiense*

Morphometric Analysis

From raw data in Appendix III, 8 measured characters of 1011 shells from 15 species were transformed to ratios by using MI value with other values. ANOVA Duncan's multiple rang test ($p < 0.05$) were employed to analyzed and groupd.

Canonical Discriminant Analysis was arranged to classify rhiostomid snails (Figure 4.48).

Cladistic analysis

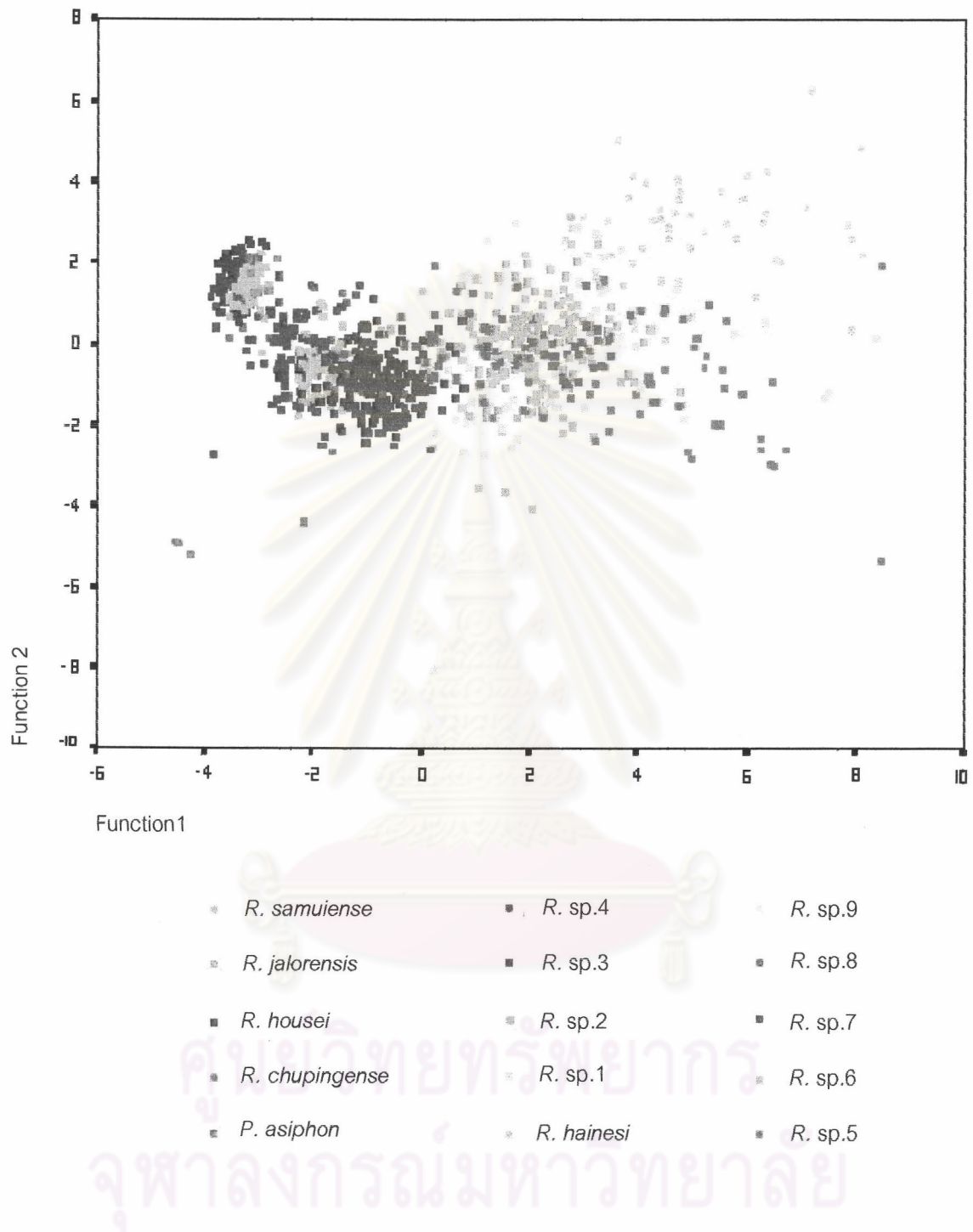
The analysis of these data set produces one parsimonious tree of 39 steps (consistency index of 0.64 and a rotation index of 0.57). The strict consensus tree is shown in Figure 4.49.



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

SPECIES	MI/MA	SW/MA	SH/MA	AH/MA	SP/MA	IA/MA	OA/MA	AP/MA
<i>R. housei</i>	0.8443 ¹	1.1681 ³	0.6783 ³	0.4843 ²	0.1937 ³⁴	0.3522 ³	0.4688 ³	0.3561 ³
<i>R. sp.7</i>	0.8449 ¹²	1.1038 ²	0.6069 ¹²	0.4167 ¹	0.1902 ²³⁴	0.1369 ²	0.2100 ²	0.3336 ²
<i>R. chupingense</i>	0.8477 ¹²³	1.3481 ⁵	0.7875 ⁵	0.6185 ⁴	0.1688 ¹	0.5534 ⁵	0.8186 ⁵	0.3825 ⁴
<i>R. hainesi</i>	0.8480 ¹²³	1.5329 ⁷	1.0390 ⁷	0.8209 ⁶	0.2125 ⁵⁶	0.7960 ⁷	1.2871 ⁹	0.4452 ⁶
<i>R. sp.4</i>	0.8497 ¹²³	1.1056 ²	0.6485 ²³	0.4310 ¹	0.2173 ⁶	0.1771 ²	0.2482 ²	0.3162 ¹
<i>R. sp.1</i>	0.8501 ¹²³	1.3774 ⁵⁶	0.8237 ⁵	0.6475 ⁴	0.1770 ¹²	0.6543 ⁶	0.8910 ⁵⁶⁷	0.3862 ⁴
<i>R. sp.2</i>	0.8522 ¹²³⁴	1.0979 ¹²	0.6022 ¹	0.4111 ¹	0.1919 ²³⁴	0.1219 ²	0.1706 ²	0.3353 ²
<i>R. jalorensis</i>	0.8526 ¹²³⁴	1.3700 ⁵⁶	0.8296 ⁵	0.6453 ⁴	0.1877 ²³⁴	0.5827 ⁵	0.8473 ⁵⁶	0.3897 ⁴
<i>R. sp.9</i>	0.8529 ¹²³⁴	1.3856 ⁵⁶	0.8315 ⁵	0.6539 ³	0.1783 ¹²³	0.5873 ⁵	0.9295 ⁶⁷	0.3929 ⁴
<i>R. sp.3</i>	0.8550 ²³⁴⁵	1.0620 ¹	0.6231 ¹²	0.4001 ¹	0.2230 ⁶	0.0031 ¹	0.0044 ¹	0.3375 ²
<i>R. samuiense</i>	0.8559 ³⁴⁵	1.2916 ⁴	0.7294 ⁴	0.5632 ³	0.1672 ¹	0.4449 ⁴	0.6760 ⁴	0.3874 ⁴
<i>R. sp.8</i>	0.8613 ⁴⁵	1.0977 ¹²	0.5906 ¹	0.4135 ¹	0.1852 ²³⁴	0.1637 ²	0.2461 ²	0.3096 ¹
<i>R. sp.5</i>	0.8616 ⁴⁵	1.6858 ⁸	1.0309 ⁷	0.8671 ⁷	0.1638 ¹	0.9560 ⁸	1.1487 ⁸	0.4097 ⁵
<i>R. sp.6</i>	0.8639 ⁵	1.3999 ⁶	0.8941 ⁶	0.7011 ⁵	0.1933 ²³⁴	0.6876 ⁶	0.9373 ⁷	0.3597 ³
<i>P. asiphon</i>	0.8858 ⁶	1.1049 ²	0.6165 ¹²	0.4175 ¹	0.1990 ⁴⁵	0.0000 ¹	0.0000 ¹	0.3594 ³

Table 4.3 Result of Duncan's multiple range test. (show mean value, superscript number mean group number, colorful alphabet mean unique group)



Canonical Discriminant Functions

Figure 4.48 Analysis of all measured characters of 15 Thai rhiostomid species by Canonical

Table 4.4 Character states of 14 species of *Rhiostoma* and 1 *Pterocyclus*

Species	Character states				
<i>Pterocyclus asiphon</i>	10?00	01??0	11100	11100	0110
<i>Rhiostoma chupingense</i>	20001	01000	01111	11001	0111
<i>Rhiostoma housei</i>	10101	01110	01110	11001	0010
<i>Rhiostoma jalorensis</i>	20001	01100	01111	00001	0110
<i>Rhiostoma samuiense</i>	21001	01100	01111	00001	0110
<i>Rhiostoma hainesi</i>	21?01	11?00	01111	10001	0111
<i>Rhiostoma</i> sp.1	201?1	011?0	01111	11001	1111
<i>Rhiostoma</i> sp.2	1010?	01100	01111	10001	1110
<i>Rhiostoma</i> sp.3	10110	01000	01111	110??	0111
<i>Rhiostoma</i> sp.4	100??	01?10	01111	10001	0110
<i>Rhiostoma</i> sp.5	20??1	01001	0111?	?????	????
<i>Rhiostoma</i> sp.6	20?01	01010	01111	100??	?010
<i>Rhiostoma</i> sp.7	1000?	010?0	0111?	?????	????
<i>Rhiostoma</i> sp.8	1010?	01000	0111?	?????	????
<i>Rhiostoma</i> sp.9	20?01	01000	01111	100??	????
<i>Cyclophorus volvulus</i>	00110	000?0	0000?	???11	0000

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

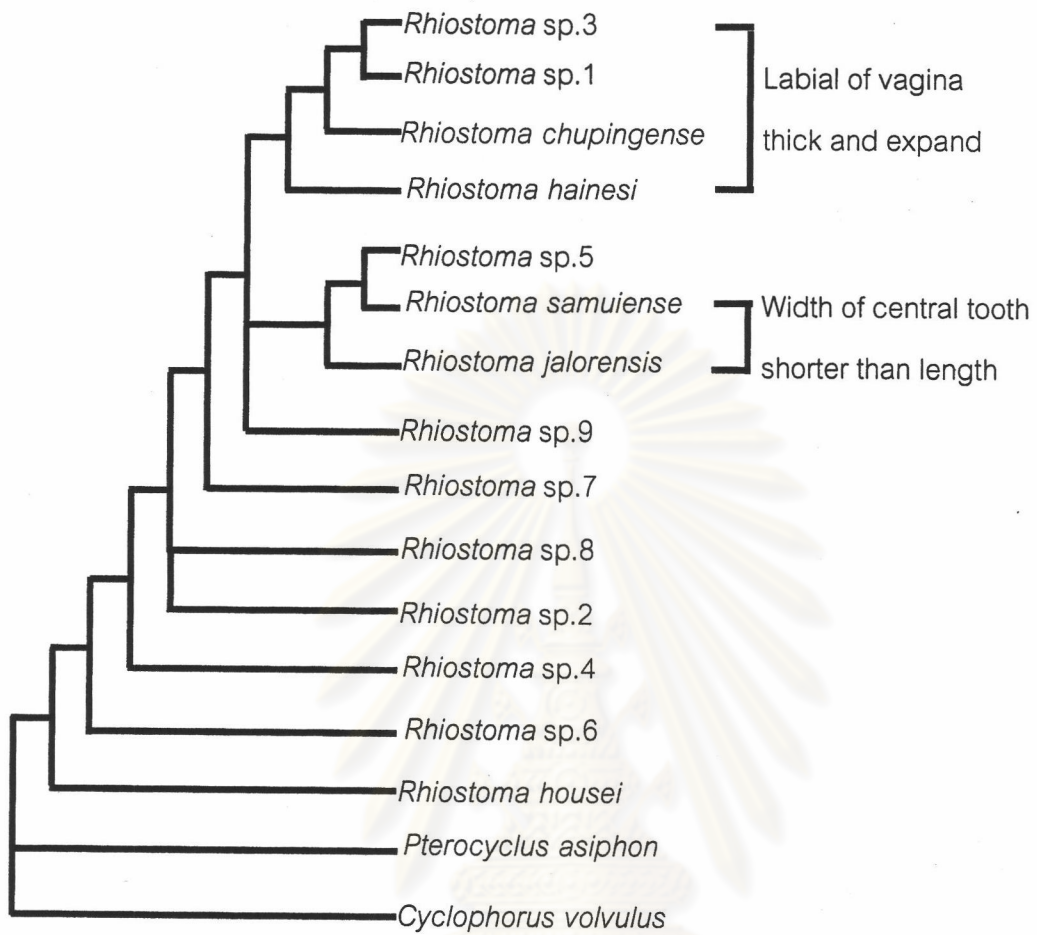


Figure 4.49 The strict consensus tree from cladistic analysis

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย