Occasional Papers On Mollusks

Published by
THE DEPARTMENT OF MOLLUSKS
Museum of Comparative Zoölogy, Harvard University
Cambridge, Massachusetts

APRIL 30, 1945 NUMBER 2

The Philippine Intermediate Snail Host (Schistosomophora quadrasi) of Schistosomiasis[1]

By R. T. ABBOTT, LIEUTENANT (jg) H(S), USNR[2]

This is a preliminary report on the Philippine freshwater snail, *Schistosomophora quadrasi* Moellendorff, which is responsible for the spread of the Oriental blood fluke, *Schistosoma japonicum* Katsurada. The snail serves as a host for the larval trematode from the miracidium to the human infective cercarial stage. Drawings in this paper were made from live specimens at the National Institute of Health in Bethesda, Maryland, and most dried material studies were made at the Museum of Comparative Zoölogy at Harvard University (Dr. Tubangui's material). Aid and advice were liberally forthcoming from the Division of Mollusks at the United States National Museum.

Genus **Schistosomophora** *Bartsch*

Schistosomophora Bartsch 1936, Smiths. Misc. Coll., **95**, no. 5, p. 29. Genotype, *Prososthenia quadrasi* Mlldff. (Surigao, Mindanao, Philippines).

Schistosomophora quadrasi *Moellendorff*

Plates 2–5, all figures

Prososthenia quadrasi Moellendorff 1895, Nachrichtsbl. Deutsch. Malak. Ges., **27**, p. 138. (Surigao, Mindanao, Philippines).

---

[1] The opinions expressed in this article are those of the author and are not to be construed as official or reflecting the views of the Navy Department, or of the Naval Service at large.

[2] Preventive Medicine Division, Bureau of Medicine and Surgery, Navy Department.

Blanfordia quadrasi Moellendorff, Tubangui 1932, Philippine Journ. Sci., **49,** no. 2, pp. 298-301, pl. 5, figs. 1a-b, pl. 2, fig. 3.

Oncomelania hydrobiopsis Rensch 1932, Philippine Journ. Sci., **49,** pp. 551-552, figs. 1a-c (Palo, Leyte, Philippine Islands).

Oncomelania quadrasi Moellendorff, Rensch 1933, Philippine Journ. Sci., **50,** p. 325.

Oncomelania quadrasi Moellendorff, Bequaert 1934, Journ. Parasit., **20,** p. 281.

Schistosomophora quadrasi Moellendorff, Bartsch 1936, Smiths. Misc. Coll., **95,** no. 5, pp. 31-32, pl. 1, fig. 8, pl. 2, fig. 5, pl. 3, fig. 1.

Schistosomophora hydrobiopsis Rensch, Bartsch 1936, Smiths. Misc. Coll., **95,** no. 5, pp. 32-33, pl. 1, fig. 7, pl. 2, fig. 6, pl. 3, fig. 2.

Blanfordia quadrasi Moellendorff, Tubangui and Pasco 1941, Philippine Journ. Sci., **74,** no. 4, pp. 302-324.

Schistosomophora quadrasi Moellendorff, Bartsch 1939, Volumen Jub. pro Prof. Sadao Yoshida, Osaka, **2,** pp. 644-645.

Description of shell. Adult shell about 4.5 to 6 mm. in length, elongate-ovate, thin, color a translucent chocolate brown to light brown (often covered by black pond slime), with a thin, very dark brown color line around the peristome or entire mouth border. Nuclear whorls (developed in egg mass) two in number, rounded, glassy, appearing minutely granulated under magnification. Postnuclear whorls (developed after hatching) regularly increasing in size, rounded, with the body or last whorl more than 3/5 of the total length of the shell. Extremely fine axial sculpture of slightly retractively slanting lines of growth. Spiral sculpture seldom visible. Suture between whorls well indented. Base of body whorl short, rounded, with a narrow, slit-like umbilicus. There is a slight thickening of the outer lip just behind the aperture into a callus or weak varix. Aperture broadly ovate, slightly expanded, slightly reflected. Parietal wall slightly glazed. Interior of aperture light chocolate brown. Periostracum absent. Operculum very thin, transparent, paucispiral with eccentric nucleus and two to three whorls. Scar of muscular attachment about half the area of the operculum.

Animal (Plate 3, figs. 1-6) small, with a simple foot, underside of which is broad and short, rounded behind and truncate in front. Anterior edge of foot with a narrow, fairly deep mucous slit. Foot often carried in life with a longitudinal fold of flesh along the midline of the side of the foot. Head relatively small,

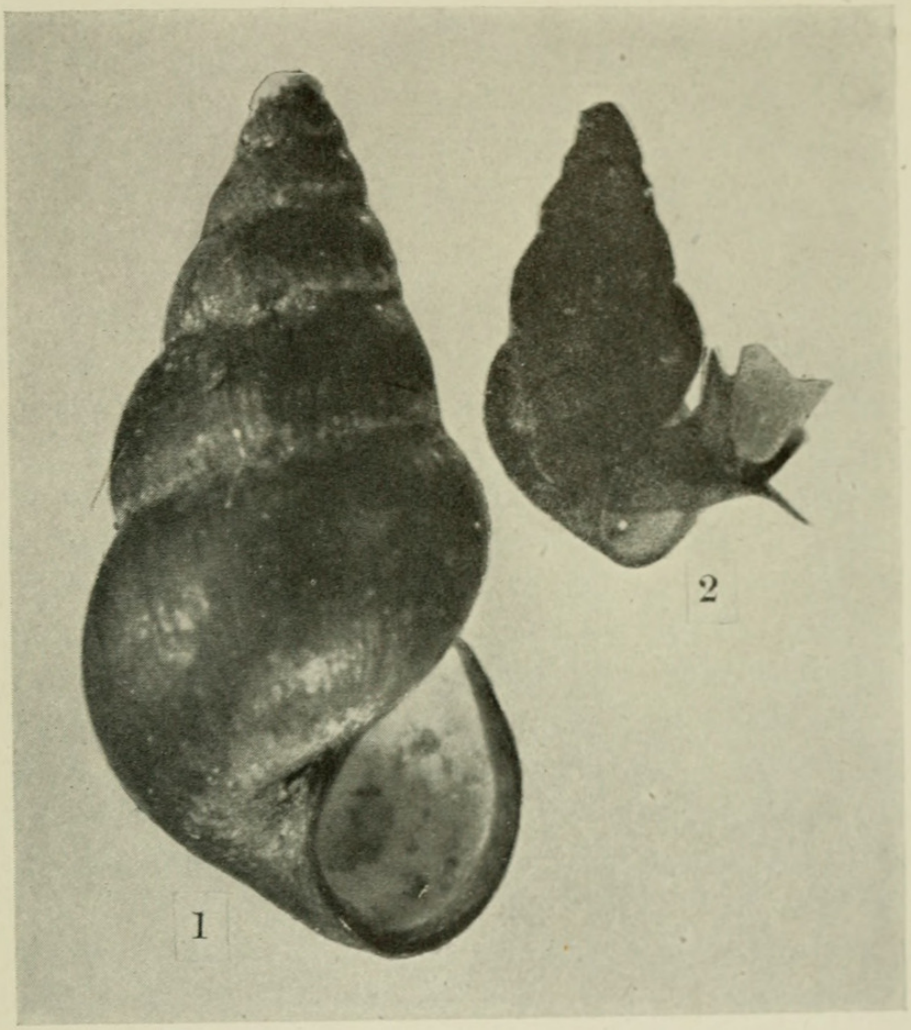

Plate 2. *Schistosomophora quadrasi* Mlldff. Fig. 1. Shell from Samar Island, Philippines, about 17x. Fig. 2. View of live animal, about 9x (both Navy photographs).

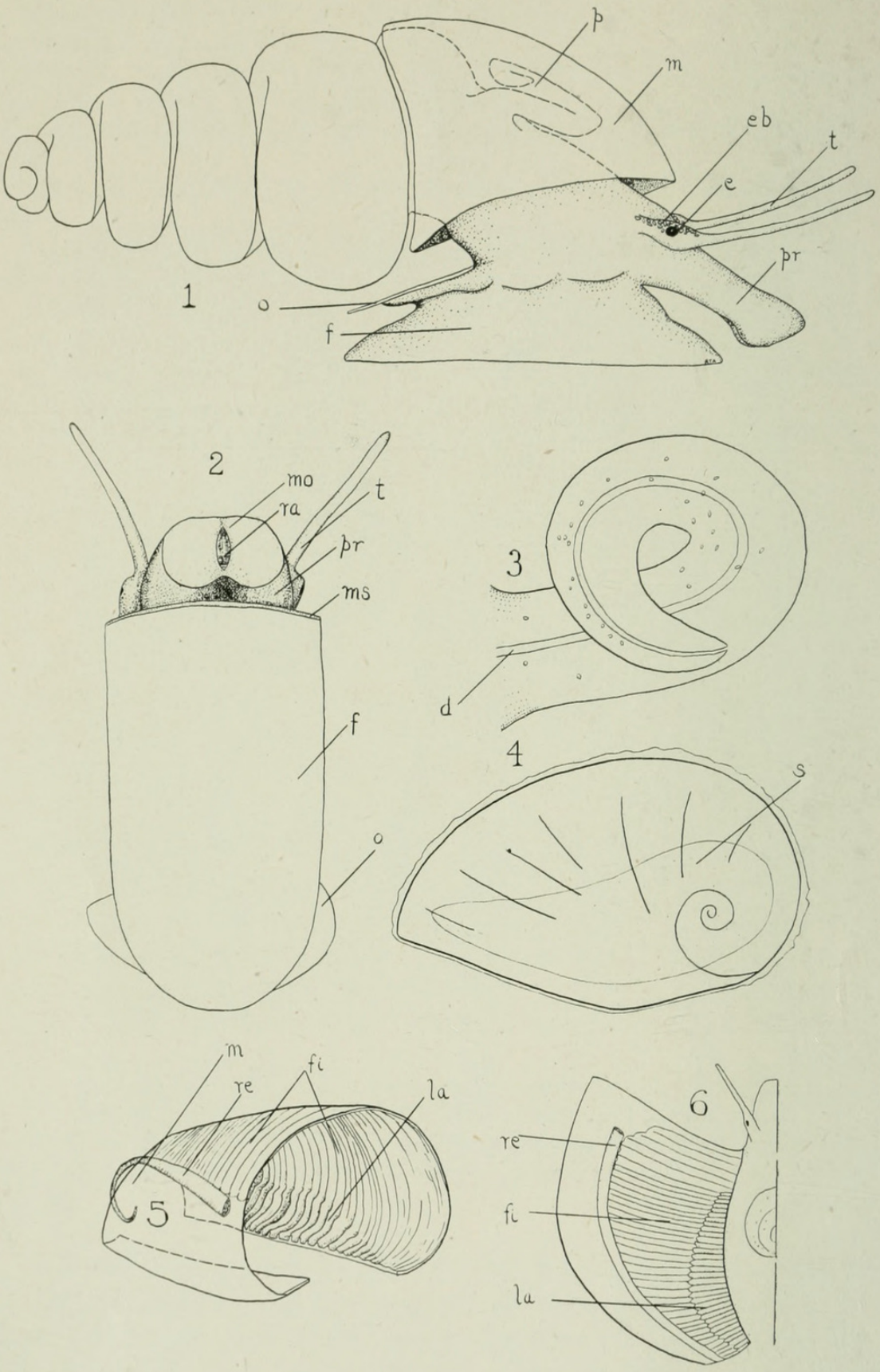

Plate 3. (Explanation of plate on opposite page.)

proboscis or snout blunt, short, bilobed in front. Single tentacle on each side of head simple, slender, swollen at the base where the eye is located. In male specimens, the verge or penis is located well behind the head on the dorsal side of the body and on the midline. It is far enough back to be obscured by the mantle. Penis simple with a single functional spermduct, translucent yellowish, slightly flattened dorsally, rounded ventrally and tapering gradually towards the rounded distal end, carried in a sinistral, single-coil position. Mantle thin with a slightly thickened border. In females the mantle border just opposite the "vaginal" opening is capable of being puckered into a funnel-shaped notch.

Color of animal in general a dark blackish gray. The most distinguishing color markings are the bright splotching of yellow, granular-like dots over each eye forming false "eyebrows." In detail: underside of foot gray, peppered with minute white dots. Sides of foot and body grayish with a heavy suffusion of minute black dots. A few yellow or white dots are sometimes present on the sides of the upper body and dorsal side of the forefoot. There is a suffusion of white dots on the inside of the mantle opposite the anal and "vaginal" openings. Eyes jet black with a tiny clear lens. Proboscis sandy gray-black with a reddish tinge caused by the buccal "cartilages" inside. Interior of mouth at the anterior end of the proboscis reddish. During feeding, the glint of the glass-like teeth of lingual ribbon or radula may be seen. Tentacles translucent gray intermingled with tiny gray dots. The feces of healthy animals are small, compact, hen's egg in shape, and may be seen through the shell lined up in the rectum in the last two or three whorls. Under a bright light and magnification, the edges and folds of the body and foot give off a beautiful metallic blue sheen.

Plate 3. Fig. 1. Side view of living animal with shell removed in drawing. Fig. 2. Underside of foot and head. Fig. 3. Verge or penis of male. Fig. 4. Operculum, top side. Fig. 5. Looking back under the mantle showing gills on left wall. Fig. 6. Dorsal view of animal with right side of mantle cut and laid back to show gills and rectum attached to inside of mantle.

d=sperm duct; *e*=eye; *eb*=yellow "eyebrow" color granules; *f*=foot; *fi*=gill filaments or para-ctenidial folds; *la*=gill lamella; *m*=mantle; *mo*=mouth; *ms*=mucous slit; *o*=operculum; *p*=penis; *pr*=proboscis or snout; *ra*=radula ribbon; *re*=rectum; *s*=muscular attachment scar; *t*=tentacle.

Variations in animal noted were a case of one female with a split or double-tipped right tentacle, and variation in the amount of yellow coloring over the eyes.

Variation in shells is considerable in several characters in adult specimens from the same locality, nearby localities and distant localities on other islands. Measurements of the number of whorls, length and width of shell were made on twenty or more specimens from eight lots (5 specimens only from Surigao) with the following results: (largest shell = length 6.4 mm.; width 3.2 mm.).

Locality	Whorls average number	Length average	Width average	Length divided by width (average)
Surigao, Mindanao	5.8	5.7 mm.	2.8 mm.	2.03
Jabonga, Agusan, Mindanao	6.4	4.8	2.5	1.92
Palo, Leyte (1935)	6.2	4.7	2.5	1.88
Palo, Leyte (1945)	6.1	5.0	2.4	2.08
Dagami, Leyte	6.3	4.9	2.7	1.81
Calbiga, Samar	5.9	4.3	2.4	1.79
Naujan, Mindoro	6.4	5.0	2.5	2.00

These differences indicate that this species varies in stoutness and length with little or no correlation with its geographical distribution. After adequate field study, it may be found that local ecological conditions are responsible. Other variations of the same nature include size of lip thickening or varix, predominence of minute axial sculpturing, thinness of shell, shape of operculum, and number of whorls in the nucleus of the operculum. There is no sexual difference detectable in the shells of five females and three males examined.

Radula. The lingual ribbon or radula is situated in the buccal cavity in close association with the buccal cartilages. There are about 70 rows of teeth on the ribbon which is held together by a thin, transparent membrane bearing two side wings (Plate 4, figs. 2 and 3). Each row consists of a single rachidian (or central) tooth flanked closely on each side by first a lateral (or median) tooth, then an inner (or first) marginal and lastly by an outer (or second) marginal tooth. Each tooth bears a char-

acteristic number of tiny denticles. Radula counts in this paper refer to the number of denticles on each tooth. The usual count on the rachidian tooth for this species is two small denticles on each side of a single large denticle on the top edge of the tooth and three small basals on each lower side (written thus: $\frac{2\text{-}1\text{-}2}{3\text{-}3}$. (Plate 4, fig. 1).

A study of every tooth on several ribbons revealed a varying frequency in the denticle counts. From anterior end of ribbon to the posterior growing end, the variation in the upper or front edge of the rachidians were: first 10 teeth, 2-1-2; next 6, 1-1-2; next 2, 2-1-2; next 7, 2-1-1; next 13, 2-1-2; next 7, 2-1-1; last 20, 2-1-2. The basals varied from 3-3 in the first half of the ribbon gradually to 2-2 in the last half. Lateral counts 2-1-3 mostly, a few 1-1-3, a few 3-1-3. Inner marginal tooth 9 mostly, some 8. Outer marginal 7, 6 mostly, a few 5.

It is evidently unsound to create species or genera, at least in this group, on the basis of denticle counts which vary as much as they do. Chinese workers have found this same type of radula variation in *Oncomelania* and *Katayama*.

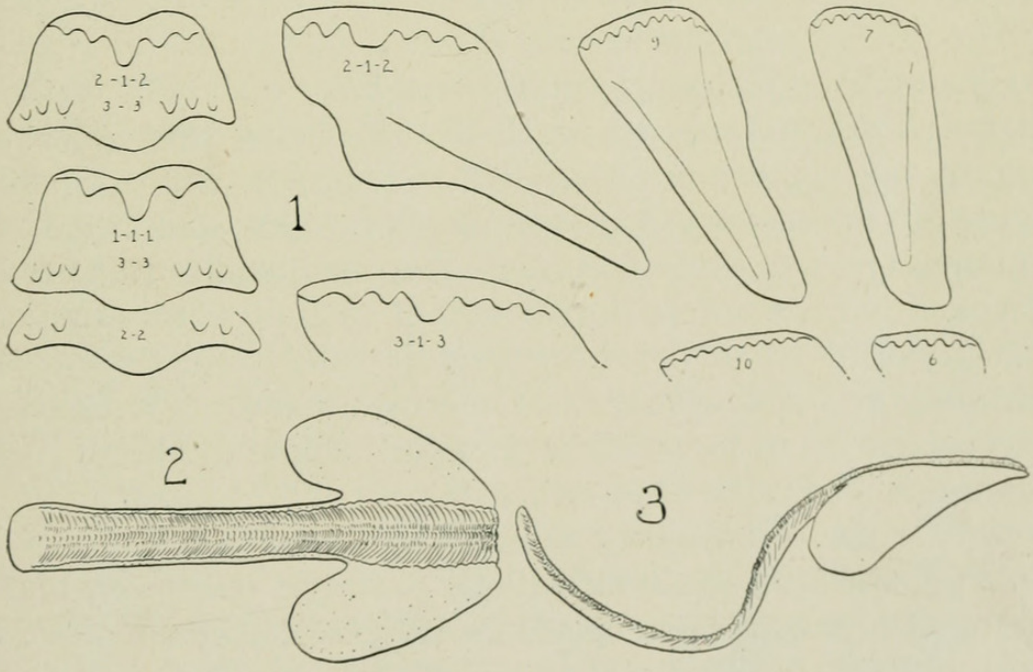

Plate 4. Fig. 1. Radula (left to right: rachidian, lateral, inner marginal, outer marginal). Top row, most frequent counts encountered. Middle row, extreme variation in rachidian from Samar Island. Bottom row, infrequent counts. Fig. 2. Dorsal view of entire lingual ribbon showing transparent membrane. Fig. 3. Side view. Anterior end on the right.

The gills or ctenidia consist of a series of 40 to 50 low, narrow lamellae or plate-like flesh folds which are attached to the inner left side of the mantle. The gills stretch across the mantle only as far as the rectum which is also welded to the mantle. The lamellae extend up on the mantle for a short distance and then flatten out into indistinct filaments or para-ctenidial folds which are closely welded to the mantle (Plate 3, figs. 5 and 6).

The pharynx in the proboscis contains two, paired flattish buccal "cartilages" tinged with a reddish brown pigment (slightly visible externally through the wall of the proboscis). Salivary glands sac-like, paired and lying along the sides of the oesophagus with the ducts leading forward and into the pharyngeal cavity. The oesophagus leads back into the body and joins the stomach which is in the posterior part of the body whorl. The brownish spotted hepato-pancreas or "liver" extends from the apical (tip) region of the shell down to the penultimate whorl. The rectum, after passing down through the last four whorls (paralleling the uterus in females) comes forward fused to the right side of the mantle. The bean-shaped pericardial sac or heart in the body whorl contains the auricle and ventricle.

The central nervous system (Plate 5, figs. 1 and 2) is strikingly similar to Robson's figure (Ann. Mag. Nat. Hist. (9) **8**, p. 401) of *Katayama nosophora* Robson, differing only in having a long and slender supra-intestinal ganglion (as in Heude's figure of *Oncomelania hupensis* Gredler. Mém. Hist. Nat. Emp. Chinois, **1**), three instead of four labial and ocular area nerves arising from the antero-dorsal area of each cerebral ganglion, and a pair of small nerves arising dorsally from each of the para- and pro-podial ganglia. The inner labial nerve splits in two not far from its cerebral ganglial origin, unlike in *Katayama* and similar to *Oncomelania.*

Only scanty information is available to date on the eggs of *Schistosomophora quadrasi* Mlldff. A single, small egg and a clump of four eggs have been seen under aquarium conditions.

Habitat and Habits. Amphibious, remaining out of water for long periods of time attached to moist, shaded grass, banks of ditches, wooden pilings, and in the area of rice fields. Prefers water of a slightly acid pH. Early Japanese workers found that

specimens of *Katayama nosophora* Robson were killed in a one per cent solution of lime in 24 hours. In the Katayama District of Japan, 75 to 85% of the snail population was eliminated in a 0.1% solution of lime. Copper carbonate would be effective in small ditches and ponds.

The animal is a continual browser in and out of water, and has a tendency to move upwards out of water. The mode of locomotion is in the form of a sliding, not loping, motion.

Trematode Parasite. Schistosomophora quadrasi was first implicated as the intermediate host of *Schistosoma japonicum* Katsurada in 1932, by M. A. Tubangui (Philippine Journ. Sci., **49,** pp. 295-304, pls. 1-5). Subsequent workers from 1934 to 1945 have substantiated this discovery. Until 1945 no other species of snail has been known to be a vector of this disease in the Philippines.

Locality Records. Philippines—MINDANAO: Surigao (United States National Museum and Museum of Comparative Zoölogy); Jabonga, Agusan Prov. (MCZ). LEYTE: Palo (USNM and MCZ); Dagami (MCZ). SAMAR: Calbiga (MCZ). MINDORO: Naujan (MCZ).

Range. (To date). Northern Mindanao, eastern Leyte, all of Samar, eastern Mindoro. Not reported from Luzon as yet. Wading birds might possibly be a mode of spreading this species, since the animal is able to withstand weeks of desiccation and might by chance be carried adhering to the feet of waders.

Nomenclature. Rensch recognized in a brief note (Philippine Journ. Sci. **50,** 1933, p. 325) that his *Oncomelania hydrobiopsis* of 1932 is identical with *Prososthenia quadrasi* Mlldff. Bequaert in 1934 concluded on the basis of paratypes of *P. quadrasi* Mlldff. in the M.C.Z. collection that *O. hydrobiopsis* Rensch was a synonym. Two years later, Bartsch maintained the two species were distinct on the basis of a single, stout paratype and on the basis of a difference of one denticle count on the outer marginal radula. That specimen is found now by Bartsch to fall well within the limits of variation of the specimens from all four islands.

A discussion of generic position or generic validity is not

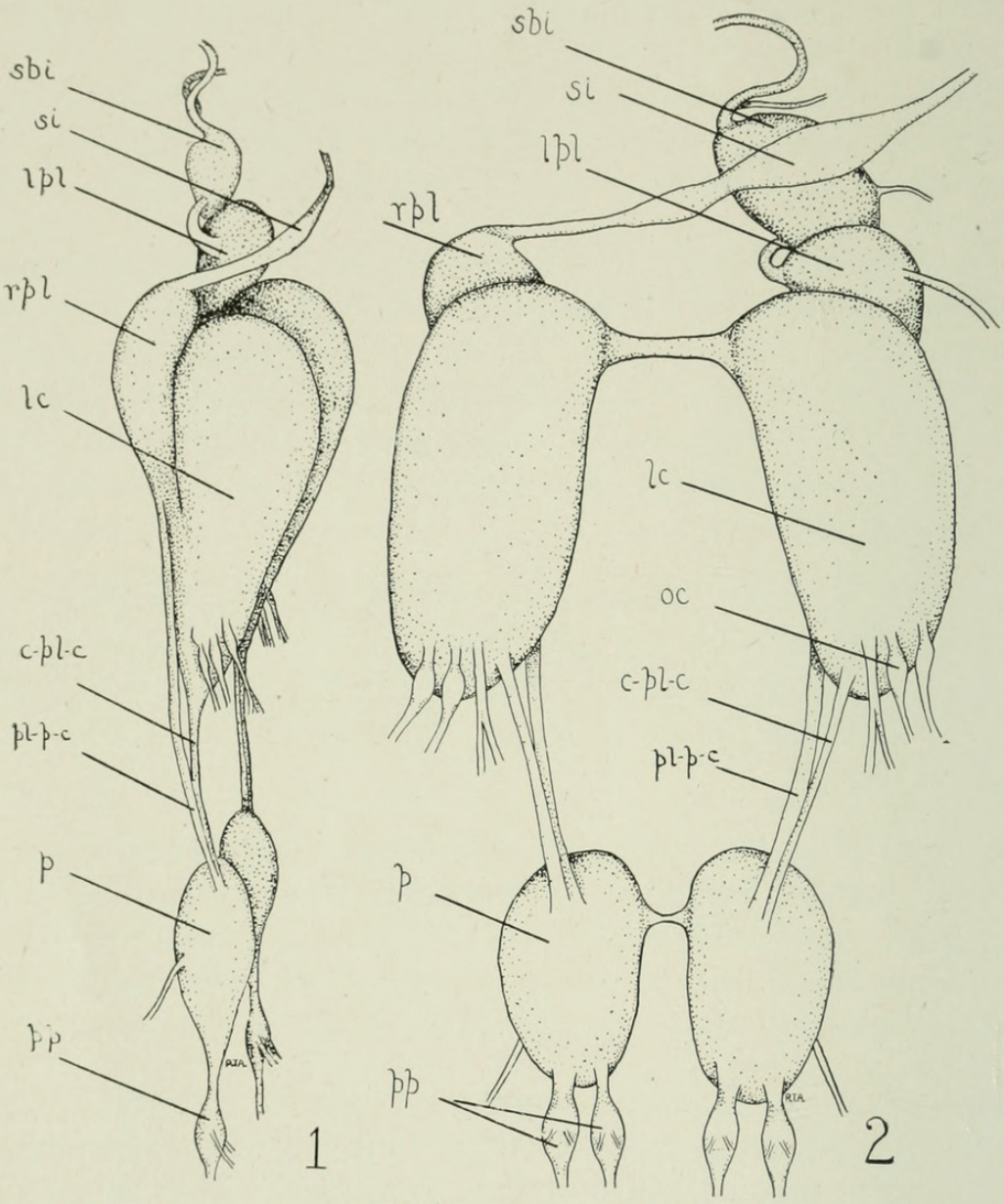

Plate 5. Central Nervous System. Fig. 1. Right side view. Fig. 2. Dorsal view (both slightly spread).

c-pl-c=cerebro-pedal connective; *lc*=cerebral ganglion; *lpl*=left pleural ganglion; *oc*=ocular, tentacular and labial nerve group; *p*=right pedal ganglion; *pp*=parapodial and propodial ganglia; *pl-p-c*=pleural-pedal connective; *rpl*=right pleural ganglion; *sbi*=sub-intestinal ganglion; *si*=supra-intestinal ganglion.

given in this paper, pending observations on live Japanese and Chinese material.

Note on Identification

Proper identification of the snail intermediate host and a greatly increased knowledge of its geographical distribution are highly important, as schistosomiasis is endemic only in places where the mollusk is found. In the Philippines the snail host can be confused with a small land mollusk, *Lamellaxis* (*Allopeas*) *gracilis* Hutton which has *no operculum*, and with young melanid snails which have beautiful, *heavy sculpturing* on the early whorls. Every effort is being made by malacologists to render quick identifications as accurately as possible.

Acknowledgments

The author wishes to express his gratitude to the many people and institutions that have given so generously of their time, efforts, and material. For general malacological information, the United States National Museum and its shell workers, Dr. Paul Bartsch, Dr. J. P. E. Morrison and Dr. Harald Rehder. For live snails, the National Institute of Health and Dr. W. H. Wright, Dr. Myrna Jones, and Dr. Eloise Cram. For information on trematodes, Johns Hopkins School of Hygiene and Public Health and Dr. W. W. Cort and Dr. G. F. Otto. For records and notes, the Academy of Natural Sciences, Philadelphia, and Dr. Horace B. Baker. For a study collection and general malacological information, the Museum of Comparative Zoölogy at Harvard College and its research workers, Dr. Joseph Bequaert and Mr. William J. Clench.