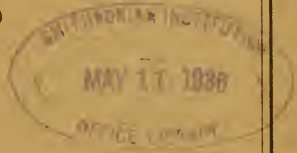


SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 95, NUMBER 5

MOLLUSCAN INTERMEDIATE HOSTS OF THE
ASIATIC BLOOD FLUKE, SCHISTOSOMA
JAPONICUM, AND SPECIES CONFUSED
WITH THEM

(WITH EIGHT PLATES)



BY

PAUL BARTSCH

Curator of Mollusks and Cenozoic Invertebrates,
U. S. National Museum



(PUBLICATION 3384)

CITY OF WASHINGTON
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INTRODUCTION

The importance which certain groups of insignificant-looking, small mollusks possess, because they have been proved to serve as intermediate hosts in part of the life history of parasites that in their adult stage affect man or his domestic animals, is demonstrated by the number of pages that have been devoted to them in the medical, scientific, and popular press.

Prior to the discovery of the Japanese blood fluke of man, *Schistosoma japonicum* Katsurada, by Miyairi and Suzuki in 1913, and the working out of its life history in Japan, little attention was paid to the mollusks serving as intermediate hosts for that dire disease-producing organism. In fact, the species involved in the Japanese Empire were unknown to science at the time.

The brilliant researches by Japanese investigators were the first to make known definitely that an intermediate host problem existed in schistosomiasis. These and other studies demonstrated that an inconspicuous amphibious mollusk shared with man, the dog, cat, cattle, and rat, an ailment that may affect, as recorded by Faust (48, p. 432), a hundred million inhabitants of China, as well as many in Japan and a lesser number in Formosa and the Philippines.

The molluscan material from the Asiatic continent and off-lying islands, particularly the inconspicuous fresh-water animals, had up to this time received scant attention. They had little to commend them to humanity at large, and the number of molluscan students collecting them were few and their endeavors restricted to limited localities. It is therefore not surprising that our knowledge of them was as fragmentary as it proved to be at the time that schistosomiasis in Japan came to the fore. Even now, as this paper will show, the subject is not exhausted, but enough information is at hand to point a way for future exploration in the molluscan field and to show its medical importance.

I believe most of the medical men who have to deal with Asiatic schistosomiasis and particularly the control problem connected therewith have chafed, to say the least, under the inconsistency of names used in the writings of the intermediate host students. But they should consider this to be in the nature of growing pains.

The mixed concepts which the molluscan pages reveal are undoubtedly due to the lack of adequate material for comparative study, the authors adding small fragments from time to time as these became available. It seems to me that now we have sufficient adequately preserved material in the collections of the United States National Museum of almost all the forms to attempt an exhaustive comparative study.

I have given a separate historical account and discussion under each genus here considered, feeling that this will prove most helpful to the workers occupying the definite areas inhabited by these animals. This will enable them to recognize more readily the species involved in the intermediate host problem of Asiatic schistosomiasis and to exonerate some innocents.

There are many people to whom acknowledgment should be made for helpfulness in making this endeavor as complete as it is. First I should mention those who have contributed material. Among these are, outstandingly, Dr. H. A. Pilsbry, of the Philadelphia Academy of Natural Sciences, Dr. Fu-ching Li, of Honan University, Kaifeng, Honan, China, Dr. Y. T. Yao, Director of the Central Field Health Station, National Government of the Republic of China, Dr. E. A. Faust, of Tulane University, New Orleans, La., Dr. H. E. Meleney, Vanderbilt University, Nashville, Tenn., Dr. Sado Yoshida, Pathological Institute, Osaka Imperial University, Osaka, Japan, Dr. Mary N. Andrews, of the Henry Lester Institute of Medical Research, Shanghai, China, and many others, particularly the early molluscan collectors whose efforts are recorded with material in the collection of the United States National Museum, outstanding among whom are von Möllendorff, Quadras, and A. Adams.

I am also indebted to the members of my staff, Dr. J. P. E. Morrison, who has made the radula and opercula preparations and supervised the careful drawing thereof by our artist, Mrs. Aime M. Awl, and to Dr. Harald A. Rehder for much helpfulness.

The four genera here discussed are *Blanfordia*, *Katayama*, *Oncamelania*, and *Schistosomophora*.

The species of *Blanfordia*, as far as known, are innocent of taking a part in schistosomiasis. The name, however, has been erroneously applied to the true menace in Japan, Formosa, and parts of China.

It is deemed wise here to give reasons why a clean bill of health is bestowed upon them.

The most important genus, as far as Asiatic schistosomiasis is concerned, is *Katayama*, which ranges from southern Japan through Formosa, to Canton, China.

In China by far the most important intermediate hosts are the various species of *Oncomelania*, all of which, whether technically demonstrated as intermediate hosts or not, should be looked upon as a potential menace.

The last genus, *Schistosomophora*, established in this paper, includes the newly demonstrated host of *Schistosoma* in the southern Philippines; one species not yet a demonstrated host is found in the Island of Honshu, Japan.

I will now give a series of keys which I believe will prove helpful to students in the identification of these genera.

KEY TO THE RADULAE OF THE GENERA OF THE INTERMEDIATE HOSTS
OF SCHISTOSOMA JAPONICUM

- Rachidian tooth 3-cusped in adults¹
 - Basal denticles 3-3.....*Katayama*.
 - Basal denticles 2-2.....*Oncomelania*.
- Rachidian tooth 5-cusped in adults¹
 - Basal denticles 2-2.....*Schistosomophora*.
 - Basal denticles 4-4.....*Blanfordia*.²

KEY TO THE OPERCULA OF THE GENERA OF THE INTERMEDIATE
HOSTS OF SCHISTOSOMA JAPONICUM

- Whorls 1.5*Schistosomophora*.
- Whorls 2.2
 - Nucleus very excentric.....*Oncomelania*.
 - Nucleus not very excentric.....*Blanfordia*.
- Whorls 3.2*Katayama*.

Unfortunately, the characters of the shells are not as clear cut as the radula and opercula, and their placement in a key would be rather involved. Suffice it to say here that *Oncomelania*, always, as far as we know, has the shell axially ribbed; *Katayama* in Japan and China has the shell elongate-conic, but in the Formosan species it is ovate, thus resembling *Blanfordia* and *Schistosomophora*. The *Blanfordias* are larger than the *Schistosomophoras*, excepting *Blanfordia integra*, which is almost as small.

¹ In very young mollusks or unworn parts of the radula a slight outer third cusp may be present on each side of the central tooth.

² No species of the genus *Blanfordia* as here limited has so far been implicated as intermediate host of *Schistosoma japonicum*.

DESCRIPTION OF GENERA AND SPECIES

BLANFORDIA

Genotype.—*Tomichia bensoni* A. Adams.

The name *Blanfordia* has so frequently been associated with mollusks serving as intermediate hosts for the Asiatic blood fluke that I have felt it necessary here to go into convincing details to show that there is no excuse for this. The species belonging to this genus form a compact small group whose distribution is limited to northern Japan, north of the schistosomophorous Katayamas.

HISTORY

In 1861 Arthur Adams (1, p. 308)³, a ship surgeon in the British Navy and an indefatigable student of mollusks, which he appears to have gathered in every port made by ships on which he traveled, described among other things two new species from Japan, namely, *Tomichia bensoni* from Hokkaido and *Tomichia japonica* from Sado. Finding that these two species were not congeneric with *Tomichia*, he created for them in 1863 (2, p. 424) the new genus *Blanfordia*. *Tomichia japonica* Adams thus became *Blanfordia japonica* Adams and *Tomichia bensoni* Adams, *Blanfordia bensoni* Adams. Here he states:

In Japan, at Matsumai and Sado, I discovered two species of terrestrial Mollusks, with similar animals, which (in the "Annals" for October 1861) I referred to the genus *Tomichia*, Benson, a form of Truncatellidae from the Cape [Good Hope]. Since then, I have sent specimens of the shells, accompanied by drawings of the animals, to Mr. Benson; and he assures me that his *Tomichiae* are very different. He writes to me as follows:

"A comparison of the animal of the Cape *Tomichia* with that of your Japanese shells leads to the impression that your discoveries belong to a distinct genus, which, but for the operculum, may rather be regarded as a land-shell. I have examined a specimen, and find it horny and subspiral in construction, the same as that of *Tomichia*, but more solid."

After describing the genus, Adams states that the tentacles are short and triangular, that the eyes are sessile on the upper base of the tentacles, that the foot is lobed on each side in front with a posterior dorsal lobe which bears the operculum. He further states that both of his species were found on damp banks covered with vegetation in rocky situations near the sea. He dedicated the genus to his friend, W. T. Blanford, a student of Indian mollusks, and

³ Numbers in parentheses refer to list of references cited at end of paper.

figures the animal of *Blanfordia japonica* on plate 7 as figure 12, and *Blanfordia bensoni* on plate 7, figure 11.

In 1876 Pfeiffer (3, p. 22) lists *Blanfordia japonica* and *Blanfordia bensoni* and also other species which do not belong in this genus.

In 1878 Nevill (4, p. 254) fixed the type of *Blanfordia* by designating *Blanfordia bensoni* as type species.

A long interval passed before reference is again made to this genus. In 1897 von Möllendorff (11, p. 32) redescribed *Blanfordia bensoni* A. Adams from material collected by B. Schmacker near the city of Hakodate, Jeso, Japan.

In 1900 Dr. Pilsbry (13, p. 12) renamed *Blanfordia bensoni*, calling it *Pomatiopsis hirasei*, which becomes a synonym of *Blanfordia bensoni*.

In the same year (1900) von Möllendorff (12), after referring to his former treatise on *Blanfordia bensoni*, described *Blanfordia japonica*, which he states was collected by Hirase on Sado, *i. e.*, the type locality.

Pilsbry (14), in 1901, in his "Notes on the Recent Literature of Japanese Land-Snails", places his *Pomatiopsis hirasei* in the synonymy of *Blanfordia bensoni* Adams, and bestows the name *Blanfordia bensoni* var. *minor* upon the mollusk described under the name *Blanfordia japonica* by von Möllendorff. With this dictum I do not agree, but hold that von Möllendorff was correct.

The following year Pilsbry (15, pp. 26-27) again discussed *Blanfordia japonica* and *Blanfordia bensoni* and described *Blanfordia japonica* var. *simplex* as new from Nishigo, Uzen (Honshu Id.).

In 1903 Pilsbry (16, p. 114) again refers to *Blanfordia japonica* from Sado Island, and raises his subspecies *Blanfordia japonica* var. *simplex* to specific rank.

For 12 years no papers appear in the malacological press, but in 1915 Dr. Pilsbry (23) again reviews "The Japanese Species of *Blanfordia*" and wrongly places *Katayama nosophora* in this genus. He again lists *Blanfordia japonica*, *Blanfordia bensoni*, and *Blanfordia simplex* and with them *Blanfordia nosophora* and figures all four and gives a key to them.

Here, too, he wrongly designates *Blanfordia japonica* as type of the genus *Blanfordia*, this having been established by Nevill in 1878 to be *Blanfordia bensoni* A. Adams.

Nine years later, 1924, Pilsbry (30) adds another species, *Blanfordia integra*, from Makuragisan, Izumo (Honshu Id.) to this genus. Here also he establishes the subgenus *Vicina*, with *Pomatiopsis hirasei* as type, which he says is apparently synonymous with

Blanfordia bensoni. He states that the subgenus also includes *Blanfordia simplex* Pilsbry. This subgenus, *Vicina*, therefore was still-born, as it is a pure and simple synonym of *Blanfordia*, having the same type.

The same year Annandale (31) published his paper on "The Molluscan Hosts of the Human Blood Fluke in China and Japan, and Species Liable to be Confused with Them." Here he gives a description of the animal, which I copy under the generic definition. He rightfully considers *Blanfordia* generically distinct from the rest of the complex. He gives a new name to *Blanfordia japonica*, namely, *Blanfordia pilsbryana*, from the type locality of *Blanfordia japonica*, naming it from Pilsbry's figures 1 and 2, *Nautilus*, 1915, page 2. He also wrongly lumps *Blanfordia simplex* under *Blanfordia bensoni*.

In 1928 Bequaert (37) published two papers on "Mollusks of Importance in Human and Veterinary Medicine." In this he places the Japanese intermediate hosts in *Blanfordia* and the Chinese in *Hemibia*.

Thiele (38) in 1929 recognized *Blanfordia* A. Adams as distinct from *Oncomelania* Gredler. He cites also the subgenus *Vicina*.

In 1932 Tubangui (40) published a paper on "The Molluscan Intermediate Host in the Philippines of the Oriental Blood Fluke, *Schistosoma japonicum* Katsurada." Here he cites *Blanfordia quadrasi* (= *Prososthenia quadrasi* Möllendorff) as host. He says this is most closely related to *Blanfordia formosana* Pilsbry and Hirase. He also says that the mollusks can stand prolonged desiccation, at least up to 4 weeks, under laboratory conditions. This is the *Schistosomophora hydrobiopsis* Rensch described in this paper.

Two years after this, in 1934, Bequaert (44) discusses the intermediate host of the Asiatic blood fluke in the Philippines and reviews the field as a whole on the basis of what has been said before. He places all the species in *Blanfordia*, which, as we have shown in the present effort, is not tenable.

The Philippine mollusk implicated is Rensch's *Oncomelania hydrobiopsis*, here made congeneric with *Prososthenia quadrasi* Möllendorff, which I am now rechristening *Schistosomophora quadrasi*; he calls it *Blanfordia quadrasi*.

Following Bequaert's paper in the same journal is a review of the subject by Pilsbry (45) which is largely devoted to a criticism of Annandale's effort, and supports Bequaert's contention.

GENERIC DEFINITION

Shell.—Shell ovate, thin, with inflated whorls which are marked by irregular incremental lines that in some species almost attain the

strength of threads, and spiral lirations which vary in different species from mere indications to well pronounced. The nuclear whorls (tip), usually eroded away, when present scarcely differentiated from the rest of the spire but a little smoother (*Blanfordia integra*). Aperture broadly ovate, peristome dark-edged, usually thicker behind the edge and usually reenforced with a callus behind the outer lip. There is considerable variation in the strength of these characters, not only in the different species of the genus, but in the shells of individual species themselves; in *Blanfordia integra* the thickenings are merely indicated. Base narrowly umbilicated.

Operculum.—The operculum is thin, horny, paucispiral, that is, it consists of 2.2 whorls, the nucleus of which is not very excentric.

Radula.—The radula, like the shell, is larger in *Blanfordia* than in the other genera. The rachidian tooth has 5 denticles, a large median with a smaller one adjacent to this and the outer still smaller. In worn parts of the radula the latter is sometimes lost, but a search for it in less worn parts will always reveal it. The basals in the rachidian tooth are 4 on each side; the formula thus becomes $\frac{2-1-2}{4-4}$.

The lateral tooth is very oblique with 2 denticles inside of the large cusp and 3 or 4 on the outside of this. The first marginal bears 7-8 denticles. The outer marginal tooth has a thumblike projection on the inner end of the row of denticles. The denticles vary from 6 to 7. A glimpse at plate 3, figures 4-7, will give a better understanding of these features than does my description.

Animal.—I have not seen living *Blanfordias*. Adams (2) says of them, *i. e.*, *Blanfordia japonica* and *Blanfordia bensoni* A. Adams:

The tentacles are short and triangular; * * * the eyes are sessile on the upper bases of the tentacles. * * * The foot * * [is] lobed on each side in front and with a posterior dorsal lobe which bears the operculum. Both my species are found on damp banks covered with vegetation, in rocky situations near the sea.

I have copied Adams' figures of both species. To this Annandale (31) adds:

The snout is much longer and relatively narrower than that of *Oncomelania* and is highly extensile, forming a regular proboscis, while the foot is divided by a transverse furrow into two parts, which are capable of independent movement. The snail, instead of gliding evenly on its foot, moves something like a leech, dragging itself forward by means of its snout, the tip of which is applied to the ground, and pressing down the two parts of its foot separately.

KEY TO THE SPECIES OF THE GENUS BLANFORDIA

- Incremental sculpture consisting of closely spaced, well defined threads. *integra*.
 Incremental sculpture not consisting of closely spaced, well defined threads.
 Outer lip reenforced by a heavy varicial callus. *japonica*.
 Outer lip not reenforced by a heavy varicial callus.
 Callus of the outer lip merely indicated.
 Shell large; height more than 7.5 mm. *bensoni*.
 Shell smaller; height less than 7.0 mm. *simplex*.

BLANFORDIA INTEGR Pilsbry

Plate 1, fig. 12; plate 2, fig. 2; plate 3, fig. 4

1924. *Blanfordia integra* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 76, p. 12, fig. 3.

Shell small, very broadly ovate, thin, semitranslucent, horn-colored with the outer edge of the peristome bounded by a narrow, very dark brown zone; interior of the aperture of the same color as the exterior. Nuclear whorls 2.2, inflated, strongly rounded, very finely granulose when viewed under high magnification, forming a rather blunt apex. Postnuclear whorls 2.9 in the specimen figured, strongly inflated. The first turn at its junction with the nuclear whorl marked by almost axial riblets, which slant retractively and which gradually become lessened in strength and on the last turn appear as fine axial threads, which are about as wide as the spaces that separate them. These whorls are also marked by faintly incised spiral lines which give to the surface an obscurely granulose effect when viewed under high magnification. Suture strongly constricted. Periphery inflated, strongly rounded. Base inflated, strongly rounded, moderately openly umbilicated, having the same sculpture as the spire covering it and extending into the umbilicus. Aperture large, very broadly obliquely ovate; peristome somewhat expanded all around and adnate at the parietal wall to the preceding whorl. Operculum thin with 2.2 whorls. In the radula the rachidian tooth has a strong median cusp bordered by two lesser cusps which decrease regularly in size outwardly. The basals are 4 in number and also decrease regularly outwardly, the formula for this, therefore, being $\frac{2-1-2}{4-4}$. The lateral tooth is very oblique with a very strong cusp and 2 minute cusps on the inside of this and 4 on the outside, the outer one being extremely small. The first marginal bears 7 denticles which decrease in size from the innermost outwardly. The outer marginal has 6 denticles with a seventh one indicated on the thumblike projection on the inside of the denticulated end.

Three specimens of this species, the type and two paratypes, are before me. They belong to the Philadelphia Academy of Natural Sciences, bearing the catalogue number 95757, and were collected by Y. Hirase in 1908 at Makuragisan, Izumo, Japan. They measure:

No. of whorls	Height in mm	Diameter in mm
5.0 ^a	4.6	3.0 (type)
5.3	5.2	3.2
4.5	3.6	2.4

^a The type, whose shell, operculum, and radula I have figured.

The small size and strong axial sculpture easily distinguish this species from the other *Blanfordias*.

BLANFORDIA JAPONICA (A. Adams)

Plate 1, figs. 11, 14 (type); plate 2, fig. 1; plate 3, fig. 5; plate 6, fig. 2

1861. *Tomichia japonica* A. ADAMS, Ann. Mag. Nat. Hist., ser. 3, vol. 8, p. 308.
 1863. *Blanfordia japonica* A. ADAMS, Ann. Mag. Nat. Hist., ser. 3, vol. 12, p. 424, pl. 7, fig. 12.
 1876. *Blanfordia japonica* PFEIFFER, Mon. Pneumon. Viv., pt. 4, p. 22.
 1878. *Blanfordia japonica* NEVILL, Hand List Moll. Ind. Mus., pt. 1, p. 254.
 1900. *Blanfordia japonica* MÖLLENDORFF, Nachrichtsbl. Deutsch. Malakoz. Ges., vol. 32, pp. 153-154.
 1901. *Blanfordia japonica* *minor* PILSBRY, Ann. Mag. Nat. Hist., ser. 7, vol. 8, p. 6.
 1902. *Blanfordia japonica* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 54, pp. 26-27.
 1903. *Blanfordia japonica* PILSBRY, Nautilus, vol. 16, p. 114.
 1906. *Blanfordia japonica* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 58, p. 751.
 1915. *Blanfordia japonica* PILSBRY, Nautilus, vol. 29, p. 2, figs. 1, 1a.
 1924. *Blanfordia pilsbryana* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, p. 290.
 1924. *Blanfordia japonica* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, pp. 286, 288-291, text fig. 6c.
 1929. *Blanfordia japonica* THIELE, Handb. Syst. Weicht., pt. 1, p. 150.
 1934. *Blanfordia japonica* PILSBRY, Journ. Parasit., vol. 20, pp. 282-283.
 1934. *Tomichia japonica* BEQUAERT, Journ. Parasit., vol. 20, p. 282.
 1934. *Blanfordia pilsbryana* PILSBRY, Journ. Parasit., vol. 20, p. 283.

Shell of medium size, elongate-ovate, rather stout, horn-colored, with the outer edge of the peristome bounded by a narrow zone of dark chocolate brown. Interior of the aperture pale yellowish. The early whorls of all our specimens, except one, are decollated and the decollation is closed with a plug. In this specimen, which is in lot U.S.N.M. no. 346038, 2.2 whorls are present, but they are so

badly worn that no remarks about their sculpture can be made. Furthermore, part is broken away to show that a plug has already been formed in the interior, indicating where decollation is to take place. The remaining whorls are inflated and strongly rounded and are crossed by incremental lines of varying strength, some of which, not regularly spaced, assume almost the strength of threads. In addition to these, more or less regularly distributed incised microscopic spiral lines and obsolete lirations are present. Suture strongly constricted; periphery inflated and well rounded; base narrowly umbilicated, having the same sculpture as the spire. The last whorl is provided with a very heavy callus, slightly behind the peristome, which might be called a varix. Aperture very oblique, irregularly ovate, expanded at the outer edge and appressed and adnate to the base of the preceding turn at the parietal wall. The operculum is thin, horny, and has 2.2 whorls. In the radula the rachidian tooth has a strong median cusp, a lesser one adjoining this and a feeble one outside of it. The basals are 4 in number on each side and decrease in size from the inner outwardly, the outer one being poorly developed, the formula being $\frac{2-1-2}{4-4}$. The lateral has a very large cusp and 2 lesser ones on the inside of this, and 4 on the outside, the fourth being feebly developed. The inner marginal bears 7 denticles and the outer 6.

Adams' type, U.S.N.M. no. 21188, measures: Height, 7.1 mm, diameter, 4.2 mm. This has the outer lip partly fractured. I have therefore, in addition to this, figured another typical specimen from the type locality, U.S.N.M. no. 175797, which has 4.3 whorls remaining and measures: Height, 7.2 mm, diameter, 4.6 mm.

The additional specimens in our collection yield the following measurements:

	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 21188.....	4.3	7.1	4.2 (type)
U.S.N.M. no. 175797.....	4.3 ^a	7.2	4.6
	4.3	7.2	4.6
	4.5	7.9	4.6
	4.5	7.6	4.6
	3.8	7.0	4.6
	4.2	7.1	4.4
	3.8	6.4	4.0

	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 346038.....	4.2	7.3	4.8 (type)
	3.4	7.4	4.4
	3.7	6.7	4.3
	4.3	6.8	3.9
	4.0	6.3	3.8
	4.0	6.6	4.2
	4.0	6.2	4.1
	3.7	6.7	4.3
	5.7 ^b	6.5	3.8
U.S.N.M. no. 307810.....	4.7	7.8	4.7
	4.3	7.3	4.8
	4.3	7.2	4.2
	4.4	7.4	4.6
	4.4	6.9	4.3
U.S.N.M. no. 307811.....	4.6	7.3	4.3
	4.5	8.0	4.8
	4.6	7.9	4.7
	4.3	7.4	4.5
	4.3	7.2	4.7
	4.5	7.4	4.5
Greatest	5.7	8.0	4.8
Least	3.7	6.2	3.8
Average	4.3 ²	7.14	4.4

^a Figured specimen.^b Apex entire.

This species is easily differentiated from all the other *Blanfordias* by its very strong, varix-like callus behind the outer lip.

BLANFORDIA BENSONI (A. Adams)

Plate 1, fig. 13; plate 2, fig. 3; plate 3, fig. 7; plate 6, fig. 3

1861. *Tomichia bensoni* A. ADAMS, Ann. Mag. Nat. Hist., ser. 3, vol. 8, p. 308.
 1863. *Blanfordia bensoni* A. ADAMS, Ann. Mag. Nat. Hist., ser. 3, vol. 12, p. 424, pl. 7, fig. 11.
 1876. *Blanfordia bensoni* PFEIFFER, Mon. Pneumon. Viv., pt. 4, p. 22.
 1878. *Blanfordia bensoni* NEVILL, Hand List Moll. Ind. Mus., pt. 1, p. 254.
 1897. *Blanfordia bensoni* MÖLLENDORFF, Nachrichtsbl. Deutsch. Malakoz. Ges., vol. 29, p. 32.
 1900. *Pomatiopsis hirasci* PILSBRY, Nautilus, vol. 14, p. 12.
 1900. *Blanfordia bensoni* MÖLLENDORFF, Nachrichtsbl. Deutsch. Malakoz. Ges., vol. 32, p. 153.
 1901. *Pomatiopsis hirasci* PILSBRY, Ann. Mag. Nat. Hist., ser. 7, vol. 8, p. 5.
 1901. *Blanfordia bensoni* PILSBRY, Ann. Mag. Nat. Hist., ser. 7, vol. 8, p. 5.
 1902. *Blanfordia bensoni* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 54, pp. 26-27.

1915. *Blanfordia bensoni* PILSBRY, Nautilus, vol. 29, p. 2, fig. 4.
 1924. *Pomatiopsis hirasci* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 76, p. 12.
 1924. *Pomatiopsis bensoni* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 76, p. 13.
 1924. *Blanfordia bensoni* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, pp. 288-291, fig. 13.
 1924. *Blanfordia bensoni hirasci* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, pp. 291-293, text fig. 6B.
 1929. *Blanfordia (Vicina) bensoni* THIELE, Handb. Syst. Weicht., pt. 1, p. 150.
 1934. *Blanfordia bensoni* PILSBRY, Journ. Parasit., vol. 20, pp. 281-283.
 1934. *Blanfordia hirasci* PILSBRY, Journ. Parasit., vol. 20, p. 283.
 1934. *Tomichia bensoni* BEQUAERT, Journ. Parasit., vol. 20, p. 281.

Shell large, elongate-ovate, moderately thick, light horn-colored with the outer edge of the peristomes chestnut brown. Interior of aperture a little lighter than the outside. The nuclear whorls in all of our specimens are decollated. The postnuclear whorls are inflated and strongly rounded and marked by moderately strong incremental lines which at irregular intervals develop into axial threads, probably marking resting stages in the growth. In addition to this, the whorls are marked by microscopic incised spiral lines and distantly placed, poorly and irregularly developed spiral lirations. All these sculptural elements are less strongly developed in the early postnuclear turns and gain slightly in strength as the shell increases in size. Suture strongly impressed; periphery and base inflated and strongly rounded, and marked with the same sculpture that characterizes the spire. The base is narrowly unilobed. Aperture very broadly irregularly ovate; peristome slightly expanded and appressed and adnate to the preceding turn on the parietal wall. The operculum has 2.2 whorls. The radula is large and the rachidian tooth has a strong median cusp with 2 lesser cusps on each side and 4 basals on each side that decrease in size from the inner outward, the formula therefore being $\frac{2-1-2}{4-4}$. The lateral tooth is very oblique and has a powerful cusp with 2 lesser cusps on the inside of this and 3 on the outside. The first marginal bears 7 denticulations, and the outer marginal has 5.

The United States National Museum has three lots of this species, all collected by Y. Hirase in the southern end of the island of Hokkaido, as follows:

U.S.N.M. no. 307812, seven specimens from Ojima. Of one of these, we have given the figure of the shell, radula, and operculum.

A second lot, U.S.N.M. no. 162602, six specimens from Shikunobe, Ojima.

The last lot, U.S.N.M. no. 346036, 15 specimens from Ojima. These yield the following measurements:

	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 307812.....	4.8 ^a	9.7	5.4
	4.6	9.2	5.3
	4.5	8.1	5.1
	4.4	8.6	5.1
	4.5	8.1	5.0
	4.5	8.0	4.8
	4.3	8.2	4.9
U.S.N.M. no. 162602.....	5.1	9.0	5.2
	4.4	8.7	4.9
	4.5	8.2	5.0
	4.5	7.9	4.8
	4.4	7.7	5.1
	4.5	8.3	4.8
U.S.N.M. no. 346036.....	4.7	9.2	5.7
	4.6	8.9	5.1
	4.6	9.1	5.3
	4.7	9.0	5.0
	4.6	8.6	5.1
	4.7	8.4	4.9
	4.7	8.8	5.3
	4.7	8.5	5.0
	4.5	8.5	5.0
	4.5	8.2	5.1
	4.4	7.9	5.0
	4.6	7.9	4.6
	4.4	8.0	5.1
	4.6	7.8	4.7
	Greatest	5.1	9.7
Least	4.3	7.7	4.6
Average	4.58	8.46	5.05

^a Shell, operculum, and radula figured.

In the measurements that we are citing, it should be borne in mind that the early whorls have been lost and the measurements are of the whorls remaining.

The large size of this species will easily distinguish it from the other *Blanfordias*.

BLANFORDIA SIMPLEX Pilsbry

Plate 1, fig. 10; plate 2, fig. 4; plate 3, fig. 6

1902. *Blanfordia japonica* var. *simplex* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 54, pp. 26-27.
1903. *Blanfordia simplex* PILSBRY, Nautilus, vol. 16, p. 114.
1915. *Blanfordia simplex* PILSBRY, Nautilus, vol. 29, p. 2, figs. 3, 3a.
1924. *Blanfordia simplex* PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 76, p. 13.
1924. *Blanfordia japonica simplex* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, p. 291.
1934. *Blanfordia bensoni* PILSBRY, Journ. Parasit., vol. 20, p. 283.
1934. *Blanfordia bensoni simplex* PILSBRY, Journ. Parasit., vol. 20, p. 283.

Shell of medium size, ovate, thin, semitranslucent, pale horn-colored with the peristome bounded by a very narrow zone of chocolate brown; interior of aperture a little paler than the outside. Part of the nuclear spire is decollated, the portion remaining so cleverly plugged that one might be misled into taking it for the apex of the nucleus. The remaining turn is marked by fine granulations apparent only under high magnification. Postnuclear whorls strongly inflated, well rounded, marked by slender, depressed, threadlike incremental lines which are about as wide as the spaces that separate them, and microscopic spiral striations. Suture strongly constricted; periphery and base of the last whorl decidedly inflated and strongly rounded. The latter is marked like the spire. The base is narrowly umbilicated. Aperture oblique, oval with the peristome slightly expanded and appressed and adnate to the preceding turn at the parietal wall.

There are four lots before us, all collected by Y. Hirase. The specimen described and figured, U.S.N.M. no. 346042, is one of seven and comes from Uzen, Japan.

U.S.N.M. no. 346041, nine specimens from Noto, Japan.

U.S.N.M. no. 307809, six specimens from Nishigo, Uzen, Japan.

U.S.N.M. no. 162601, six specimens from Nishigo, Uzen, Japan.

They yield the following measurements:

	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 346042.....	4.6 ^a	6.3	3.9
	4.5	6.3	3.9
	5.1	6.8	4.2
	4.7	6.5	3.9
	4.4	6.4	4.0
	4.3	6.5	4.1
	4.2	6.2	4.2

	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 346041.....	4.5	6.6	3.9
	4.5	6.8	4.1
	4.5	6.8	4.2
	4.4	6.7	3.9
	4.5	6.5	3.9
	4.3	6.1	3.9
	4.6	6.9	4.0
	4.1	6.3	3.9
U.S.N.M. no. 307809.....	4.4	6.0	3.8
	4.3	6.1	3.4
	4.5	5.9	3.8
	4.4	6.2	3.9
	4.5	6.6	4.1
	4.3	6.1	3.7
U.S.N.M. no. 162601.....	4.5	6.0	3.8
	4.7	6.7	4.2
	4.4	6.4	4.0
	4.3	6.2	4.0
	4.5	6.4	3.9
	4.4	6.0	3.9
Greatest	5.1	6.9	4.2
Least	4.1	5.9	3.7
Average	4.46	6.39	3.97

^a Figured specimen.

KATAYAMA

Genotype.—*Katayama nosophora* Robson.

Human schistosomiasis, its cause, and the life history of the organisms responsible for it furnish a fascinating chapter in the history of medicine, parasitology, and malacology. No other group of helminths yield the same stimulus to the historian—in fact, of all human parasites malaria alone furnishes a comparable theme. However, it is not within the scope of the present paper to elucidate this, but to render better known the mollusks constituting the key point for the control of the malady produced by the Asiatic blood fluke.

Probably no other small group of mollusks has met with more vicissitudes as far as the nomenclatorial problems are concerned than the members of the genus *Katayama*, and it is to be hoped that this effort will allay further changes and result in permanent names. This is especially desirable since the mollusks in question receive more attention in the medical than in the malacological press, and medical

men unskilled in molluscan lore must of necessity be puzzled, to say the least, about the names that should be applied to what they would term their pests. A perusal of the subjoined historical chapter of this genus, in which only the malacological side dealing with problems of naming has been cited, will explain past troubles.

HISTORY

From 1852, when Bilharz described *Distomum haematobium*, the African blood fluke, until 1913, only surmises were available about the probable life history of blood flukes.

The first intermediate host of *Schistosoma japonicum* to be described hailed from Rono in the center of the southern part of the Island of Formosa. It was christened *Blanfordia formosana* by Pilsbry (17, p. 751).

In 1913 Miyairi (19) announced a molluscan intermediate host for the Asiatic blood fluke. This immediately set into action with renewed energy research students in various parts of the world.

The year following, 1914, Miyairi and Suzuki (20) published their paper on "Der Zwischenwirt des *Schistosomum japonicum* Katsurada."

In 1915 Leiper and Atkinson (21) published "Observations on the Spread of Asiatic Schistosomiasis", in which they give an account of their search for the intermediate host in China and Japan.

By far the greatest impetus to an understanding of this genus was furnished by Robson (22), who in 1915 described as a new genus and new species *Katayama nosophora*, the then known intermediate host of *Schistosoma japonicum*.

Pilsbry (23) in the same year refers this to the genus *Blanfordia*. He also lists under this species the shells which I have here named *Katayama nosophora yoshidai*.

In 1918 Johnson (24), in reviewing "The Cercarian Infection of South African Snails", by F. G. Cawston, M.D., refers to *Blanfordia* (*Katayama*) *nosophora*.

The following year, 1919, Cort (25) published a paper on "The Cercaria of the Japanese Blood Fluke, *Schistosoma japonicum* Katsurada", and gives an account of its intermediate host, *Blanfordia nosophora*.

The year following, 1920, Cort (26) published a paper "On the Resistance to Desiccation of the Intermediate Host of *Schistosoma japonicum* Katsurada."

The form here used appears to be my *Katayama nosophora yoshidai*.

In 1921 Cort (28) published a splendid paper on "The Development of the Japanese Blood Fluke, *Schistosoma japonicum* Katsurada, in Its Final Host" and names as such *Blanfordia nosophora*. The mollusks he says were received from Sado Yoshida of the Osaka Medical College and were most likely my subspecies *Katayama nosophora yoshidai* received from the same source.

The same year Robson (27) published his exhaustive and splendid study "On the Anatomy and Affinities of *Hypsobia nosophora*", *i. e.*, the mollusks he had in 1915 named *Katayama nosophora*.

In 1923 Meleney and Faust (29) published a paper on "The Intermediate Host of *Schistosoma japonicum* in China" and here cite *Blanfordia nosophora* and also an *Oncomelanian*.

The next year, 1924, Faust (33) again discusses the problem in his paper entitled "Notes on Larval Flukes from China. II. Studies on Some Larval Flukes from the Central and South Coast Provinces of China." He states here (p. 243) that the cercaria of *Schistosoma japonicum* were found at Shaohsing in *Katayama nosophora*; this is the mollusk I named *Katayama fausti* the following year. He properly places *Katayama nosophora* and *Katayama formosana* in their correct genus and exonerates the *Blanfordias* from being schistosomophorous. He proclaims the *Katayamas* as mountain dwellers and the *Oncomelantias* as occupying the Yangtze delta and Grand Canal and Great Lake. These he also proclaims schistosomophorous.

The same year Annandale's (31) paper on "The Molluscan Hosts of the Human Blood Fluke in China and Japan, and Species Liable to be Confused with Them" appeared. This was an extensive study, in which he definitely eliminated *Blanfordia* as a carrier, but, reduced *Katayama* to a section of *Oncomelania*, which he called *Katayamae*. In this he placed *Oncomelania formosana* and *Oncomelania nosophora*. His treatment of *Oncomelania* I shall discuss under that genus. He discussed classification at considerable length.

In 1925 Bartsch (35) bestowed names upon three *Katayamas*: *Katayama nosophora yoshidai* from Kurume, Kyushu Island, Japan; *Katayama fausti* from Shaohsing, Chekiang Province, China; and *Katayama fausti cantoni* from Fatshan near Canton, China. He also discussed *Katayama nosophora* and *Oncomelania*.

In 1926 Germain and Neveu-Lemaire (36), in their "Essai de Malacologie Medicale", discuss the mollusks playing a part as intermediate hosts. They recognize *Oncomelania* as a genus and *Hypsobia* and *Hemibia* as sections thereof. The latter we have pointed out previously is a pure and simple synonym of *Oncomelania* with the same type, while the former is completely excluded from *Oncomelania*

by its anatomic characters. *Katayama* they consider synonymous with *Oncomelania*; under it they list *Oncomelania (Hypsobia) nosophora* and *Oncomelania (Hypsobia) formosana*. They also refer under *Oncomelania (Hypsobia) nosophora* Faust's specimens from Shaohsing and Fatshan, which I have named *Katayama fausti* and *Katayama cantoni*, respectively.

In 1928 Bequaert (37) published his essay on "Mollusks of Importance in Human and Veterinary Medicine." In this he reviews the entire field and places the *Katayamas* in *Oncomelania*. He lists *Blanfordia nosophora* and *Blanfordia formosana* as hosts of our fluke.

In 1929 Faust (39) published his textbook, "Human Helminthology", in which he discusses schistosomiasis on pages 94-155.

In 1932 Tubangui (40) announced "The Molluscan Intermediate Host in the Philippines of the Oriental Blood Fluke, *Schistosoma japonicum* Katsurada", in which he refers to *Blanfordia japonica* and *Blanfordia formosana*.

The same year, 1932, Rensch (41) in describing the Philippine intermediate host of *Schistosoma*, refers to *Hypsobia nosophora*.

In 1932 Fu-ching Li published two papers in Science, The Science Society of China, vol. 16. The first of these (42), pp. 566-582, deals with der "Zwischenwirt des *Schistosomum haematobium japonicum* (Katsurada)"; the second (43) in the same journal, pp. 583-619, deals with "Uber die postembryonale Entwicklung von dem Zwischenwirt des *Schistosomum haematobium japonicum* China." This contains 32 figures. It is unfortunate that both of these papers are in Chinese, but in a subsequent paper (46), 1934, the author uses German, so we may consider that the data here presented is summed up in that communication.

In 1934 Bequaert (44) reviews Tubangui and Rensch's papers and incidentally goes over all the ground again, referring to *Blanfordia formosana* and *Katayama nosophora*.

To the same paper Pilsbry (45) adds an appendix, "Note on the Genus *Blanfordia*", in which he substantiates Bequaert's conclusion and refers, among other things, to *Katayama nosophora yoshidai* and *Blanfordia nosophora*.

GENERIC DEFINITION

Shell.—Shell elongate-conic or very elongate-ovate, thin, semi-transparent, horn-colored with a dark line marking the edge of the peristome. Nuclear whorls well rounded, smooth, under very high

magnification minutely granulose. Postnuclear whorls moderately to well rounded, marked with incremental lines that vary in strength and spacing. Suture varying from moderately to strongly constricted. Periphery and base well rounded, base narrowly umbilicated. Outer lip provided with a callus behind the aperture. Aperture broadly ovate.

Operculum.—The operculum is thin, horny, paucispiral, consisting of 3.2 whorls, with the nucleus somewhat excentric.

Radula.—The radula is moderately large. The rachidian tooth has 3 denticles, *i. e.*, a large median and a lesser one flanking this on each side. The basal denticles in the rachidian tooth are 3 on each side; the formula therefore is $\frac{1-1-1}{3-3}$. The lateral tooth is very oblique, bearing 6 denticles, of which the third from the inner edge is a giant compared to the rest. The inner marginal tooth varies in the number of denticles in the different species, from 7 to 9. The number of denticles in the outer marginal tooth range from 5 to 7, the innermost being much larger than the rest. In this character the *Katayamas* are also distinguished from the *Blanfordias*.

Animal.—I have not studied these animals alive; all the information here cited is therefore second-hand.

The anatomy of the alimentary, respiratory, renal, circulatory, nervous and reproductive systems is beautifully described and figured by Robson (27). The affinities of the animal are also worked out by him. To this masterly paper we refer any one interested in these subjects.

The egg.—The eggs, Dr. Li writes me, "are attached as individual specimens to rocks and are covered with sand." His figure here published (pl. 6, fig. 4) also shows five side by side in chain formation. In *Oncomelania* they form clumps enclosed in a common jelly mass.

Ecology.—Robson, quoting Leiper, says that they (*Katayama nosophora*) "occur in damp moss and grass on the sides of plants in the rice fields in very great quantities."

Li, as well as Faust and Meloney, found the Chinese species to be mountain dwellers. A glimpse at an Eastern Chinese topographic map shows that the mountain range attains a height of 4,000 feet at a moderate distance from shore along the coast, and it is in the streams of this that *Katayama* finds a suitable habitat. Of the habits of *Katayama fausti* Faust (32) states:

[At] the village of Ch'en Chia Chiao, about three and a half miles from the southwest corner of Shaohsing City, * * on the intermediate ground of moist

humus and moss numerous specimens of a snail, recognized as a *Katayama*, were found. * * * The specimens collected were all taken from mossy banks or underneath the moss in the porous humus or loose wet mud. Both living snails and dead shells were found in this locality, but in the clay banks above the stone bridge, where there was no moss, the *Katayamas* were absent.

Of *Katayama cantoni*, Faust (32) states:

In the village of Tip Kan [Island of Honam], about one mile from Fatshan, the banks of a secondary stream were covered at high water level with moss and loose moist humus. Careful search at this point revealed numerous specimens of *Katayama*.

Dr. Li gives an interesting discussion on the ecology and geographical distribution of these forms based upon personal field studies, which students will find fertile reading.

All the species here discussed are schistosomophorous. The Chinese *Katayama fausti* and *Katayama cantoni* were first so implicated by Faust and Meleney. *Katayama lii* was found also by Dr. Li to serve as intermediate host.

KEY TO THE SHELLS OF THE SPECIES OF THE GENUS KATAYAMA

Shell elongate-ovate *formosana*.

Shell not elongate-ovate.

Shell elongate-conic.

Shell rather slender, obsolete threadlike axial sculpture fine, closely spaced.

Average measurements of complete shell:

No. whorls 7.6; height 6.4 mm; diam. 2.8 mm. *nosophora*.

No. whorls 8.6; height 7.5 mm; diam. 3.1 mm. *n. yoshidai*.

Shell rather stout, obsolete threadlike axial sculpture coarse and more distantly spaced.

Shell large; height more than 7.7 mm. *lii*.

Shell smaller; height not more than 6.6 mm.

Shell rather coarse. *fausti*.

Shell rather delicate. *cantoni*.

SYNOPSIS OF THE NUMBER OF DENTICULATIONS ON THE MARGINAL TEETH OF THE SPECIES OF KATAYAMA

1st marginal	2d marginal	Species
9	7	<i>lii</i>
9	6	<i>nosophora</i>
9	5	<i>formosana</i>
8	6	<i>yoshidai</i>
8	5	<i>fausti</i>
7	5	<i>cantoni</i>

KATAYAMA NOSOPHORA NOSOPHORA Robson

Plate 1, fig. 4; plate 2, fig. 8; plate 4, fig. 1

1913. Description of Intermediate Host of *Schistosoma japonicum* MIYAIRI, K. Tokio Med. Weekly, no. 1839.
1914. Der Zwischenwirt des *Schistosoma japonicum* MIYAIRI and SUZUKI, Mitt. Med. Fak. Kais. Univ. Kyushu, vol. 1, pp. 187-197, pls. 1-2.
1915. *Katayama nosophora* ROBSON, Brit. Med. Journ., Jan. 1915, p. 203, figs. 7-9, 11.
1915. *Blanfordia nosophora* PILSBRY, Nautilus, vol. 29, pp. 1-4, figs. 2, 2a.
1918. *Blanfordia (Katayama) nosophora* JOHNSON, Nautilus, vol. 31, p. 141.
1919. *Blanfordia nosophora* CORT, Univ. California Publ., vol. 18, pp. 485-507.
1920. *Blanfordia nosophora* CORT, Journ. Parasit., vol. 6, pp. 84-88.
1921. *Hypsobia nosophora* ROBSON, Ann. Mag. Nat. Hist., ser. 9, vol. 8, pp. 401-413, figs. 1-7.
1921. *Katayama nosophora* ROBSON, Ann. Mag. Nat. Hist., ser. 9, vol. 8, p. 402.
1921. *Blanfordia nosophora* CORT, Amer. Journ. Hyg., vol. 1, pp. 1-38.
1924. *Oncomelania nosophora* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, pp. 283-284, 286, 289, 290, pl. 36, figs. 6-8.
1924. *Katayama nosophora* FAUST, Amer. Journ. Hyg., vol. 4, p. 269.
1925. *Katayama nosophora* BARTSCH, Journ. Washington Acad. Sci., vol. 15, p. 71.
1926. *Oncomelania (Hypsobia) nosophora* GERMAIN and NEVEU-LEMAIRE, Ann. Parasit., vol. 4, p. 293, fig. 1.
1928. *Blanfordia nosophora* BEQUAERT, Amer. Journ. Trop. Med., vol. 8, p. 225.
1929. *Katayama nosophora* FAUST, Human Helminthology, p. 136, fig. 47a.
1932. *Blanfordia nosophora* TUBANGUI, Philippine Journ. Sci., vol. 49, p. 299.
1932. *Hypsobia nosophora* RENSCH, Philippine Journ. Sci., vol. 49, p. 552.
1934. *Blanfordia nosophora* PILSBRY, Journ. Parasit., vol. 20, pp. 283-284.
1934. *Katayama nosophora* PILSBRY, Journ. Parasit., vol. 20, p. 284.
1934. *Katayama nosophora* BEQUAERT, Journ. Parasit., vol. 20, p. 282.

Shell elongate-conic, thin, horn-colored with the outer edge of the peristome marked by a dark chocolate line. Nuclear whorls 2.1, well rounded, smooth except for exceedingly minute microscopic granulations, which are apparent only under very high magnification. The nuclear spire terminates rather bluntly. Postnuclear whorls moderately well rounded, marked by fine incremental lines which might be called obsolete, closely spaced, slender axial threads. Suture rather strongly constricted; periphery of the last whorl well rounded. Base moderately long, narrowly umbilicated, well rounded and marked by a continuation of the incremental sculpture referred to above. The base is not thickened at the columella as it is in the Chinese species, but remains comparatively slender. The last whorl is thickened into a moderately strong callus behind the edge of the peristome. Aperture broadly ovate; peristome slightly expanded and reflected. Parietal wall adnate to the preceding turn. Operculum thin, horny, paucispiral, consisting of 3.2 whorls with the nucleus excentric.

This subspecies differs from *Katayama nosophora yoshidai* in being smaller in every way and in having an additional denticle on the inner marginal tooth.

We have seen three lots, 60 specimens, of this race. The first, U.S.N.M. no. 346040, 9 specimens, collected by Y. Hirase comes from Katayama, Bingo Province, Honshu Island, Japan, the type locality of *Katayama nosophora nosophora*.

U.S.N.M. no. 341076 contains 10 specimens from the same locality, collected by Dr. M. Miyajima.

U.S.N.M. no. 420948 contains 41 specimens collected by Dr. E. C. Faust at Okayama, Honshu Island, Japan, near the type locality. These yield the following measurements:

	No. of whorls	Height in mm	Diameter in mm	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 346040..	6.8 ^a	7.5	2.9	5.4	6.5	3.1
	6.4	7.1	2.9	6.3	7.6	3.2
	5.4	6.4	2.9	6.4	6.8	2.9
	6.1	6.5	2.6	5.5	5.8	2.8
	6.2	5.7	2.4	6.1	6.0	2.7
	5.3	6.6	3.1	5.8	5.8	2.7
	6.3	6.3	2.7	4.9	5.7	3.0
	6.0	5.8	2.4	5.7	5.9	2.7
	4.7	5.1	2.6	5.8	5.8	2.9
				5.2	5.4	2.4
U.S.N.M. no. 341076..	6.2	6.9	3.1	6.6	6.4	3.0
	5.5	7.0	3.4	6.3	5.8	2.6
	4.8	6.4	3.2	5.7	5.7	2.5
	5.4	6.8	3.3	4.7	5.2	2.6
	5.8	7.4	3.4	5.4	5.4	2.4
	7.5	7.5	3.3	5.7	6.3	2.9
	5.9	7.0	3.3	6.2	6.0	2.8
	5.2	6.5	3.2	6.4	7.1	3.1
	5.3	5.9	3.0	6.0	7.2	3.3
	5.1	5.8	2.9	6.3	6.5	2.9
				6.8	6.7	2.8
U.S.N.M. no. 420948..	5.6	6.5	3.1	5.3	6.8	3.2
	6.0	8.0	3.4	7.6	7.6	3.2
	5.5	6.2	2.7	6.7	7.0	3.1
	6.4	7.2	2.9	6.2	7.0	3.1
	7.5	6.4	2.8	6.8	7.5	3.2
	5.1	6.0	2.8	5.7	7.1	3.2
	6.8	7.4	3.0	8.0	8.6	3.3
	7.6	8.1	3.2	6.5	7.1	3.0
	6.8	7.7	3.4	5.7	7.5	3.4
	5.3	6.0	2.8	7.4	7.7	3.3
Greatest				8.0	8.6	3.4
Least				4.7	5.1	2.4
Average				6.03	6.62	2.97

^a Figured specimen.

KATAYAMA NOSOPHORA YOSHIDAI Bartsch

Plate 1, fig. 1; plate 2, fig. 9; plate 4, fig. 2

1915. *Blanfordia nosophora* PILSBRY, Nautilus, vol. 29, p. 3, figs. 2, 2a.
 1920. ?*Blanfordia nosophora* CORT, Journ. Parasit., vol. 6, pp. 84-85.
 1921. ?*Blanfordia nosophora* CORT, Amer. Journ. Hyg., vol. 1, pp. 1-38.
 1924. *Katayama nosophora* FAUST and MELENEY, Amer. Journ. Hyg., Mon. Ser. no. 3, pp. 29-30; 34; 37-42; 82-83; 87.
 1924. *Oncomelania nosophora* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, p. 284, in part.
 1925. *Katayama nosophora yoshidai* BARTSCH, Journ. Washington Acad. Sci., vol. 15, pp. 71-72.
 1929. *Katayama nosophora* FAUST, Human Helminthology, p. 136, in part.
 1934. *Katayama nosophora yoshidai* PILSBRY, Journ. Parasit., vol. 20, p. 283.
 1934. *Blanfordia nosophora* PILSBRY, Journ. Parasit., vol. 20, p. 283.

Shell in every way similar to *Katayama nosophora nosophora*, differing from it in being in every way a little larger and in having a different denticulation count in the inner marginal teeth. *Katayama nosophora yoshidai* has 8 denticles, and *Katayama nosophora nosophora* has 9.

The type and the 100 paratypes here measured were received from Dr. Yoshida and were collected at Kurume, Kyushu Island, Japan. The 100 paratypes whose measurements are subjoined here were not selected but taken at random.

Only the specimens marked with a superior b have the shell complete.

	No. of whorls	Height in mm	Diameter in mm	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 362024..	7.8 ^a	8.1	3.4	5.8	6.6	3.0
				5.7	6.8	3.0
U.S.N.M. no. 340953..	4.7	7.3	3.4	6.1	7.4	3.3
	6.3	7.4	3.3	5.2	6.7	3.3
	5.5	6.9	3.2	7.0	7.3	3.0
	5.7	6.8	3.1	6.0	6.8	3.1
	5.7	6.7	3.2	6.0	7.0	3.0
	5.8	6.3	2.8	5.6	6.4	2.9
	7.6	7.1	3.0	5.6	6.6	3.1
	6.0	7.3	3.0	6.2	6.8	3.1
	5.8	6.9	3.1	5.7	6.7	3.3
	8.7 ^b	8.2	3.2	5.2	6.0	2.8
	6.7	7.9	3.4	6.3	7.1	3.2
	6.1	7.2	3.0	6.1	7.1	3.1
	6.1	7.2	3.2	5.8	6.1	2.9
	5.7	6.1	2.9	7.5	7.1	3.0
	8.5 ^b	7.4	2.9	5.7	6.3	3.0
	7.1	6.4	2.9	5.7	6.3	2.9
	5.4	6.1	2.8	6.2	7.3	3.2
	5.7	6.8	3.1	6.5	7.9	3.4

U.S.N.M. no. 340953..	No. of whorls	Height in mm	Diameter in mm	No. of whorls	Height in mm	Diameter in mm
	6.3	6.6	2.9	7.1	7.3	3.1
	6.7	7.0	3.0	5.6	6.7	3.0
	5.4	6.1	3.0	5.6	6.4	2.8
	6.6	6.3	2.9	5.7	6.6	3.1
	7.7	7.7	3.1	8.5 ^b	7.8	3.4
	6.6	7.4	3.3	6.0	6.5	3.0
	6.1	7.2	3.1	6.3	7.1	3.3
	6.5	6.4	2.9	5.4	6.5	2.9
	6.1	7.0	3.0	6.6	7.9	3.4
	5.7	6.2	3.0	5.7	6.4	2.9
	6.2	7.2	3.4	6.0	7.3	3.2
	6.3	7.6	3.3	6.4	7.4	3.2
	6.2	6.4	2.8	5.8	6.6	3.0
	7.4	7.8	3.2	5.7	6.5	2.9
	6.1	6.7	3.0	5.6	6.4	2.9
	5.7	7.0	3.3	5.3	6.2	2.9
	6.3	7.1	3.1	5.8	5.7	2.7
	5.7	6.2	2.9	7.8 ^b	6.7	2.9
	6.0	7.1	3.2	6.0	6.3	2.8
	6.3	7.2	3.1	6.2	6.9	3.0
	6.1	6.5	3.0	6.1	7.5	3.3
	5.9	6.6	3.1	6.2	6.6	3.1
	5.7	7.2	3.4	5.5	6.8	3.0
	6.0	6.6	2.9	6.1	6.9	3.2
	6.0	6.7	2.8	6.2	7.1	3.2
	5.6	6.8	3.4	5.5	6.6	3.1
	5.7	7.0	3.1	6.0	7.3	3.2
	6.1	6.9	3.2	7.5	7.5	3.2
	6.0	7.4	3.1	5.4	6.1	2.8
	5.5	6.3	2.9	6.4	7.1	3.2
	5.3	5.8	2.8	6.3	6.8	3.2
Greatest				8.7	8.2	3.4
Least				4.7	5.7	2.7
Average				6.13	6.86	3.07

^a Figured type.

^b Complete shell.

KATAYAMA FORMOSANA (Pilsbry and Hirase)

Plate 1, fig. 6; plate 2, fig. 12; plate 4, fig. 3

1906. *Blanfordia formosana* PILSBRY and HIRASE, Proc. Acad. Nat. Sci. Philadelphia, vol. 57, pp. 750-751.
1924. *Katayama nosophora* FAUST and MELENEY, Amer. Journ. Hyg., Mon. Ser. no. 3, p. 82.
1924. *Oncomelania formosana* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, pp. 284-286, 293, pl. 36, figs. 3-5.
1924. *Katayama formosana* FAUST, Amer. Journ. Hyg., vol. 4, p. 274.
1925. *Katayama formosana* BARTSCH, Journ. Washington Acad. Sci., vol. 15, p. 71.

1925. *Blanfordia formosana* BARTSCH, Journ. Washington Acad. Sci., vol. 15, p. 71.
1926. *Oncomelania (Hyphsobia) formosana* GERMAIN and NEVEU-LEMAIRE, Ann. Parasit., vol. 4, p. 294.
1928. *Blanfordia formosana* BEQUAERT, Amer. Journ. Trop. Med., vol. 8, p. 225.
1929. *Katayama formosana* FAUST, Human Helminthology, p. 136.
1932. *Blanfordia formosana* TUBANGUI, Philippine Journ. Sci., vol. 49, p. 299, pl. 2, fig. 4.
1934. *Blanfordia formosana* BEQUAERT, Journ. Parasit., vol. 20, p. 281.

Shell elongate-ovate, thin, semitranslucent, horn-colored, bordered by a chocolate-brown line. Interior of the aperture of the same color as the exterior. Nuclear whorls 2.0, well rounded, smooth, except for exceedingly fine microscopic granules, forming a rather blunt apex. Postnuclear whorls somewhat inflated, strongly rounded, and marked by slightly retractively curved incremental lines, which here and there assume the strength of obsolete threads. There are also obsolete spiral lirations present. Suture strongly impressed; periphery inflated, strongly rounded. Base rather short, strongly rounded, narrowly umbilicated and marked like the spire. The last whorl has a heavy callus behind the outer lip which extends to the columella. Aperture broadly ovate; outer lip thin, slightly reflected and adnate at the parietal wall to the preceding turn. Operculum thin, paucispiral, horny, consisting of 3.2 whorls with the nucleus excentric. The radula possesses the typical katayamid formula, that is $\frac{1-1-1}{3-3}$, for

the rachidian tooth. The lateral has likewise the typical rachidian formula of 6 denticles, with the third counting from the inside, much larger than the rest. The first marginal has 9 denticles and the outer marginal has 5 denticles with the innermost much larger than the rest.

The specimen described and figured, U.S.N.M. no. 307270, is one of several hundred specimens from Rono, Formosa. It has 7.2 whorls, and measures: Height, 6.5 mm; diameter, 3.4 mm.

A hundred additional specimens, U.S.N.M. no. 420941, yield the measurements given in the subjoined table.

	No. of whorls	Height in mm	Diameter in mm	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 307270..	7.2 ^a	6.5	3.4	6.7	5.5	3.0
				6.8	5.7	2.9
U.S.N.M. no. 420941..	6.8	5.5	2.9	6.4	4.8	2.5
	6.4	5.0	2.9	6.4	5.2	2.7
	6.5	5.3	2.8	6.3	4.7	2.5
	6.4	5.0	2.8	6.8	5.8	3.0
	6.5	5.6	3.2	6.3	5.3	2.9
	6.5	5.3	2.9	7.3	6.4	3.2
	7.2	5.9	2.9	6.8	5.3	2.7

	No. of whorls	Height in mm	Diameter in mm	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 420941..	7.0	5.8	3.1	6.5	4.9	2.5
	7.2	6.3	3.2	6.3	4.8	2.5
	6.4	5.7	3.1	6.4	5.2	2.7
	6.5	5.1	2.8	6.8	5.5	2.8
	6.4	4.7	2.5	6.6	5.5	2.9
	6.7	5.0	2.5	7.1	6.0	2.9
	6.6	5.2	2.8	6.6	5.5	2.8
	5.6	4.2	2.6	6.5	5.1	2.8
	6.3	4.8	2.7	6.6	5.4	3.0
	6.4	5.3	2.9	6.4	4.9	2.7
	6.8	5.4	2.9	6.8	5.2	2.7
	7.2	6.0	3.2	6.3	5.3	2.9
	7.0	5.8	3.0	6.7	5.3	2.8
	7.0	5.7	3.0	6.7	5.5	3.0
	6.5	5.2	2.7	6.7	5.6	3.0
	6.8	5.3	2.8	6.4	5.2	2.9
	6.5	5.0	2.8	6.6	5.5	3.1
	6.5	5.3	2.7	6.4	5.1	2.8
	7.0	5.8	3.2	6.6	5.2	2.8
	7.2	6.2	3.1	6.7	5.3	2.9
	7.2	5.6	2.8	6.3	4.9	2.5
	6.9	5.5	3.0	6.6	5.6	2.9
	6.8	5.9	3.2	6.5	5.0	2.6
	6.4	5.1	3.0	6.7	5.6	3.1
	6.4	5.2	2.9	7.2	6.1	3.0
	6.4	4.9	2.7	6.7	5.6	2.9
	6.7	5.5	2.8	6.9	5.9	2.9
	7.3	6.4	3.1	6.1	4.7	2.7
	6.7	5.6	2.9	6.0	4.5	2.5
	6.4	4.9	2.6	6.1	4.7	2.5
	6.6	5.6	3.0	6.8	5.5	2.9
	6.5	5.1	2.8	6.3	4.7	2.5
	7.1	6.2	3.2	6.5	4.8	2.5
	7.3	6.1	3.1	6.4	5.2	2.7
	6.8	5.6	2.9	6.6	5.4	2.9
	6.5	5.6	2.9	6.7	5.7	3.0
	7.0	5.8	3.1	6.4	5.0	2.6
	7.0	5.6	2.8	6.5	5.6	3.0
	6.3	4.8	2.6	6.4	5.2	2.8
	6.8	5.7	3.0	6.4	5.1	2.6
	7.0	5.6	2.8	6.4	4.9	2.7
	6.8	5.5	2.8	6.6	5.2	2.5
Greatest	7.3	6.4	3.2			
Least	5.6	4.2	2.5			
Average	6.63	5.37	2.84			

^a Figured specimen.

This species can at once be distinguished from all the other *Katayamas* by its elongate-ovate shape.

KATAYAMA LII, n. sp.

Plate 1, fig. 5; plate 2, fig. 11; plate 4, fig. 4; plate 6, figs. 4, 7

Shell elongate-conic, moderately heavy, horn-colored with a narrow chocolate-brown line edging the peristome. The interior of the aperture is the same as the exterior. Nuclear whorls 2.1, well rounded, smooth except for fine microscopic granulations. The postnuclear whorls are well rounded, marked by low, obsolete, threadlike incremental lines which are rather coarse and of varying size and spacing. Microscopic lirations are merely indicated as a spiral sculptural element. Suture moderately strongly constricted; periphery of the last whorl well rounded. Base well rounded, narrowly umbilicated, marked like the spire. There is an exceedingly strong callus behind the outer peristome, which extends over the columella and renders this rather thickened. Aperture broadly ovate, tending toward subquadrate. Peristome slightly expanded and reflected and adnate to the preceding whorl at the parietal wall. Operculum thin, horny, paucispiral, having 3.2 turns with the nucleus excentric. The radula has the typical rachidian tooth, that is, $\frac{1-1-1}{3-3}$. The lateral is likewise typically katayamid, having 6 denticles with the third from the inside much larger than the rest. The inner marginal bears 9 denticles and the outer 7.

The type, U.S.N.M. no. 420949, is a complete specimen with 8.5 whorls and measures: Height, 8.0 mm; diameter, 3.4 mm.

We have three additional specimens, U.S.N.M. no. 420942, which yield the following measurements. These were collected by Dr. Fuching Li, for whom the species is named, at Lin-an and Hiau-Fen, China, respectively.

	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 420949.....	8.5 ^a	8.0	3.4 (type)
U.S.N.M. no. 420942.....	7.5	8.2	3.2
	8.7	8.2	3.4
	7.2	7.7	3.4

^a Type specimen.

This species is most nearly related to the other two Chinese forms here described, but differs from them conspicuously in its larger size and the radular formula.

KATAYAMA FAUSTI Bartsch

Plate 1, fig. 2; plate 2, fig. 10; plate 4, fig. 5

1924. *Oncomelania nosophora* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, pp. 283-284, in part, also p. 293.
1924. *Katayama nosophora* FAUST, Amer. Journ. Hyg., vol. 4, pp. 243, 269, 274.
1925. *Katayama fausti* BARTSCH, Journ. Washington Acad. Sci., vol. 15, pp. 71-72.
1926. *Oncomelania (Hypsobia) nosophora* GERMAIN and NEVEU-LEMAIRE, Ann. Parasit., vol. 4, p. 293, in part.
1929. *Katayama nosophora* FAUST, Human Helminthology, p. 136, in part.

Shell elongate-conic, brownish horn-colored. Nuclear whorls decollated in all our specimens. The postnuclear whorls, well rounded, marked by irregular, rather coarse, incremental lines, which might be interpreted as closely spaced obsolete riblets, which are best developed on the last turn. Suture strongly constricted; periphery well rounded. Base slightly prolonged, well rounded, marked by a continuation of the sculpture present on the spire, narrowly umbilicated. The last whorl is provided with a very heavy callus immediately behind the aperture, which extends over the base of the lip on to the columella, thickening this materially. The outer lip is slightly expanded and reflected and adnate to the preceding turn at the parietal wall. The operculum is thin, corneous, paucispiral with excentric nucleus. The radula has the formula $\frac{1-1-1}{3-3}$, 2-1-3 for the median, that is, two inner small teeth followed by a very large third and 3 small. The inner marginal has 8 denticles and the outer 5.

The type, U.S.N.M. no. 362025, as well as two additional specimens, U.S.N.M. no. 362026, were collected by Dr. E. C. Faust at Shaohing, Chekiang Province, China. They yield the following measurements:

	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 362025.....	5.4 ^a	6.6	3.0
U.S.N.M. no. 362026.....	5.2	5.5	2.8
	4.7	6.5	3.2

^a Figured type.

This species can readily be distinguished from *Katayama lii* by its smaller size and radular formula, and from *Katayama cantoni* by its radular formula and heavier coarser shell.

KATAYAMA CANTONI Bartsch

Plate 1, fig. 3; plate 2, fig. 13; plate 4, fig. 6

1924. *Oncomelania nosophora* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, pp. 283-284, in part.
1925. *Katayama fausti cantoni* BARTSCH, Journ. Washington Acad. Sci., vol. 15, pp. 71-72.
1926. *Oncomelania (Hypsobia) nosophora* GERMAIN and NEVEU-LEMAIRE, Ann. Parasit., vol. 4, pp. 292-293, in part.

Shell elongate-conic, thin, semitranslucent, horn-colored, the outer lip bordered with a slightly darker edge. The early whorls eroded, those remaining well rounded and marked by obsolete incremental lines, and on the last whorl by indications of irregularly distantly spaced, axial threads. Suture constricted; periphery well rounded. Base well rounded, narrowly umbilicated and marked by the same sculpture that characterizes the spire. The last whorl has a little behind the aperture a moderately thick callus that extends over the base of the lip to the columella, which it somewhat thickens. Aperture ovate; outer lip slightly expanded and reflected and adnate to the preceding turn at the parietal wall. The operculum is thin, horn-colored, and paucispiral with 3.2 whorls, and has an excentric nucleus.

The radula has the typical rachidian tooth $\frac{1-1-1}{3-3}$. The lateral is also typical, 2-1-3, that is, 2 smaller inner denticles with a large third tooth followed by 3 lesser denticles. The inner marginal has 7 denticles, the outer 5.

The type, U.S.N.M. no. 362027, was collected by Dr. E. C. Faust at Fatshan, near Canton, China. It has 5.3 whorls and measures: Height, 6.4 mm; diameter, 2.8 mm.

An additional specimen, U.S.N.M. no. 362028, from the same source yields the following measurements: Height, 6.3 mm; diameter, 3.1 mm. It has 5.3 whorls.

This species, which we first considered a subspecies of *fausti*, is far removed from that by reduction of the denticles of the inner marginal tooth to 7. The shell also is thinner and more fragile.

SCHISTOSOMOPHORA, n. gen.

Genotype.—*Prososthenia quadrasi* Möllendorff.

The discovery of the intermediate host of the Asiatic blood fluke in the southern Philippines by Tubangui made it desirable to investigate its relationship to the other schistosomophorous mollusks, with the result that although related to *Katayama* and *Oncomelania*, the

mollusks in question, nevertheless, are as different from each of these as these differ among themselves. It is for this reason that I propose the generic name *Schistosomophora* for them.

HISTORY

In 1895 von Möllendorff (10) described, among other minute operculates, *Prososthenia quadrasi* from near the town of Surigao, northeastern Mindanao, Philippine Islands. Little did he suspect the important role that this insignificant-looking snail would be found to play in the health of this region. We, therefore, find little beyond a mere listing of the species in catalogs of mollusks until Tubangui (40) established its intermediate host status in his paper on "The Molluscan Intermediate Host in the Philippines of the Oriental Blood Fluke *Schistosoma japonicum* Katsurada."

Following Tubangui, Rensch (41), to whom some of these mollusks were sent for determination, christened them *Oncomelania hydrobiopsis* in 1932.

In 1934 Bequaert (44) published "The Molluscan Intermediate Host of the Blood Fluke, *Schistosoma japonicum* Katsurada", where he calls it *Blanfordia quadrasi*, and makes *Oncomelania hydrobiopsis* Rensch synonymous with it.

GENERIC DEFINITION

Shell.—Shell small, elongate-ovate, thin, horn-colored or darker, with a slender dark line bordering the peristome. Nuclear whorls 2.0, inflated, strongly rounded, glassy, appearing finely granulated under very high magnification. Postnuclear whorls inflated, well rounded, marked by retractively slanting lines of growth, which in *hydrobiopsis* assume almost the strength of threads. In this they are rather coarse and closely approximated. In the other two species the indication of axial sculpture, although similar, is very much reduced, that is, merely indicated. Suture strongly constricted; periphery inflated, well rounded. Base short, inflated, strongly rounded, narrowly umbilicated. There is a thickening of the outer lip behind the aperture into a callus, which is scarcely indicated in *minima*.

Operculum.—Operculum thin, horny, paucispiral, consisting of only 1.5 whorls, which have the nucleus excentric.

Radula.—The radula is small and has a rachidian tooth with 5 denticles, of which the middle one is the largest and the other two decrease in size. There are only 2 basals on each side present in this

genus. The formula for it, therefore, is $\frac{2-1-2}{2-2}$. The median tooth is oblique, similar in shape to that of the other genera and bears 7 denticles, of which the median is much larger than the rest. The first marginal varies from 8 to 9 in the different species, and the outer marginal from 8 to 6.

Animal.—Of this I know nothing, except the features described under shell, operculum, and radula. Of its ecology I may quote from Dr. Tubangui (40):

The Philippine snail further agrees with the other species of *Blanfordia*, or *Oncomelania*, in its amphibious habits. It was very seldom encountered under water, but most frequently under dead leaves and other objects in moist surroundings above the edge of the water. It was also often seen attached to the stems and leaves of grasses and other weeds and to such objects as house and bridge posts, its position in every case being just a few millimeters above the surface of the water. It was never met with in the vicinity of principal rivers or their branches where the current is rapid, but seems to prefer small bodies of water where there is very little, if any, current. It appears to be a dirty feeder, for it was collected in largest numbers along the banks of a small mountain brook, a pond, a terminal irrigation canal, and irrigated rice paddies, where there are houses and where the presence of human faeces was very apparent. * * * the Philippine mollusk can withstand prolonged desiccation, at least up to four weeks under laboratory conditions.

SCHISTOSOMOPHORA QUADRASI (Möllendorff)

Plate 1, fig. 8; plate 2, fig. 5; plate 3, fig. 1

1895. *Prososthenia quadrasi* MÖLLENDORFF, *Nachrichtsbl. Deutsch. Malakoz. Ges.*, vol. 27, p. 138.
1932. *Prososthenia quadrasi* TUBANGUI, *Philippine Journ. Sci.*, vol. 49, pp. 298-301.
1932. *Blanfordia quadrasi* TUBANGUI, *Philippine Journ. Sci.*, vol. 49, pp. 298-301, pl. 2, fig. 3.
1934. *Prososthenia quadrasi* BEQUAERT, *Journ. Parasit.*, vol. 20, pp. 280-282.

Shell small, regularly elongate-conic, thin, semitranslucent, horn-colored with the edge of the peristome marked by a line of chestnut brown. The first turn of the nucleus has been lost; the last is rounded, smooth, and, under high magnification, minutely granulose. Post-nuclear whorls very inflated, strongly rounded, and marked by feeble, almost vertical, incremental lines which give one the impression of very fine threads, closely approximated when viewed under high magnification. Indications of spiral striations here are more pronounced than in *Schistosomophora hydrobiopsis*. Suture strongly constricted; periphery inflated, strongly rounded. Base inflated,

strongly rounded, moderately broadly umbilicated, a little more so than in *Schistosomophora hydrobiopsis*. The outer lip is reenforced by a heavy callus a little behind the peristome. Aperture broadly oval and rather broadly expanded and reflected, adnate to the preceding turn at the parietal wall. The operculum is thin, horny, and has 1.5 whorls, which are excentric. In the radula the rachidian tooth has the formula $\frac{2-1-2}{2-2}$. The median has 7 denticles, of which the middle one is much larger than the rest. The inner marginal has 8 denticles, the outer 7.

The specimen described and figured, U.S.N.M. no. 420943, a paratype, received from the von Möllendorff Collection, was collected by Quadras at Surigao, Mindanao, Philippine Islands. It has 5.9 whorls, and measures: Height, 5.2 mm; diameter, 3.0 mm.

This species differs from *Schistosomophora hydrobiopsis* in being stouter and having the whorls more inflated, the axial sculpture finer and closer spaced and indications of spiral sculpture stronger, and in having 7 denticles in the outer marginal tooth of the radula.

SCHISTOSOMOPHORA HYDROBIOPSIS (Rensch)

Plate 1, fig. 7; plate 2, fig. 6; plate 3, fig. 2

1932. *Oncomclania hydrobiopsis* RENSCH, Philippine Journ. Sci., vol. 49, pp. 551-552, figs. 1a-c.
 1932. *Blanfordia quadrasi* TUBANGUI, Philippine Journ. Sci., vol. 49, pp. 298-299, pl. 2, fig. 3, pl. 5, fig. 1.
 1932. *Prososthenia quadrasi* TUBANGUI, Philippine Journ. Sci., vol. 49, pp. 298-299, 301.
 1934. *Blanfordia quadrasi* BEQUAERT, Journ. Parasit., vol. 20, pp. 280-281.
 1934. *Oncomclania hydrobiopsis* BEQUAERT, Journ. Parasit., vol. 20, p. 281.
 1934. *Prososthenia quadrasi* BEQUAERT, Journ. Parasit., vol. 20, pp. 280-281.

Shell small, elongate-ovate, thin, light horn-colored, with the nuclear whorls transparent; a slender chestnut-brown line edges the peristome. Nuclear whorls 2.0, inflated, strongly rounded, glassy, appearing finely granulated under very high magnification. Post-nuclear whorls moderately inflated, strongly rounded, and marked by rather strong, slightly retractively curved lines of growth which almost constitute axial riblets. In addition to this there are faint indications of spiral sculpture—so faint that only under certain angles of the light does this become apparent, chiefly about the periphery and the upper portion of the base. Suture strongly constricted; periphery inflated, well rounded. Base short, moderately umbilicated, marked by the same sculpture as the spire. The outer lip is reenforced

behind the peristome by a very heavy callus which extends down to the base. Aperture broadly ovate, slightly expanded and reflected and adnate to the preceding turn at the parietal wall. The operculum is thin, corneous, and consists of 1.5 whorls. It has an excentric nucleus. In the radula the rachidian tooth has the formula $\frac{2-1-2}{2-2}$.

There are 7 denticles on the lateral tooth, of which the middle is by far the heaviest. Both the first and second marginals have each 8 denticles.

U.S.N.M. no. 426101 contains 17 topotypes collected by Dr. Tubangui, and presented to us by Dr. Faustino of the Philippine Bureau of Science, from Polo, Leyte, the type locality. Fifteen of these have yielded the following measurements:

	No. of whorls	Height in mm	Diameter in mm
U.S.N.M. no. 426101.....	6.2 ^a	4.6	2.7
	6.5	4.7	2.6
	5.7	4.9	2.7
	5.5	5.0	2.8
	5.4	4.9	2.9
	5.5	4.7	2.7
	5.7	3.9	2.5
	6.1	4.3	2.5
	6.2	4.3	2.6
	5.8	4.1	2.5
	5.7	3.9	2.4
	4.3	3.7	2.4
	5.6	3.7	2.2
	4.8	4.7	2.8
	5.1	4.7	2.7
Greatest	6.5	5.0	2.9
Least	4.3	3.7	2.2
Average	5.6	4.4	2.6

^a Figured specimen.

Schistosomophora hydrobiopsis can be distinguished from *quadrasi* by the stronger axial sculpture and by the narrow umbilicus and in having 8 denticles in both marginals.

SCHISTOSOMOPHORA MINIMA, n. sp.

Plate 1, fig. 9; plate 2, fig. 7; plate 3, fig. 3

Shell minute, elongate-ovate, thin, horn-colored, with the outer edge marked by a hairline of chestnut brown. Early whorls decollated in all our specimens, those remaining, inflated, strongly rounded and

marked by retractively curved lines of growth, which on the last whorl suggest obsolete threads of irregular width and spacing. In addition to this there are feeble, poorly defined, spiral lirations which are best seen on the last turn. Suture strongly constricted; periphery inflated, strongly rounded. Base short, moderately broadly umbilicated and marked by the same sculpture that characterizes the last whorl. Aperture large, broadly ovate, with the peristome slightly expanded and reflected. The thickening on the outer lip behind the peristome characteristic of the other members of the group almost absent. The operculum is thin, corneous, and consists of 1.5 turns with the nucleus strongly excentric. In the radula the rachidian tooth has 5 denticles, of which the median is the strongest. There are 4 basals, that is, the formula is $\frac{2-1-2}{2-2}$. The lateral tooth is very oblique and has 7 denticles, of which the middle one is much stronger than the rest. The inner marginal has 9 denticles and the outer 6.

The type, U.S.N.M. no. 420950, was collected by Mr. Hirase at Noto, Honshu Island, Japan. It has 3.4 whorls remaining, the apical ones of which are badly eroded, and measures: Height, 3.5 mm; diameter, 2.4 mm.

Two additional specimens, U.S.N.M. no. 346039, yields the following measurements: 2.5 and 2.7 whorls; height, 3.4 and 3.0 mm; diameter, 2.2 and 2.3 mm, respectively.

This species is much smaller than the two Philippine members and has a quite different formula for the outer radular tooth.

These shells were sent to us by Y. Hirase under the name *Blandfordia minima* Hirase. I have been unable to find a description of this, and therefore consider that the name is new.

ONCOMELANIA Gredler

Genotype.—*Oncomelania hupensis* Gredler.

From the very first to the last published paper upon members of this genus doubt and uncertainty seem to have possessed the minds of the students reporting upon them.

Gredler (5), in creating the genus and species *Oncomelania hupensis*, devotes considerable space to the justification of this act. Heude (8), after describing six new species and recognizing two of the previously named forms, also seems to have been puzzled about the many forms which he described, for he says:

In the presence of the forms figured on plate 33, everybody is at liberty to decide for himself whether we have only local modifications of the same thing in different localities which would be nothing but simple varieties, or if those

modifications are sufficient to adopt the specific names here proposed. In the former case we would have nothing but varieties of the earlier *Oncomelania hupensis* Gredler * * * which would mean that the province of Hupeh is the mother country of the prototype. There is nothing against this because from the appearance of this species this territory more than in our days must have been a vast fresh-water sea, mixing the waters of lakes Po-yang and Tong-ting with those of the upper Yangtze.

From that time to Dr. Li's able efforts, doubt and uncertainty as to the scientific status of the named species have obtained.

I hope that definitely separating the Katayamas from the *Oncomelania*s will remove some of the difficulties. Also that the recognizing of Heude's species and the adding of some more will stimulate the collecting and studying of material from many more localities and that this may result in removing the doubts expressed by Heude, which I am not altogether able to allay.

HISTORY

This genus was established in 1881 by Vincenz Gredler (5) for *Oncomelania hupensis* Gredler. He based his contention on three specimens collected by P. Fuchs in March at "U-tschang-fu" (Wuchang, Hupeh Province).

The next to add to our knowledge of the group was O. F. von Möllendorff (6), who in 1888 believed that *Oncomelania* Gredler should be replaced by the earlier *Prososthenia* Neumayr, in which we do not concur, but in spite of his contention he here also describes and figures *Oncomelania schmackeri* collected by Schmacker "near Shanghai."

In 1889 R. P. M. Heude (7) discusses *Prososthenia* and *Oncomelania* and states that the latter name is not suitable because it suggests affinities with *Melania*, while in reality the mollusks in question he believes belong to the Rissoidae. He states that for a long time they have had this labeled *Hemibia* in their museum, and he therefore rechristens it *Hemibia* on account of the amphibious habits of the animal. *Hemibia*, therefore, is a pure and simple synonym of *Oncomelania* with the same type, *i. e.*, *Oncomelania hupensis* Gredler.

In 1890 B. Schmacker and O. Böttger (9) discuss *Prososthenia schmackeri* and state that they have typical specimens from the hills near Shanghai; Kah-ding (Kashing) near Shanghai; Chapoo (Chapu) on Hang-choo (Hangchow) Bay and Kiukiang (Kiangsi Province). Here also they describe *Prososthenia moellendorffi* from Ningkuofu (Ningkwofu), Anhwei Province.

By far the most extensive work on the group was done by P. M. Heude (8), who, in the same year, 1890, published six additional species in his memorable work on the terrestrial and freshwater mollusks of the valley of the Fleuve Bleu. Here he refers all the species to the genus *Hemibia*. He gives figures of the shell of *Hemibia schmackeri* on plate 33, figure 1a, and of the soft parts on the same plate in figures 1 to 5, and of the radula, figure 7 (enlarged 400 times). The material upon which these studies are based came from "Grand Lac" (Lake Tai Hu).

He here lists *Hemibia hupensis* Heude, which his figure 19, plate 33, plainly proclaims to be *Oncomelania schmackeri*.

His next species is *Hemibia sublevis*, which he figures on plate 33, figure 15. This figure agrees with Schmacker and Böttger's description and figure of *Oncomelania moellendorffi*, and comes from almost the same locality.

Both *Oncomelania moellendorffi* and *Oncomelania sublevis* were described in 1890. Schmacker and Böttger's paper was published in the July-August number of the *Nachrichtsblatt*. No exact date for Heude's publication is available. It was reviewed in October. I shall accept the name *moellendorffi*, unless it is proved to be antedated by *sublevis*, because it was better described.

His next species, *Hemibia carectorum*, is figured on plate 33, figure 16, and is said to come from the left bank of the Yangtze opposite Nanking; this I believe also to be merely a form of *Oncomelania schmackeri*.

His next species, *Hemibia luteola*, we also feel is nothing but a variant of *Oncomelania schmackeri*; it is his figure 17.

Hemibia crassa Heude, plate 33, figure 18, comes from farther up the Yangtze, namely, "Tong-lieou" (Tungliuhs), Anhwei Province. We have no specimens from that region and quote his text and figure.

His next species, *Hemibia longiscata*, is figured on plate 33, figure 20, and comes from opposite "Kin tcheou-fu" (Kingchowfu), Hupeh Province.

His last species, *Hemibia costulata*, like the foregoing, represents the most western location known. He does not figure it, but the sculptural characters and size make me hesitate to refer it to the large species. We shall, therefore, consider it distinct and quote his description. It comes also from the same locality as the last.

Heude's many names and the lack of comparative material evidently held up further advances in our knowledge of *Oncomelania*. It was

not until these mollusks were implicated as intermediate hosts of *Schistosoma japonicum* that a renewed interest was manifested.

Bavay and Dautzenberg (18, p. 38), in their "Description de Coquilles Nouvelles de l'Indo-Chine", discuss *Oncomelania* and *Hemibia*.

In 1923 Meloney and Faust (29) demonstrated that *Oncomelania* served in the Soochow area as intermediate host of *Schistosoma japonicum*.

In 1924 Faust (34) published "Schistosomiasis in China", in which he states that he and Meloney also found what they called *Katayama nosophora*, which I named in 1925 *Katayama fausti*, to be a carrier.

In the same year appeared Faust's (33) paper, "Notes on Larval Flukes from China", in which he cites all the localities in which they have demonstrated intermediate hosts.

Faust here states that:

These forms are all amphibious in habits. They are not found in large or swift bodies of water, but in among the grass and weeds and moist humus of overhanging banks all along terminal canals and quiet coves. They are also found in the rice nursery beds * * * The snails do not live in clayey soil, but can usually be located near freshly deposited human fertilizer. The region north of the Yangtze Valley is incompatible to their existence. Here, too, the *Oncomelania*s are found only in streams with considerable lime supply.

Faust and Meloney's schistosomiasis studies in China resulted in Nelson Annandale's researches in intermediate host subject. His studies (31) are recorded in 1924 in his paper on "The Molluscan Hosts of the Human Blood Fluke in China and Japan, and Species Liable to be Confused with Them", where he expresses the conclusion that *Katayama* of Robson is not generically distinct from *Oncomelania*. He fails to recognize true *Oncomelania hupensis*, citing 8 mm for its height, though that species is almost half again that size. He lumps all of Heude's species under *Oncomelania hupensis*, retaining only as doubtfully specifically distinct, *Oncomelania longiscata* and *Oncomelania sublaevis*. Such a conclusion is not surprising, considering the scant material available for his studies. He establishes two sections: *Katayamae* and *Hemibiae*. In the first he places *Oncomelania nosophora* (Robson) and *Oncomelania formosana* (Pilsbry). His *Hemibiae* embraces *Oncomelania hupensis* Gredler, in which species he includes *Melania* (? *Sulcospira*) *schmackeri* Böttger erroneously, also Heude's *Hemibia schmackeri*, *carectorum*, *luteola*, *crassa*, and *costulata*, and *Oncomelania sublaevis* (not *sublevis* Heude) and *longiscata*. His treatment of *Blanfordia* has been discussed under that genus.

In 1924 Faust (33, p. 276) states of *Katayama* in China that the *Katayama* species appear to live only in mountain stream water, and the *Oncomelania* species have been found only in water with considerable lime supply.

Bartsch (35), in his paper on "Some new Intermediate Hosts of the Asiatic Human Blood Fluke", refers to *Oncomelania*.

In 1926 L. Germain and M. Neveu-Lemaire (36), in their "Essai de Malacologie Medicale", make *Hemibia* Heude, 1889, a subgenus of *Oncomelania* and recognize under this *Oncomelania* (*Hemibia*) *hupensis* Gredler, *Oncomelania* (*Hemibia*) *sublaevis* Heude and *Oncomelania* (*Hemibia*) *longiscata* Heude. They give enlarged figures of a shell which they consider *Oncomelania* (*Hemibia*) *hupensis*, but which in reality is *Oncomelania schmackeri* Möllendorff.

In 1928 Bequaert (37) in his exhaustive paper, "Mollusks of Importance in Human and Veterinary Medicine", refers *Oncomelania hupensis* to *Hemibia*.

Thiele (38), in his "Handbuch der Systematischen Weichtierkunde", 1929, page 150, considers *Hemibia* of Heude and *Katayama* of Robson synonymous with *Oncomelania*.

Tubangui (40), in his paper, 1932, "The Molluscan Intermediate Host in the Philippines of the Oriental Blood Fluke, *Schistosoma japonicum* Katsurada", refers to *Oncomelania*.

Rensch (41), in his "Eine Neue Hydrobiidae von den Philippinen", calls his shell *Oncomelania hydrobiopsis*. I have here rechristened it *Schistosomophora hydrobiopsis*.

Bequaert (44) in his 1934 paper, "The Molluscan Intermediate Host of the Blood Fluke, *Schistosoma japonicum* Katsurada", in the Philippines discusses the relationship of this animal to *Oncomelania*.

By far the most important paper, from a molluscan standpoint, was contributed by Dr. Fu-ching Li (46), "Anatomie, Entwicklungsgeschichte, Oecologie und Rassenbestimmung von *Oncomelania*, des Zwischenwirtes von *Schistosoma japonicum* (Katsurada 1904) in China." He here gives a very careful anatomic and embryologic, as well as ecologic, study of *Oncomelania*. I have quoted extensively from this in my introduction to the genus.

GENERIC DEFINITION

Shell.—The shell of *Oncomelania* is elongate-conic, moderately thick. It is covered with a yellow, greenish, or olivaceous periostracum, which darkens materially at the edge of the peristome. Nuclear whorls 2, well rounded, smooth except for microscopic granules. The

early postnuclear whorls are marked by incremental lines and gradually developing axial ribs which vary materially in strength and spacing in the various species. These ribs extend over the periphery and base but become enfeebled toward the umbilicus. The spaces between the ribs, as well as the axial ribs themselves, are marked by slender threadlike incremental lines which also vary decidedly in strength. In addition to this, these incremental lines in some of the species are flexed at more or less regular intervals, which tends to give them a spiral sculpture effect. In mature shells a strong varix is present a little behind the edge of the peristome of the outer and basal lip, which in some of its species decidedly thickens even the base of the columella. Suture strongly impressed. Periphery rounded. Base narrowly umbilicated. Aperture somewhat oblique, varying from oval to subquadrate. Peristome thin, expanded and reflected, adnate to the preceding whorl at the parietal wall.

Operculum.—The operculum is thin, corneous, paucispiral, having 2.2 whorls, with very excentric nucleus. The operculum in number of whorls therefore agrees with *Blanfordia*, but is much smaller and with more excentric nucleus.

Radula.—The radula of the various species of *Oncomelania* show no diversions in the rachidian or lateral teeth. The rachidian tooth has 3 denticles on the free edge, of which the central is the larger. It also has two pairs of basals; its formula, therefore, is $\frac{1-1-1}{2-2}$. In this respect it stands between *Katayama*, which has the formula $\frac{1-1-1}{3-3}$, and *Schistosomophora*, which has the formula $\frac{2-1-2}{2-2}$. The lateral tooth is very oblique and bears 6 denticles, of which the third from the inside is by far the largest. This may be designated as 2-1-3, in which respect it agrees with *Katayama*, but not *Schistosomophora*, which has 3-1-3. It is in the inner marginal that we find considerable variation. One group has 9, a second 7, and another 6 denticles. The outer marginal bears 5 denticles, of which the inner is larger than the rest, in which character it agrees with both *Katayama* and *Schistosomophora*.

Animal.—The animal of *Oncomelania schmackeri* was figured by Heude (8), plate 33, figures 1-7. Li (46) also based his splendid anatomic and embryologic studies on this species.

I have not seen living specimens and would have to quote from these sources; I prefer to refer students to Dr. Li's careful and

detailed study. I may merely call attention to the fact that the foot in *Blanfordia* is divided, while that of *Oncomelania* is entire.

Egg.—Li (46) states, pages 128-9, that he found the eggs at Djia Schan in 1933 laid in the water in April and May in masses of 15-30 enclosed in a jelly mass and attached to stones and plants. This also distinguishes them from those of *Katayama*, whose eggs are deposited singly or in short chains.

Ecology.—Of *Hemibia hupensis*, Faust and Meleney (32) write:

In warm weather it inhabits the moist earth, just above the water's edge, always within 50 cm. of the water and usually within 10 cm. of it. It is found attached to the earth, to stones or to the stems of grass or plants growing out of the water. It prefers sloping banks but avoids exposure to the sun. It must therefore be searched for in secluded spots, beneath loose grass, under projecting clods of earth or beneath stones. The bodies of water on whose shores it is found are relatively clear, cool and still. It has not been found in large canals where there is much traffic and where there is, therefore, much movement of the water, but may be found not over four or five meters from such a canal, in a small terminal branch. It may be found singly or in groups. . . . It is occasionally found on stones or roots of grass, a few centimeters below the surface of the water, but dredgings of deep water-grass have not been found to contain it, nor has it been found in the bottom of a canal on whose shore it was abundant.

In the laboratory, if placed in a deep glass dish in shallow water, it usually climbs out from the water in a few minutes, on the side of the dish away from the window, and, after creeping far enough to free itself from water, will fasten its shell to the glass by mucus at the aperture, retreat into its shell and remain there for hours or days. It may drop or creep back into the water, or may possibly remain desiccated until death. Reimmersion in water after such drying, usually brings the snail rapidly out of its shell and into full activity.

KEY TO THE SPECIES OF ONCOMELANIA⁴

Denticles on the marginal teeth 9: 5.

Axial ribs 20 or more per whorl. *moellendorffi*.

Axial ribs 18 or less per whorl. *longiscata*.

Denticles on the marginal teeth not 9: 5.

Denticles on the marginal teeth 7: 5.

Axial ribs poorly developed. *elongata*.

Axial ribs strongly developed.

Incremental lines strong. *hupensis*.

Incremental lines feeble. *schmackeri*.

Denticles on the marginals not 7: 5.

Denticles on the marginals 6: 5. *multicosta*.

⁴Heude's *Hemibia crassa* and *Hemibia costulata* are not included in this key for want of material from the type locality.

Summary of Characters of the Species of *Oncomelania* ^a

Name	Radula formula	No. of whorls remaining	No. of axial ribs per whorl	Height in mm	Diameter in mm
<i>moellendorffi</i>	$\frac{1-1-1}{2-2} : 2-1-3 : 9 : 5$	6.14	22.27	7.35	3.24
<i>longiscata</i>	$\frac{1-1-1}{2-2} : 2-1-3 : 9 : 5$	6.38	12.65	8.04	3.77
<i>elongata</i>	$\frac{1-1-1}{2-2} : 2-1-3 : 7 : 5$	8.95	16.04	9.45	3.80
<i>hupensis</i>	$\frac{1-1-1}{2-2} : 2-1-3 : 7 : 5$	7.02	12.50	8.21	3.76
<i>schmackeri</i>	$\frac{1-1-1}{2-2} : 2-1-3 : 7 : 5$	5.85	15.29	7.41	3.58
<i>multicosta</i>	$\frac{1-1-1}{2-2} : 2-1-3 : 6 : 5$	6.60	21.50	8.05	3.48

^a *Oncomelania crassa* and *Oncomelania costulata* are not included for lack of material.

ONCOMELANIA MOELLENDORFFI (Schmacker and Böttger)

Plate 1, fig. 19; plate 2, fig. 18; plate 5, fig. 1

1890. *Prososthenia moellendorffi* SCHMACKER and BÖTTGER, *Nachrichtsbl. Deutsch. Malakoz. Ges.*, vol. 22, pp. 126-7, pl. 2, fig. 7.
1890. *Hemibia sublevis* HEUDE, *Mem. Concern. Hist. Nat. Emp. Chinois*, p. 168, pl. 33, fig. 15.
1924. *Oncomelania sublaevis* ANNANDALE, *Amer. Journ. Hyg., Mon. Ser. no. 3*, p. 287.
1926. *Oncomelania (Hemibia) sublaevis* GERMAIN and NEVEU-LEMAIRE, *Ann. Parasit.*, vol. 4, p. 294.
1932. *Oncomelania moellendorffi* RENSCH, *Philippine Journ. Sci.*, vol. 49, p. 552.

Shell elongate-conic, the early whorls a little paler than the later, which are olive-colored. The postnuclear whorls are moderately rounded and crossed by rather retractorily slanting axial ribs, which are about as wide as the spaces that separate them. Of these ribs 19 occur on the last turn behind the varix, 29 on the penultimate, 31 on the third from the last, 27 on the fourth from the last, 26 on the fifth from the last and 12 on the ribbed portion of the seventh whorl. The parts preceding this are not definitely ribbed. The varix behind the peristome is moderately strong. The intercostal spaces and ribs are marked by rather fine, feebly developed incremental lines. Suture moderately constricted. Periphery well rounded. Base slightly elongated and marked by the continuation of the axial ribs which extend onto the umbilicus. Aperture obliquely oval with the peristome slightly expanded and reflected and edged with a dark line, adnate to the preceding turn at the parietal wall. The operculum is typically oncomelanid. The radula presents the formula $\frac{1-1-1}{2-2} : 2-1-3 : 9 : 5$.

The specimen described and figured, U.S.N.M. no. 426221, has 6.4 whorls remaining, and measures: Height 8.1 mm; diameter 3.3 mm. This and 26 additional specimens were collected by Dr. Mary N. Andrews at Cha Hsien, Chekiang Province, China. Ten of these yield the following measurements:

No. of whorls	Height in mm	Diameter in mm	Ultimate	Penultimate	Antepenultimate	4	5	6	7	8
6.1	7.1	3.1	18	18	21	21	22	7+		eroded
6.4	7.6	3.2	+14	23	22	22	4+			"
6.5	7.9	3.3	21	26	28	27	23+			"
6.6	8.2	3.4	19	21	24	24	22			"
6.6	7.4	3.0	19	26	25	24	2+			"
6.2	7.5	3.2	18	20	23	22	24			"
6.4	8.1	3.3	19	29	31	27	26	12+		"
6.0	8.0	3.3	21	21	20	21	22	21+		"
8.4 ^a	7.8	3.2	20	20	22	20	22	20		"
5.1	6.8	3.2	21	27	22	21	15+			"

Ribs per whorl

Greatest	21	29	31	27	26
Least	14	18	20	20	22
Average	19	23.1	23.8	22.9	23.0

^a Apex entire.

U.S.N.M. no. 428584 contains 19 specimens received from Dr. Y. T. Yao, of the Central Field Health Station, National Government of the Republic of China, collected at Cha-Hsien, Chekiang Province.

Another lot, U.S.N.M. no. 428575, 10 specimens from the same source collected at Pucheng, Nanking, Kiangsu Province.

This species is distinguished from the other that has the marginal teeth radula formula of 9:5 by its much greater number of axial ribs and finer incremental lines.

ONCOMELANIA LONGISCATA (Heude)

Plate 1, fig. 20; plate 2, fig. 19; plate 5, fig. 2

1890. *Hemibia longiscata* HEUDE, Mem. Concern. Hist. Nat. Emp. Chinois, p. 169, pl. 33, fig. 20.

1924. *Oncomelania longiscata* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, p. 287.

1926. *Oncomelania (Hemibia) longiscata* GERMAIN and NEVEU-LEMAIRE, Ann. Parasit., vol. 4, p. 294.

Shell rather broadly elongate-conic, stout, horn-colored, with the postnuclear whorls strongly rounded and marked with very heavy

and rather distantly spaced axial ribs, of which 11 occur on the last whorl behind the varix, 14 on the penultimate, 11 on the third and fourth from the last, 12 on the fifth from the last, and 15 on the sixth from the last whorl. The intercostal spaces, as well as the ribs, are marked by strong incremental lines which have a decided wavy aspect. Suture strongly constricted. Periphery well rounded. Base slightly elongate, well rounded, narrowly umbilicated and marked by the continuation of the axial ribs and incremental lines which extend into the umbilicus. There is a strong varix a little distance behind the peristome. Aperture broadly oval; peristome thickened and reflected and adnate to the preceding turn at the parietal wall. The operculum is typically oncomelanid. The radula presents the formula $\frac{1-1-1}{2-2}$: 2-1-3:9:5.

The specimen described and figured, U.S.N.M. no. 420953, as well as the other specimens entered under this catalog number, were collected by Dr. H. E. Meleney on the shore of Lake Tung Ting, near the city of Yochow, Hunan Province, China. Ten specimens from this lot yield the following measurements:

No. of whorls	Height in mm	Diameter in mm	Ultimate	Penultimate	Antepenultimate	4	5	6	7
7.4 ^a	9.2	3.7	11	14	11	11	12	15	eroded
6.6	8.2	3.8	16	15	14	12	15		"
6.6	8.2	3.9	13	14	14	13	15	5+	"
6.4	9.0	4.0	12	14	13	12	13	15	"
6.7	9.3	4.1	12	14	12	12	12	16	"
6.3	9.2	4.2	12	13	13	11	11		"
6.5	8.6	4.0	14	14	12	12	11		"
6.3	9.1	4.0	12	12	12	11	12	9+	"
6.1	7.8	3.7	12	13	11	11	11	11+	"
6.4	8.5	3.9	12	12	11	10	12	14	"

Ribs per whorl

Greatest	16	15	14	13	15
Least	11	12	11	10	11
Average	12.6	13.5	12.3	11.5	12.4

^a Figured specimen.

I believe that it will prove of interest to give the number of whorls and the measurements of the height and diameter of the entire lot of 37 additional specimens, so I am subjoining them here:

No. of whorls	Height in mm	Diameter in mm	No. of whorls	Height in mm	Diameter in mm
6.4	8.1	3.9	5.4	7.6	3.9
6.3	7.8	3.7	5.4	6.7	3.5
7.0	8.3	3.6	5.4	7.9	4.2
6.5	8.3	3.8	5.2	7.3	3.7
6.2	8.1	3.9	7.2	7.5	3.5
6.7	7.9	3.5	7.2	8.0	3.6
6.7	7.6	3.7	6.0	7.2	3.5
6.9	8.7	3.9	6.7	7.9	3.7
7.0	8.4	3.5	6.4	8.6	3.9
6.2	8.2	3.8	6.4	7.3	3.5
6.6	8.1	3.9	6.3	7.7	3.9
6.3	8.1	3.7	6.4	7.9	3.8
7.2	7.3	3.6	6.3	7.4	3.6
6.6	8.6	3.8	5.2	7.1	3.8
7.4	8.9	3.9	6.0	8.1	3.7
5.8	7.6	3.8	6.4	7.8	3.5
6.2	7.7	3.6	5.5	7.7	3.9
7.0	8.1	3.6	6.5	7.7	3.9
5.5	7.6	3.8			
Greatest ^a	.....		7.4	9.3	4.2
Least ^a	.....		5.2	6.7	3.5
Average ^a	.....		6.38	8.04	3.77

^a Of 47 specimens.

ONCOMELANIA ELONGATA, n. sp.

Plate 1, fig. 15; plate 2, fig. 15; plate 5, fig. 4

Shell elongate-conic, wax yellow, the remaining nuclear whorls finely microscopically granose. Early postnuclear whorls marked by incremental lines which slowly develop into axial ribs, which are not heavy, rather flattened, of irregular strength and spacing. The intercostal spaces and axial ribs are marked by incremental lines and show a somewhat malleated aspect. Suture strongly constricted. Periphery well rounded. Base well rounded, narrowly umbilicated and marked by the continuation of the axial ribs. There is a very strong varix a little behind the peristome. The aperture is broadly oval with the peristome expanded and reflected and adnate to the preceding turn on the parietal wall. The operculum is typically oncomelanid. The radula has the typical rachidian tooth $\frac{1-1-1}{2-2}$, also the typical lateral of 2-1-3; the inner marginal has 7 denticles, the outer 5.

The type, U.S.N.M. no. 420954, was collected by Dr. Li in Chekiang Province. It has 9.5 whorls and measures: Height 10 mm; diameter 4 mm. It has 13 ribs behind the varix on the first whorl, 16 on the

penultimate, 14 on the third from the last, 15 on the fourth from the last, 17 on the fifth from the last, and 15 on the sixth from the last, which is also the last whorl to show developed ribs.

There are three additional specimens, U.S.N.M. no. 420955, which yield the following measurements:

No. of whorls	Height in mm	Diameter in mm	Ultimate	Penultimate	Antepenultimate	4	5	6
8.9	9.1	3.7	15	17	15	14	15	11+
9.2	9.8	3.7	15	18	18	17	18	17
8.2 ^a	8.9	3.8	15	17	18	17	16	17

^a Broken.

This species can be differentiated from the other two that have 7:5 denticles on the marginals by having the shell much more elongate and more whorls, and the ribs much less strongly developed.

ONCOMELANIA HUPENSIS Gredler

Plate 1, fig. 17; plate 2, fig. 14; plate 5, fig. 5

1881. *Oncomelania hupensis* GREGLER, Jahrb. Deutsch. Malakoz. Ges., vol. 8, pp. 120-1, pl. 6, fig. 5.
1888. *Prososthenia hupensis* MÖLLENDORFF, Malakoz. Blätt., n. s., vol. 10, pp. 142-3.
1888. *Oncomelania hupensis* MÖLLENDORFF, Malakoz. Blätt., n. s., vol. 10, pp. 142-3.
1890. *Prososthenia hupensis* SCHMACKER and BÖTTGER, Nachrichtsbl. Deutsch. Malakoz. Ges., vol. 22, pp. 126-7.
1890. *Oncomelania hupensis* HEUDE, Mem. Concern. Hist. Nat. Emp. Chinois, p. 167.
1890. *Oncomelania hupensis* HEUDE, Mem. Concern. Hist. Nat. Emp. Chinois, p. 170.
1890. *Hemibia hupensis* HEUDE, Mem. Concern. Hist. Nat. Emp. Chinois, p. 170.
1912. *Oncomelania hupensis* BAVAY and DAUTZENBERG, Journ. Conchyl., vol. 60, p. 38.
1924. *Oncomelania hupensis* FAUST, Amer. Journ. Hyg., vol. 4, p. 275.
1924. *Oncomelania hupensis* FAUST and MELENEY, Amer. Journ. Hyg., Mon. Ser. no. 3, p. 82.
1924. *Oncomelania hupensis* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, pp. 285-7, in part.
1926. *Oncomelania (Hemibia) hupensis* GERMAIN and NEVEU-LEMAIRE, Ann. Parasit., vol. 4, p. 294.
1928. *Hemibia hupensis* BEQUAERT, Journ. Trop. Med., vol. 8, p. 177; 224-5.
1929. *Oncomelania hupensis* THIELE, Handb. Syst. Weicht., pt. 1, p. 150.
1934. *Oncomelania hupensis* BEQUAERT, Journ. Parasit., vol. 20, pp. 281-2.

Shell broadly elongate-conic, wax yellow. Nuclear whorls 2, well rounded, minute, granulose, the early succeeding postnuclear turns

marked by incremental lines which gradually develop into ribs on the later whorls. Postnuclear whorls inflated, strongly rounded, marked by very strong, slightly retractorily slanting, axial ribs, of which, in the specimen figured, there are 12 on the last whorl behind the varix, 13 on the penultimate, 12 on the next 3 whorls, 14 on the sixth from the last, and 8 plus on the seventh from the last whorl. The broad intercostal spaces and the ribs are marked by heavy wavy incremental lines. It is the regularity of these waves that suggests spiral sculpture. Suture strongly constricted. Periphery strongly rounded. Base narrowly umbilicated, marked by the continuation of the axial ribs and incremental lines which extend onto the umbilicus. There is a heavy varix behind the peristome on the outer lip. The aperture is broadly ovate. Peristome is thickened and reflected, dark-edged, adnate to the preceding turn at the parietal wall. The operculum is typically oncomelanid. The radula has the formula $\frac{1-1-1}{2-2}$: 2-1-3: 7: 5.

The specimen described and figured, U.S.N.M. no. 420956, was collected by Dr. H. E. Meleney from ponds just north of the Yangtze River, a few miles east of Hankow, Hupeh Province, China. It has 7 whorls remaining, and measures: Height 9.9 mm; diameter 4.1 mm.

Ten specimens from this lot yield the following measurements:

No. of whorls	Height in mm	Diameter in mm	Ultimate	Penultimate	Antepenultimate	4	5	6	7	8	Apex
6.6	8.8	3.8	12	14	13	14	14	17	smooth		eroded
7.4	9.8	3.9	12	14	13	12	13	17	8+	"	"
7.4	9.4	4.2	11	11	10	9	9	13	5+	"	"
7.8	9.2	4.0	12	15	12	12	12	15	3+	"	"
7.2	9.8	4.2	11	12	14	12	12	13	18	"	"
7.0 ^a	9.9	4.1	12	13	12	12	12	14	8+	"	"
6.7	7.8	3.6	12	13	13	11	14	11+		"	"
7.0	9.0	3.9	14	14	13	13	12	12		"	"
6.5	8.4	3.7	11	13	12	12	11	8+		"	"
6.4	7.9	3.7	13	15	14	14	15				

Ribs per whorl

Greatest	14	15	14	14	15	17	18
Least	11	11	10	9	9	12	
Average	12	13.4	12.6	12.1	12.4	14.4	

^a Figured specimen.

Forty additional specimens from the same locality give the following measurements:

No. of whorls	Height in mm	Diameter in mm	No. of whorls	Height in mm	Diameter in mm
7.0	9.3	4.0	6.1	7.7	3.7
7.2	8.4	3.6	5.1	6.8	3.8
6.9	8.5	3.8	6.5	8.0	3.7
7.3	9.3	4.0	6.2	8.5	3.8
6.4	8.6	3.9	7.3	8.4	4.0
7.1	9.1	4.0	6.5	7.8	3.5
6.3	8.3	3.8	8.2 ^a	8.2	3.6
6.5	8.1	3.9	6.6	7.8	3.7
7.2	8.2	3.9	7.3	8.0	3.5
7.2	8.3	3.9	6.2	7.2	3.7
6.4	7.8	3.8	4.9	6.8	3.7
6.6	8.0	3.8	6.4	8.3	3.7
7.0	7.7	3.5	7.2	8.8	4.1
6.8	7.4	3.5	7.2	7.8	3.7
7.7	8.6	3.7	7.3	8.3	3.5
6.7	7.0	3.6	6.5	7.6	3.6
6.6	7.9	3.9	6.8	8.2	3.8
7.4	8.6	3.8	4.7	6.9	3.5
6.9	8.3	3.8	6.6	7.7	3.5
6.3	8.2	3.7	6.4	7.2	3.4

Greatest	8.2	9.9	4.2
Least	4.7	6.8	3.4
Average	6.75	8.23	3.77

^a Apex entire.

U.S.N.M. no. 428586 contains three specimens received from Dr. Y. T. Yao, of the Central Field Health Station, National Government of the Republic of China, collected at Huangzhou, Anhwei Province.

This species is differentiated from the other two having the marginal denticles 7:5, by having the ribs exceedingly strong and the incremental lines very heavy.

ONCOMELANIA SCHMACKERI Möllendorff

Plate 1, fig. 18; plate 2, fig. 17; plate 5, fig. 3; plate 6, figs. 1, 5, 8, 9

1888. *Oncomelania schmackeri* MÖLLENDORFF, Malakoz. Blätt., n. s., vol. 10, p. 143, pl. 4, figs. 4a, b.

1890. *Hemibia schmackeri* HEUDE, Mem. Concern. Hist. Nat. Emp. Chinois, p. 168, pl. 33, figs. 1-7.

1890. *Hemibia hupensis* HEUDE, Mem. Concern. Hist. Nat. Emp. Chinois, p. 168, pl. 33, fig. 19.

1890. *Hemibia carectorum* HEUDE, Mem. Concern. Hist. Nat. Emp. Chinois, p. 169, pl. 33, fig. 16.

1890. *Hemibia luteola* HEUDE, Mem. Concern. Hist. Nat. Emp. Chinois, p. 169, pl. 33, fig. 17.
1890. *Prososthenia schmackeri* SCHMACKER and BÖTTGER, Nachrichtsbl. Deutsch. Malakoz. Ges., vol. 22, pp. 126-7.
1923. *Oncomelania hupensis* MELENEY and FAUST, Proc. Soc. Exp. Biol. and Med., vol. 20, pp. 216-8.
1924. *Oncomelania hupensis* FAUST, Amer. Journ. Hyg., vol. 4, pp. 269, 274.
1924. *Hemibia hupensis* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3 p. 285, in part, pl. 36, figs. 9-11.
1926. *Oncomelania (Hemibia) hupensis* GERMAIN and NEVEU-LEMAIRE, Ann. Parasit., vol. 4, pp. 294-5, figured.
1929. *Oncomelania hupensis* FAUST, Human Helminthology, p. 136, fig. 47b.
1934. *Oncomelania hupensis* LI, Trans. Sci. Soc. China, vol. 8, pp. 103-45, 36 figs., 2 tables, 2 maps, in part.

Shell broadly elongate-conic, horn-colored, nuclear whorls 2, well rounded, smooth except for microscopic granules. The early post-nuclear whorls are marked by incremental lines which slowly concentrate into ribs. The later postnuclear whorls well rounded, marked by strong, slightly retractively curved axial ribs which are not strongly elevated. In the specimen described and figured, of these ribs 15 occur on the last whorl behind the varix, 17 on the penultimate, 18 on the third from the last, 15 on the fourth from the last whorl, which is the last ribbed whorl. The intercostal spaces and the ribs are marked by slender incremental lines. Suture strongly constricted. Periphery of last whorl well rounded. Base well rounded, narrowly umbilicated, marked by the continuation of the axial ribs and incremental lines which extend into the umbilicus. There is an exceedingly heavy varix a little distance behind the peristome on the outer lip. The aperture is broadly ovate, somewhat expanded and reflected, dark edged and adnate to the preceding turn at the parietal wall. The operculum is typically oncomelanid. The radula has the formula

$$\frac{1-1-1}{2-2} : 2-1-3 : 7 : 5.$$

The specimen described and figured, U.S.N.M. no. 426224, has 7.3 whorls remaining and measures: Height 8.5 mm; diameter 4.0 mm. This lot contains 44 specimens collected by Dr. Mary N. Andrews at Soochow, Kiangsu Province, China. Ten of these, including the specimen described and figured, yield the following measurements:

No. of whorls	Height in mm	Diameter in mm	Ultimate	Penultimate	Antepenultimate	4	5	6	7
5.9	8.1	3.9	14	17	16	16		smooth	eroded
5.1	8.5	3.8	11	14	12	12		"	"
6.2	7.1	3.4	13	13	13	9+		"	"
4.3	6.9	3.9	11	13	15			"	"
7.3 ^a	8.5	4.0	15	17	18	15		"	"
6.3	7.8	3.7	18	17	15	18		"	"
6.5	7.9	3.8	15	17	16	15		"	"
6.0	8.1	3.6	15	14	15	14		"	"
5.5	7.8	3.8	12	16	16	14		"	"
4.5	6.3	3.4	17	19	16	7+		"	"

Ribs per whorl

Greatest	18	19	18	18
Least	11	13	12	12
Average	14.1	15.7	15.2	14.86

^a Figured specimen.

To these, 10 additional measurements from the same lot may be added, as follows:

No. of whorls	Height in mm	Diameter in mm
7.7	8.7	3.6
6.9	7.7	3.6
5.0	8.3	4.1
4.4	7.4	3.7
4.5	6.5	3.3
5.0	6.4	3.3
3.2	6.4	3.8
4.2	6.1	3.6
5.0	6.7	3.4
5.3	6.5	3.3
Greatest ^a	8.7	4.1
Least ^a	6.1	3.3
Average ^a	7.38	3.65

^a Of the 20 specimens.

This sending is the nearest to the type locality of *Oncomelania schmackeri*, which von Möllendorff says was established by Schmacker in the environs of Shanghai.

We have a number of other lots from adjacent territory which yield interesting tabular measurements.

U.S.N.M. no. 426226 contains 33 specimens collected by Dr. Mary N. Andrews at Henli (Hsin Yang-Kang), Chekiang Province, China. Ten of these yield the following measurements:

No. of whorls	Height in mm	Diameter in mm	Ultimate	Penultimate	Antepenultimate	4	5	6	7	Apex
7.3	8.4	3.9	13	14	14	14	10+	smooth		eroded
8.4	8.0	3.6	14	16	15	17	15+	"		entire
7.2	8.2	3.5	14	19	17	15		"		eroded
5.6	6.8	3.3	15	15	14	9+		"		"
7.3	7.5	3.6	16	17	16	18		"		"
5.2	7.1	3.4	14	19	18	18	11+	"		"
5.8	6.2	3.0	16	18	17	14+		"		"
6.2	6.4	3.0	14	15	16	19		"		"
5.4	6.0	3.0	16	15	18	12+		"		"
6.2	6.2	3.1	16	17	17	8+		"		"

Ribs per whorl

Greatest	.....	16	19	18	19
Least	.....	13	14	14	14
Average	.....	14.8	16.5	16.2	16.8

	No. of whorls	Height in mm	Diameter in mm
Greatest	8.4	3.9
Least	5.2	3.0
Average	6.46	3.34

U.S.N.M. no. 426227 contains 54 specimens collected by Dr. Mary N. Andrews at Kashing, Chekiang Province, China, 10 of which yield the following rib counts and 40 the following additional measurements:

No. of whorls	Height in mm	Diameter in mm	Ultimate	Penultimate	Antepenultimate	4	5	6
5.4	7.7	3.5	14	17	16	15	15	smooth
7.0	7.6	3.6	14	15	14	14		"
6.1	7.4	3.6	16	19	17	15		"
5.2	7.1	3.4	15	15	14	14		"
6.8	9.4	4.0	13	15	17	16	10+	"
6.3	8.1	3.9	14	16	14	16		"
5.9	7.7	3.6	13	14	13	14		"
5.2	7.5	4.0	14	16	18	15		"
6.4	7.5	3.5	16	19	17	16	16	"
6.7	7.5	3.5	15	16	16	16		"

Ribs per whorl.

Greatest	.....	16	19	18	16
Least	.....	13	14	13	14
Average	.....	14.4	16.2	15.6	15.1

No. of whorls	Height in mm	Diameter in mm	No. of whorls	Height in mm	Diameter in mm
5.5	7.3	3.4	5.4	7.2	3.7
5.0	6.7	3.5	5.4	7.5	3.5
6.6	8.2	4.0	4.7	6.8	3.4
5.5	7.4	3.8	5.9	7.1	3.5
5.0	7.2	3.7	4.8	7.1	3.6
7.2	8.6	3.7	5.3	7.0	3.4
6.6	8.0	3.9	6.3	7.5	3.4
6.3	7.4	3.6	4.5	6.9	3.6
7.2	7.6	3.4	4.4	7.3	3.5
6.2	7.8	3.6	5.0	7.0	3.6
5.8	7.7	3.8	4.2	8.5	4.5
7.1	8.9	3.7	5.5	7.5	3.6
5.8	6.8	3.3	5.1	6.6	3.4
6.4	7.8	3.6	5.3	7.1	3.5
6.3	7.2	3.3	5.3	6.4	3.2

Greatest ^a	7.2	9.4	4.5
Least ^a	4.2	6.4	3.2
Average ^a	5.76	7.49	3.61

^a For the 40 specimens.

U.S.N.M. no. 426225 contains 39 specimens collected by Dr Mary N. Andrews at Chinking, Kiangsu Province, China, which is the type locality of *Oncomelania luteola* Heude, which I consider synonymous with *Oncomelania schmackeri*, 10 of which give the following rib count and 20 the additional measurements:

No. of whorls	Height in mm	Diameter in mm	Ultimate	Penultimate	Antepenultimate	4	5	6	7
5.7	7.9	3.8	13	15	13	14		eroded	
6.7	8.0	3.8	11	13	12	13		"	
5.0	8.0	4.2	11	14	13	13		"	
6.2	7.8	3.5	13	13	15	14		"	
6.3	7.2	3.5	12	15	16	15		"	
6.7	7.4	3.7	15	17	17	17		"	
4.8	7.8	4.2	12	14	14	15		"	
5.6	7.0	3.6	12	14	15	14		"	
5.4	7.5	3.6	12	15	14	14	15	"	
6.9	8.4	3.9	11	15	16	14		"	

Ribs per whorl

Greatest	15	17	17	17
Least	11	13	12	13
Average	12.2	14.5	14.5	14.3

	No. of whorls	Height in mm	Diameter in mm
	5.6	7.8	3.7
	6.1	8.6	3.6
	4.7	6.8	3.6
	4.5	6.9	3.8
	4.6	6.6	3.5
	4.9	7.0	3.5
	5.6	7.5	3.6
	4.6	6.4	3.5
	4.8	7.0	3.7
	6.2	8.7	3.8
Greatest ^a ..	6.9	8.7	4.2
Least ^a	4.5	6.4	3.5
Average ^a ..	5.54	7.51	3.7

^a For the 20 specimens.

U.S.N.M. no. 428582, 10 specimens received from Dr. Y. T. Yao, of the central Field Health Station, National Government of the Republic of China, collected at Sunkiang, Chekiang Province.

U.S.N.M. no. 428580, 12 specimens received from the same source, collected at Soochow, Kiangsu Province.

U.S.N.M. no. 428577, 5 specimens from the same source, collected at Wukiang, Kiangsu Province.

U.S.N.M. no. 428581, 1 specimen from Kashing, Chekiang Province.

U.S.N.M. no. 428579, 7 specimens from Nanking, Kiangsu Province.

This species can be differentiated from the other two in which the marginal teeth have 7: 5 denticles, respectively, by being more broadly conic and in having the ribs less strongly developed than *Oncomelania hupensis* and more strongly developed than in *Ocomelania elongata*.

ONCOMELANIA MULTICOSTA, n. sp.

Plate 1, fig. 16; plate 2, fig. 16; plate 5, fig. 6

Shell elongate-conic, pale wax yellow, nuclear whorls decollated. Early postnuclear whorls marked by slender incremental lines which gradually develop into ribs. The later whorls well rounded, marked by very regular, rather closely spaced slightly retractorily slanting, axial ribs, of which 21 are present on the last whorl behind the varix, 24 on the penultimate, 21 on the third from the last, 24 on the fourth and fifth from the last and 10 on the sixth from the last, beyond which they are lost. The spaces separating the ribs are about equal to them; spaces and ribs are marked by fine incremental lines. Suture

strongly constricted. Periphery well rounded. Base narrowly umbilicated, marked by the continuation of the axial ribs and incremental lines, which extend into the umbilicus. There is a heavy varix behind the peristome on the outer lip. Periphery broadly ovate, dark edged, expanded and reflected and adnate to the preceding turn at the parietal wall. The operculum is typically oncomelanid. The radula has the formula $\frac{1-1-1}{2-2} : 2-1-3 : 6 : 5$.

The type, U.S.N.M. no. 420962, was collected by Dr. Fu-ching Li at Wu Hsing, Chekiang Province, China. It has 6.6 whorls remaining, and measures: Height 8.8 mm; diameter 3.7 mm.

Three additional specimens, U.S.N.M. no. 420963, yield the following measurements:

No. of whorls	Height in mm	Diameter in mm	Ultimate	Penultimate	Antepenultimate					
						4	5	6	7	8
7.4	8.4	3.4	21	22	19	20	19	6+	smooth	eroded
6.2	7.5	3.4	20	22	19	21	22		"	"
6.2	7.5	3.4	19	22	20	23	27	18+	"	"

U.S.N.M. no. 428585, six specimens received from Dr. Y. T. Yao, of the Central Field Health Station, National Government of the republic of China, collected at Hangchow, Chekiang Province.

This species is readily distinguished from the other *Oncomelania*s by its lesser number of denticles on the inner marginal and by having the ribs much more regularly developed and spaced.

ONCOMELANIA COSTULATA (Heude)

1890. *Hemibia costulata* HEUDE, Mem. Concern. Hist. Nat. Emp. Chinois, pp. 169-70.

1924. *Oncomelania hupensis* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, p. 285, in part.

We have not seen specimens referable to this species and give a free translation of Heude's description. He states that figures of it were accidentally omitted from his plate.

It agrees with *Oncomelania crassa* Heude in height and is distinguished from all the other species by the more slender and more numerous axial ribs, which is especially true of the last whorl. The spire is elongate, pointed straight and almost entire.

It was found in company with *Oncomelania longiscata* in the upper mouth of Lake T'ong-t'ing, opposite the village of Kin-tcheoufou.

ONCOMELANIA CRASSA (Heude)

Plate 6, fig. 6

1890. *Hemibia crassa* HEUDE, Mem. Concern. Hist. Nat. Emp. Chinois, p. 169, fig. 18.
1924. *Oncomelania hupensis* ANNANDALE, Amer. Journ. Hyg., Mon. Ser. no. 3, p. 285, in part.

The collection of the United States National Museum contains no specimens referable to the species described under this name, nor do we have any specimens from a nearby locality which might be referred to it. I therefore give a free translation of Heude's description and republish his figure.

This species is readily distinguished by its elongate form and the obtuse spire which is rarely entire. The intercostal spaces are wide and distinctly marked by incremental lines, which are also present on the axial ribs. The specimen figured shows that the peristome extends beyond the varix. The edge of the peristome is black, and the periostracum is greenish black. He states that he found this species in winter, a long time out of water, along the edges of the drainage ditches which empty into Lake Tong-lieou in summer.

REMEDIAL MEASURES

It appears that where the *Katayama*, the *Oncomelania*, and the *Schistosomophora* groups are present, an acid condition of the soil exists. The use of crushed limestone over such territory will change that condition into an alkaline reaction and make it an inhospitable habitat for these mollusks, resulting in their elimination. The absence of a suitable host in a habitat will eliminate the possibility of the worm developing in that region.

REFERENCES CITED

- (1) ADAMS, ARTHUR
1861. On some new genera and species of Mollusca from the North of China and Japan. Ann. Mag. Nat. Hist., ser. 3, vol. 8, pp. 299-309.
- (2) ADAMS, ARTHUR
1863. On a new genus of terrestrial mollusks from Japan. Ann. Mag. Nat. Hist., ser. 3, vol. 12, pp. 424-425, pl. 7, figs. 11-12.
- (3) PFEIFFER, L.
1876. Mon. Pneumon. Viv., Suppl. 3, pp. i-x, 1-479.
- (4) NEVILL, GEOFFROY
1878. Hand list of Mollusca in the Indian Museum, Calcutta, pp. i-xv, 1-338.

- (5) GREDLER, VINCENZ
1881. Zur Conchylien-Fauna von China. Jahrb. Deutsch. Malakoz. Ges., vol. 8, pp. 110-132.
- (6) VON MÖLLENDORFF, O. F.
1888. Materialien zur Fauna von China. Malakoz. Blätt., (n. s.), vol. 10, pp. 132-143.
- (7) HEUDE, R. P. M.
1889. Diagnoses molluscorum novorum in sinis collectorum. Journ. Conchyl., vol. 37, pp. 40-50.
- (8) HEUDE, P. M.
1890. Notes sur les mollusques terrestres de la Vallée Fleuve Bleu. Mollusques Terrestres. Mem. Concern. Hist. Nat. Emp. Chinois, pp. 1-188, pls. 12-43.
- (9) SCHMACKER, B., and BÖTTGER, O.
1890. Neue Materialien zur Charakteristik und geographischen Verbreitung chinesischer und japanischer Binnenmollusken L. Nachrichtsbl. Deutsch. Malakoz. Ges., vol. 22, pp. 113-137.
- (10) QUADRAS, J. F., and VON MÖLLENDORFF, O. F.
1895. Diagnoses specierum novarum ex insulis Philippinis. Nachrichtsbl. Deutsch. Malakoz. Ges., vol. 27, pp. 137-149.
- (11) VON MÖLLENDORFF, O. F.
1897. Diagnosen neuer und kritischer Landdeckelschnecken. Nachrichtsbl. Deutsch. Malakoz. Ges., vol. 29, pp. 31-45.
- (12) VON MÖLLENDORFF, O. F.
1900. Blanfordia A. Ad. Nachrichtsbl. Deutsch. Malakoz. Ges., vol. 32, pp. 153-154.
- (13) PILSBRY, HENRY A.
1900. Notices of some new Japanese mollusks. Nautilus, vol. 14, pp. 11-12.
- (14) PILSBRY, HENRY A.
1901. Notes on the recent literature of Japanese landsnails. Ann. Mag. Nat. Hist., ser. 7, vol. 8, pp. 5-6.
- (15) PILSBRY, HENRY A.
1902. New land Mollusca from Japan and the Bonin Islands. Proc. Acad. Nat. Sci. Philadelphia, vol. 54, pp. 25-32.
- (16) PILSBRY, HENRY A., and HIRASE, Y.
1903. New land shells of the Japanese Empire. Nautilus, vol. 16, pp. 114-117.
- (17) PILSBRY, HENRY A., and HIRASE, Y.
1905. New land mollusks of the Japanese Empire. Proc. Acad. Nat. Sci. Philadelphia, vol. 57, pp. 750-752.
- (18) BAVAY, A., and DAUTZENBERG, PH.
1912. Description de coquilles nouvelles de L'Indo-Chine. Journ. Conchyl., vol. 60, pp. 1-54.
- (19) MIYAIRI, K.
1913. The intermediate host of *Schistosoma japonicum* and the prophyllaxis of schistosomiasis japonica. Tokyo Med. Weekly, no. 1839.

- (20) MIYAIRI, K., and SUZUKI, M.
1914. Der Zwischenwirt des Schistosomum japonicum Katsurada. Mitt. Med. Fak. Kais. Univ. Kyushu, vol. 1, pp. 187-197, pls. 1-2.
- (21) LEIPER, R. T., and ATKINSON, E. L.
1915. Observations on the spread of Asiatic schistosomiasis. British Med. Journ., Jan. 1915, pp. 201-203, 1 pl., 1 text fig.
- (22) ROBSON, GUY C.
1915. Katayama nosophora. British Med. Journ., p. 203, figs. 7-9, 11.
- (23) PILSBRY, HENRY A.
1915. The Japanese species of Blanfordia. Nautilus, vol. 29, pp. 1-4.
- (24) JOHNSON, C. W.
1918. Review of "The Cercarian infection of South African snails," by F. G. Cawston, M. D. Nautilus, vol. 31, p. 141.
- (25) CORT, WILLIAM W.
1919. The Cercaria of the Japanese blood fluke, Schistosoma japonicum Katsurada. Univ. California Publ., vol. 18, pp. 485-507, 3 text figs.
- (26) CORT, WILLIAM W.
1920. On the resistance to desiccation of the intermediate host of Schistosoma japonicum Katsurada. Journ. Parasit., vol. 6, pp. 84-88.
- (27) ROBSON, GUY C.
1921. On the anatomy and affinities of Hypsobia nosophora. Ann. Mag. Nat. Hist., ser. 9, vol. 8, pp. 401-413, text figs. 1-7.
- (28) CORT, WILLIAM W.
1921. The development of the Japanese blood fluke, Schistosoma japonicum Katsurada, in its final host. Amer. Journ. Hyg., vol. 1, pp. 1-38, pls. 1-4, text figs. 1-3.
- (29) MELENEY, HENRY EDMUND, and FAUST, ERNEST CARROLL
1923. The intermediate host of Schistosoma japonicum in China. Proc. Soc. Exper. Biol. and Med., vol. 20, pp. 216-218.
- (30) PILSBRY, HENRY A.
1924. On some Japanese land and fresh water mollusks. Proc. Acad. Nat. Sci. Philadelphia, vol. 76, pp. 11-13, fig. 3.
- (31) ANNANDALE, NELSON
1924. The molluscan hosts of the human blood fluke in China and Japan, and species liable to be confused with them. In Faust, Ernest Carroll, and Meleney, Henry Edmund. Studies on schistosomiasis japonica. Amer. Journ. Hyg., Mon. Ser. no. 3, pp. 269-294, pl. 36, text figs. 1-6.
- (32) FAUST, ERNEST CARROLL, and MELENEY, HENRY EDMUND
1924. Studies on schistosomiasis japonica. Amer. Journ. Hyg., Mon. Ser. no. 3, pp. i-xi, 1-268, pls. 1-35.
- (33) FAUST, ERNEST CARROLL
1924. Notes on larval flukes from China. II. Studies on some larval flukes from the central and south coast provinces of China. Amer. Journ. Hyg., vol. 4, pp. 241-301, pls. 1-2.

- (34) FAUST, ERNEST CARROLL
1924. Schistosomiasis in China: Biological and practical aspects. Proc. Roy. Soc. Med., vol. 17, pt. 3, pp. 31-43.
- (35) BARTSCH, PAUL
1925. Some new intermediate hosts of the Asiatic human blood fluke. Journ. Washington Acad. Sci., vol. 15, no. 4, pp. 71-73.
- (36) GERMAIN, L., and NEVEU-LEMAIRE, M.
1926. Essai de malacologie medicale. Ann. Parasit., vol. 4, pp. 286-307.
- (37) BEQUAERT, JOSEPH
1928. Mollusks of importance in human and veterinary medicine. Amer. Journ. Trop. Med., vol. 8, pt. 1, pp. 165-182; pt. 2, pp. 215-232.
- (38) THIELE, JOHANNES
1929. Handbuch der Systematischen Weichtierkunde, pt. 1, p. 150.
- (39) FAUST, ERNEST CARROLL
1929. Human helminthology, pp. i-xxii, 1-616.
- (40) TUBANGUI, MARCOS A.
1932. The molluscan intermediate host in the Philippines of the Oriental blood fluke, *Schistosoma japonicum* Katsurada. Philippine Journ. Sci., vol. 49, pp. 295-304, pls. 1-5.
- (41) RENSCH, BERNHARD
1932. Eine neue Hydrobiidae von den Philippinen. Philippine Journ. Sci., vol. 49, pp. 551-552, figs. 1a-c.
- (42) LI, FU-CHING
1932. Der Zwischenwirt des *Schistosomum haematobium japonicum* (Katsurada). Science, Science Soc. China, vol. 16, pp. 566-582.
- (43) LI, FU-CHING
1932. Ueber die postembryonale Entwicklung von dem Zwischenwirt des *Schistosomum haematobium japonicum* China. Science, Science Soc. China, vol. 16, pp. 583-619.
- (44) BEQUAERT, JOSEPH
1934. The molluscan intermediate host of the blood fluke, *Schistosoma japonicum* Katsurada. Journ. Parasit., vol. 20, pp. 280-282.
- (45) PILSBRY, HENRY A.
1934. Note on the genus *Blanfordia*. Journ. Parasit., vol. 20, pp. 282-284.
- (46) LI, FU-CHING
1934. Anatomie, Entwicklungsgeschichte, Oecologie und Rassenbestimmung von *Oncomelania*, des Zwischenwirtes von *Schistosoma japonicum* (Katsurada 1904) in China. Trans. Sci. Soc. China, vol. 8, pp. 103-145, figs. 1-36.
- (47) FAUST, ERNEST CARROLL
1935. Schistosomiasis. In McKinley, Earl Baldwin, A geography of disease. Amer. Journ. Trop. Med., vol. 15, no. 5, supplement, pp. 432-434.

EXPLANATION OF PLATES

PLATE I, SHELLS

- FIG. 1. *Katayama nosophora yoshidai* Bartsch, type.
 2. " *fausti* Bartsch, type.
 3. " *cantoni* Bartsch, type.
 4. " *nosophora* Robson.
 5. " *lii* Bartsch, type.
 6. " *formosana* Pilsbry and Hirase.
 7. *Schistosomophora hydrobiopsis* Rensch.
 8. " *quadra* Möllendorff.
 9. " *minima* Bartsch.
 10. *Blanfordia simplex* Pilsbry.
 11. " *japonica* A. Adams.
 12. " *integra* Pilsbry, type.
 13. " *bensoni* A. Adams.
 14. " *japonica* A. Adams, type.
 15. *Oncomelania elongata* Bartsch, type.
 16. " *multicosta* Bartsch, type.
 17. " *hupensis* Gredler.
 18. " *schmackeri* Möllendorff.
 19. " *moellendorffi* Schmacker and Böttger.
 20. " *longiscata* Heude.

PLATE 2, OPERCULA

- FIG. 1. *Blanfordia japonica* A. Adams.
 2. " *integra* Pilsbry.
 3. " *bensoni* A. Adams.
 4. " *simplex* Pilsbry.
 5. *Schistosomophora quadra* Möllendorff.
 6. " *hydrobiopsis* Rensch.
 7. " *minima* Bartsch.
 8. *Katayama nosophora* Robson.
 9. " " *yoshidai* Bartsch.
 10. " *fausti* Bartsch.
 11. " *lii* Bartsch.
 12. " *formosana* Pilsbry and Hirase.
 13. " *cantoni* Bartsch.
 14. *Oncomelania hupensis* Gredler.
 15. " *elongata* Bartsch.
 16. " *multicosta* Bartsch.
 17. " *schmackeri* Möllendorff.
 18. " *moellendorffi* Schmacker and Böttger.
 19. " *longiscata* Heude.

PLATE 3, RADULAE

- FIG. 1. *Schistosomophora quadrasi* Möllendorff.
 2. " *hydrobiopsis* Rensch.
 3. " *minima* Bartsch.
 4. *Blanfordia integra* Pilsbry.
 5. " *japonica* A. Adams.
 6. " *simplex* Pilsbry.
 7. " *bensoni* A. Adams.

PLATE 4, RADULAE

- FIG. 1. *Katayama nosophora* Robson.
 2. " " *yoshidai* Bartsch.
 3. " *formosana* Pilsbry and Hirase.
 4. " *lii* Bartsch.
 5. " *fausti* Bartsch.
 6. " *cantoni* Bartsch.

PLATE 5, RADULAE

- FIG. 1. *Oncomelania moellendorffi* Schmacker and Böttger.
 2. " *longiscata* Heude.
 3. " *schmackeri* Möllendorff.
 4. " *elongata* Bartsch.
 5. " *hupensis* Gredler.
 6. " *multicosta* Bartsch.

PLATE 6

- FIG. 1. Egg mass of *Oncomelania schmackeri* Möllendorff. Copy of Dr. Li's figure.
 2. Animal of *Blanfordia japonica*. Copy of A. Adams' figure.
 3. Animal of *Blanfordia bensoni*. Copy of A. Adams' figure.
 4. Egg chain of *Katayama lii* Bartsch. Manuscript figure by Dr. Li.
 5. Radula of *Oncomelania schmackeri* Möllendorff. Copy of Heude's figure.
 6. *Oncomelania crassa*. Copy of Heude's figure.
 7. *Katayama lii* Bartsch. Single eggs. Manuscript figure by Dr. Li.
 8. *Oncomelania schmackeri* Möllendorff. Foot. Copy of Dr. Li's figure.
 9. *Oncomelania schmackeri* Möllendorff. Head. Copy of Dr. Li's figure.

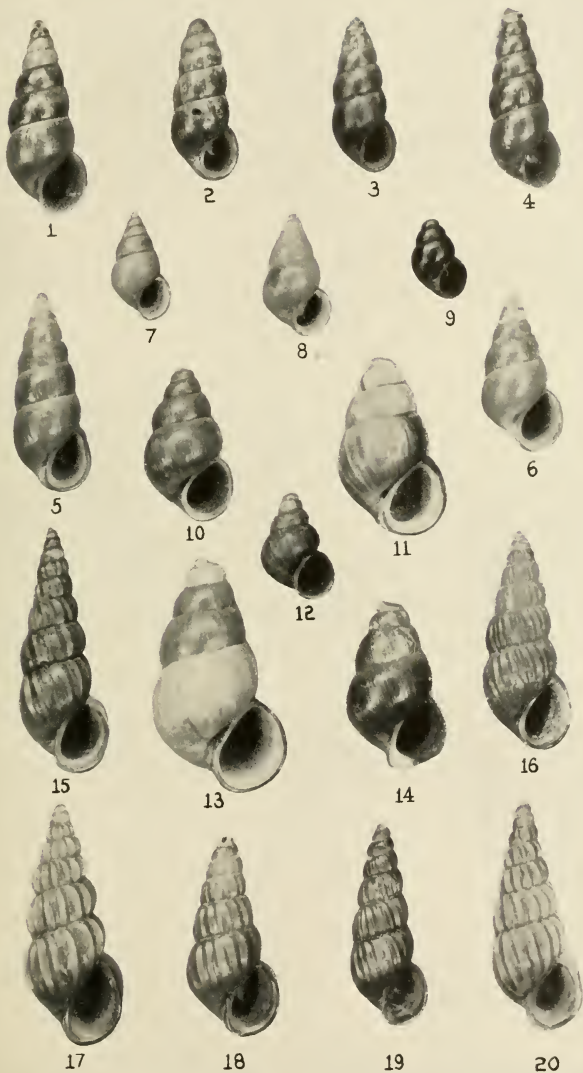
PLATE 7

Outline map showing the type localities from which the species of *Blanfordia*, *Katayama*, and *Schistosomophora* were described.

PLATE 8

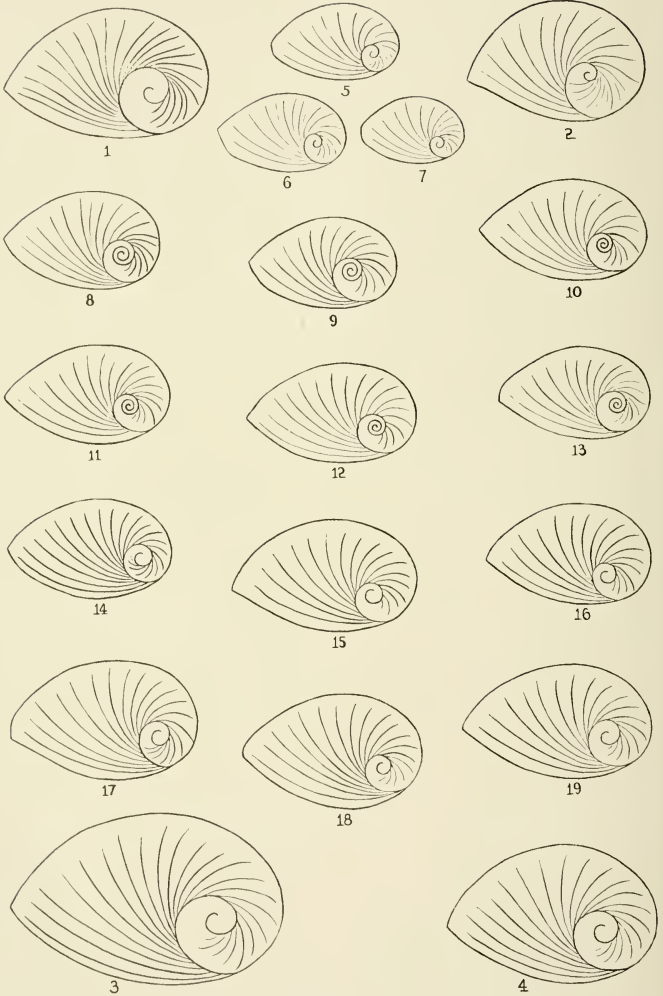
Copy of a topographic map of eastern China, showing the type localities of the described species of *Oncomelania*, as follows:

1. *Oncomelania moellendorffi*
2. " *longiscata*
3. " *elongata*
4. " *hupensis*
5. " *schmackeri*
6. " *multicosta*
7. " *costulata*
8. " *crassa*



SHELLS

(For explanation, see page 58.)



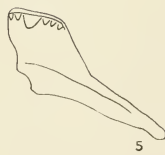
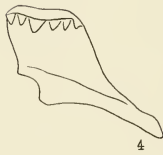
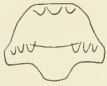
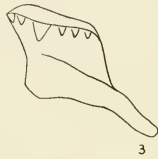
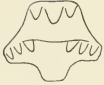
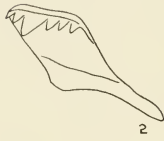
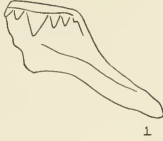
OPERCULA

(For explanation, see page 58.)



RADULAE

(For explanation, see page 59.)



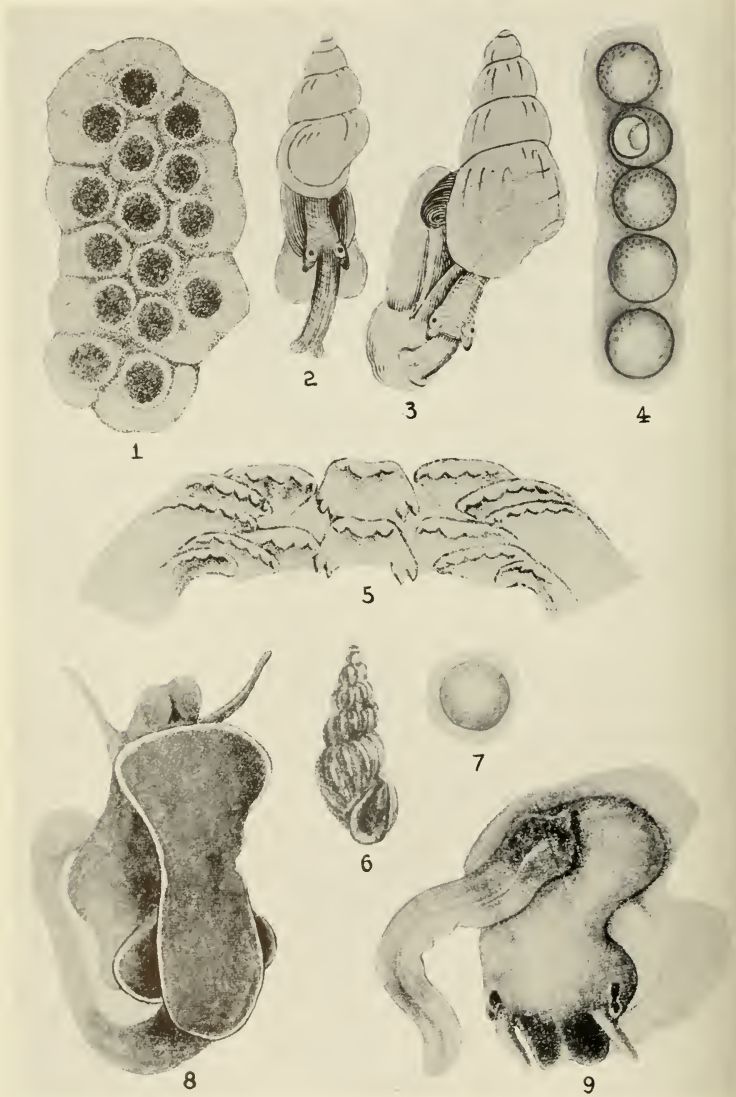
RADULAE

(For explanation, see page 59.)



RADULAE

(For explanation, see page 59.)

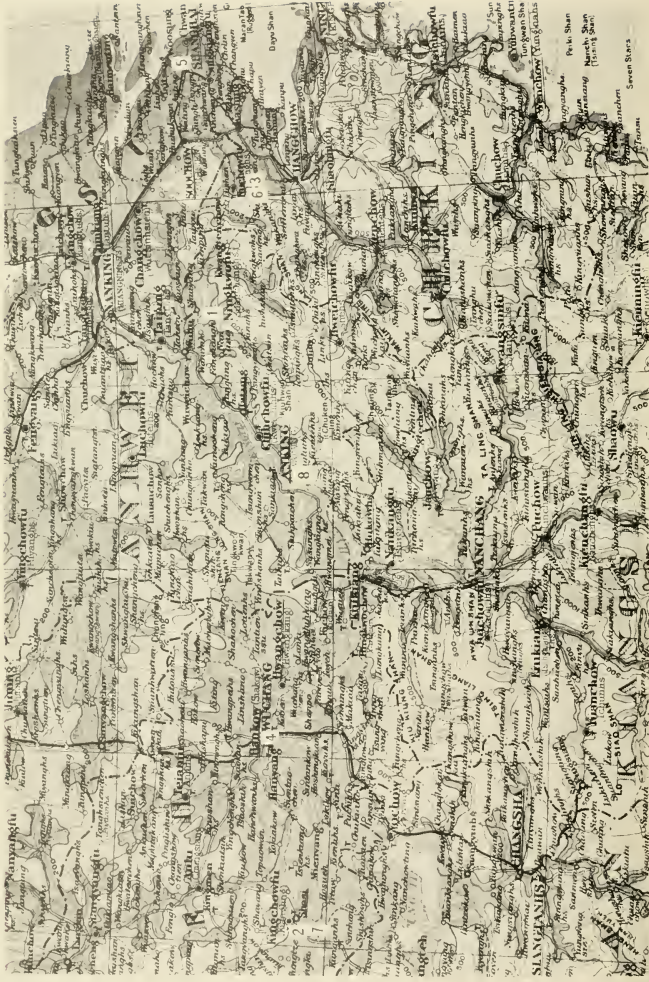


ANIMAL AND EGGS
(For explanation, see page 59.)



TYPE LOCALITIES OF BLANFORDIA, KATAYAMA, AND SCHISTOSOMOPHORA

(For explanation, see page 59.)



TYPE LOCALITIES OF ONCOMELANIA

(For explanation, see page 60.)