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ZUR KENNTNIS DER MIKROFAUNA VON BRITISCH INDIEN.

III. Copepoda Harpacticoida.

Von P. A. Chappuis, (*Cluj, Rumänien*).

Ausser *Canthocamptus cingalensis* (Brady)[1] kennen wir bis heute keinen einzigen freilebenden Süsswasser-harpacticiden aus Britisch Indien. Es war desshalb ein grosses Verdienst R. B. Seymour Sewells, des Dir. des Zool. Survey of India, mir in den Jahren 1925-27 einige Moosproben zur Untersuchung zukommen zu lassen, in welchen unter anderen Tierarten auch Copepoden gefunden wurden. Es sei mir hier gestattet, Herrn Sewell sowie den Herren Chopra und Hora, die die meisten Proben auf ihren Reisen gesammelt haben, auch hier meinen besten Dank auszusprechen.

Ueber die in diesen Proben vorgefundenen Ostracoden und Hydracarinen ist in dieser Zeitschrift von Klie und Walter schon berichtet worden. Im folgenden sollen nun auch die Copepoden beschrieben werden.

Die Proben die mir zur Untersuchung übersandt wurden stammen aus drei verschiedenen Gegenden.

1. dem westlichen Himalaya (Simla Hills und Kangra distr. im nördlichen Punjab),
2. dem östlichen Himalaya (Gegend von Darjiling),
3. den Khasi-Hills in Assam.

Die in den Proben aus dem westlichen Himalaya gefundenen fünf Arten und Unterarten gehören zwei verschiedenen Genera an und stehen alpin und arktisch geltenden Arten sehr nahe. Es sind dies; *Canthocamptus horai*, n. sp.; *C. zschokkei* subsp. *himalayensis*, n.; *C. zschokkei* subsp. *orientalis*, n.; *Maraenobiotus brucei* subsp. *himalayensis*, n. und *Maraenobiotus insignipes* subsp. *indicus*, n.

Ausser *C. horai* ist die Zugehörigkeit der verschiedenen Unterarten schon durch die Namen gegeben; *C. horai* hingegen ist in den Verwandschaftskreis des *C. echinatus* einzubeziehen, und zwar ist er dem *C. dacicus* Chappuis und *C. praegeri* Scourfield am nächsten verwandt.

Die osthimalayischen Formen und die Art aus den Khasi Hills zeigen grosse Aehnlichkeiten mit den Arten aus den Sundainseln und gehören, mit Ausnahme des *C. bryophilus*, der Gruppe des *C. elaphoides* an, einer Gruppe deren Angehörige in den tropischen und subtropischen Gegenden eine grosse Verbreitung haben und in Europa nur äusserst selten, oder dann unterirdisch auftreten.

[1] Brady, G. S. Notes on Entomostraca collected by Mr. A. Haly in Ceylon (*J. Linn. Soc. London*, Vol. XIX, 1886).

Gattung **Canthocamptus.**

Canthocamptus horai, n. sp.

(Figs. 1-4).

Untersuchtes Material:

Nur ein einziges Weibchen in der Moosprobe, etiquettiert: " Asnir near Junga, Simla Hills, alt. 4,000 ft."

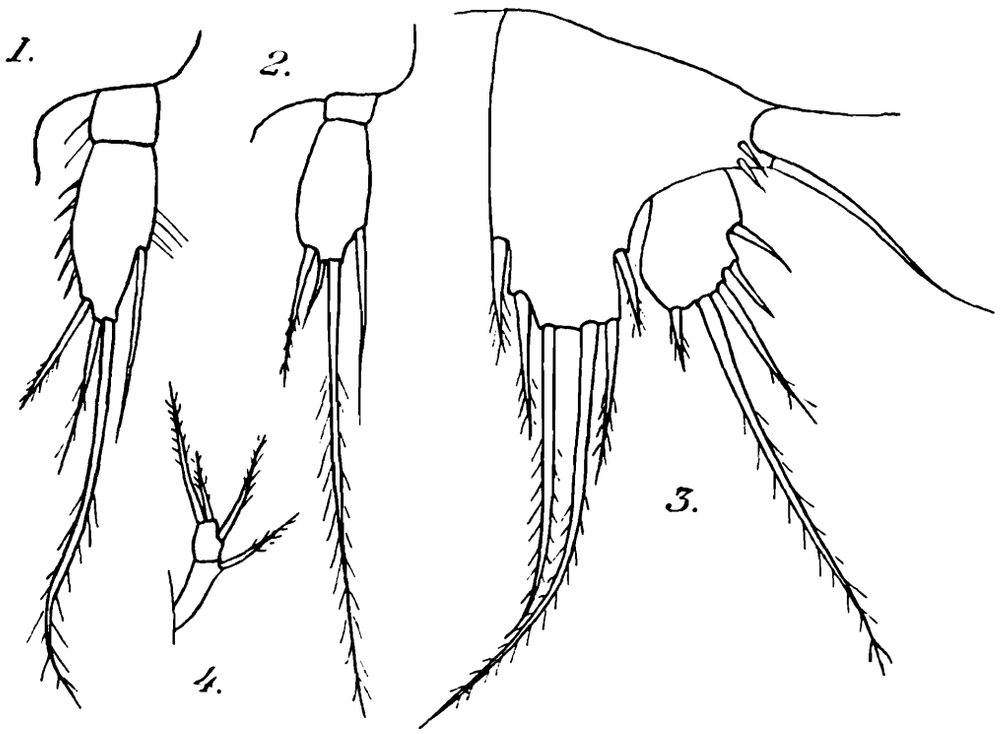


FIG. 1-4. *Canthocamptus horai*, n. sp. ♀.—Fig 1, Endopodit des zweiten Beinpaares. —Fig. 2, Endopodit des vierten Beinpaares.—Fig. 3, Fünftes Beinpaar.—Fig. 4, Nebenast der zweiten Antenne.

Kleine Art, am fünften Thoracalsegment seitlichdorsal eine kurze Dornenreihe, am darauffolgenden Genitalsegment in halber Höhe, an der Verwachsungsstelle der ursprünglichen zwei Segmente ebenfalls eine seitliche Dornenreihe. Am Hinterrande dieses und des folgenden Segmentes greift diese Dornenreihe auf die dorsale und ventrale Seite über. Am dritten Abdominalsegment ist die Dornenreihe dorsal und ventral ununterbrochen. Beim vierten Segment ventral und lateral einige Dornen. Analoperculum flachbogig, mit ca. 16 eng aneinander gereihten, kurzen Zähnen. Furka kürzer als das letzte Abdominalsegment, quadratisch, mit zwei gut entwickelten und einer schwächeren Endborste.

Erste Antenne siebengliedrig, kurz, der Sinneskolben des vierten Gliedes erreicht das Ende des Endgliedes. Nebenast der zweiten Antenne zweigliedrig, mit vier Borsten. Endopodit des ersten Beinpaares dreigliedrig, so lang wie der Exopodit. Endopodit des zweiten Beinpaares zweigliedrig, erstes Glied ohne Eckdorn, zweites Glied mit einer Innenrandborste, einem Aussenranddorn und zwei apicalen Borsten, von welchen die eine sehr zart gebaut ist.

Endopodit des dritten Beinpaares zweigliedrig; erstes Glied mit Eckdorn, zweites Glied dem des zweiten Beinpaares ähnlich, nur mit

einer Innenrandborste mehr. Endopodit des vierten Beinpaares zweigliedrig ; erstes Glied ohne Eckdorn, zweites Glied distal mit einer Innenrandborste und einem Aussenranddorn, apical eine lange und eine kleine rudimentäre Borste.

Fünfter Fuss breit ; der stark vorgezogene innere Teil des Basale überragt das Endglied beinahe und trägt sechs Borsten ; das ovale zweite Glied mit einer langen und vier kürzeren Borsten.

Wie schon erwähnt, nähert sich *C. horai* sehr den Arten *C. praegeri* und *C. dacicus*. Von der letzteren unterscheidet er sich durch die Ausbildung der Endopoditen des zweiten bis vierten Beinpaares. Von *C. praegeri* hingehen liegt nur eine Zeichnung des Endopoditen des zweiten Beinpaares vor (der im allgemeinen mit demjenigen des *C. horari* übereinstimmt) so dass der Vergleich nicht auf alle Endopoditen ausgedehnt werden kann. Ein gutes Unterschiedsmerkmal zwischen diesen zwei Arten findet sich jedoch in der Bewehrung des Analoperkulums, das bei *C. praegeri* zahlreiche feine Härchen trägt, bei *C. horai* hingegen ca. 16 Dörnchen. Auch ist bei der europäischen Art das letzte Thoracal- und das erste Abdominalsegment mit Reihen feinster Dörnchen besät, die bei *C. horai* fehlen.

Canthocamptus zschokkei subsp. **orientalis,** n.

Untersuchtes Material :

1. Sehr zahlreiche Männchen und Weibchen in der Moosprobe, etiquettiert : " Simla, W. Himalayas, 6-7,000 ft.; Aug-Sept. 1925. Moss etc. on stones in a fall in the course of a streamlet. (leg. Dr. Chopra)."

2. Wenige Männchen und Weibchen in der Moosprobe aus Asnir near Junga, Simla Hills, 4000 ft. Sept. 1925 (Simla Station 5). (leg. Dr. Chopra).

3. Mehrere Männchen und Weibchen in der Moosprobe aus Gunnallah, below the Forest-Bungalow at Kareri village, Kangra distr. Punjab, 31. V. 26. (leg. Dr. Hora).

4. Männchen und Weibchen in der Moosprobe aus Bhagsunath, Upper Dharamsala, Kangra Valley, Punjab, 4. VI. 26. (leg. Dr. Hora).

Weibchen : Die ersten zwei Segmente des Vorderleibes ohne Dornenreihen ; am dritten Segment dorsal eine kurze, horizontale, doppelte Dornenreihe ; am vierten Segment ist diese Reihe viel länger, nur in der Mitte doppelt. Am fünften Segment greift sie auf beide Seiten über, ist dorsal unterbrochen und lateral doppelt. Am ersten Abdominalsegment findet sich etwas oberhalb der Mitte die gleiche Dornenreihe wie bei *C. zschokkei f. typ.*, nur ist sie bei der Unterart viel besser entwickelt und dorsal nicht unterbrochen. Hinterrand des ersten und zweiten Abdominalsegmentes wie bei *C. zschokkei*. Am dritten Segment ist die Dornenreihe dorsal unterbrochen. Ventral sind die mittelständigen Dornen schwächer entwickelt als die anderen. Am Hinterrande des letzten Segmentes sind lateral an der Furka-basis je 4-6 Dornen. Analoperkel mit 5-6 starken, langen Zähnen.

Furka wie bei *C. zschokkei*, nur ist sie länger. Breite zur Länge wie 1 : 1,5 bei *C. zschokkei* aber wie 1 : 1,2.

Antennen und Beinpaare wie bei *forma typica*. Grösse : 0,7 mm. ohne Furkalborsten und 0,9 mm. mit diesen.

Männchen: Die Segmente des Vorderleibes weisen die gleiche Bedornung auf wie beim Weibchen. Die lateralen Dornenreihen des ersten Abdominalsegmentes dorsal durch einige kleinere Dornen verbunden. Beim zweiten und dritten Segment gleiche Dornenreihen wie bei *C. zschokkei f. typ.* beim vierten Segment ist die Dornenreihe dorsal unterbrochen, ventral sind nur die mittelständigen Dornen kleiner. Letztes Abdominalsegment und Furka wie bei der *forma typica*, nur sind auch da die Furkaläste länger.

Analoperkulum mit 6-7 grossen Zähnen.

Antennen und die vier ersten Beinpaare wie bei der typischen Art. Fünftes Fusspaar mit 6 Dornen statt nur 5 am zweiten Gliede. Grösse 0,5 mm. ohne Furkalborsten. Sämtliche Borsten und Dornen, besonders diejenigen der Abdominalsegmente, sind stärker entwickelt als bei *C. zschokkei.*

Canthocamptus zschokkei subsp. **himalayensis,** n.

Untersuchtes Material:

1. Zahlreiche Weibchen und Männchen in der Moosprobe aus Chvan Khad, below Dharamsala, Kangra district, Punjab, 29. V 26. (leg. Dr. Hora).

2. Wenige Exemplare im Moos von Gun nallah, below the Forest Bungalow at Kareri Village, Kangra distr., Punjab. (leg. Dr. Hora).

Weibchen: Die Cephalothoraxsegmente ohne Dornen, beim ersten Abdominalsegment fehlt die bei der *forma typica* vorhandene, in halber Höhe inserierende, laterale Dornenreihe. Die laterale Dornenreihe des Segmentendes ist kürzer ausgebildet. Zweites Segment wie bei *C. zschokkei*; am dritten Segment ist die Dornenreihe dorsal unterbrochen; ventral sind die mittelständigen Dornen nicht stärker entwickelt. Beim letzten Segment ventral, an der Basis der Furka, und lateral eine Dornenreihe. Analoperkel mit 3-5 grossen stumpfen Zähnen.

Sonst wie *C. zschokkei f. typica.*

Männchen: Erstes Abdominalsegment ohne Dornenreihe, das zweite, dritte und vierte mit einer ununterbrochenen ventralen Dornenreihe die lateral übergreift. Beim vierten Segment sind die ventralen Dornen nicht viel kürzer als die lateralen. Analoperkel mit 3-4 grossen stumpfen Zähnen. Zweites Glied des fünften Fusses mit 6 Borsten und Dornen.

Canthocamptus bryophilus, n. sp.

(Figs. 5-14).

Untersuchtes Material:

Ein Männchen in der Moosprobe, etiquettiert: Between Kalimpong Road station and Teesta-Bridge, 21. XII. 26, leg Hora; zwei Weibchen in der Moosprobe: Near Milestone 16½ from Darjiling (Teesta-Darjiling Road), 21. XII. 26. leg Hora.

Weibchen: Länge 0,95 mm. mit den Furkalborsten; 0,8 mm. ohne diese. Rostrum normal; der Hinterrand sämtlicher Körpersegmente, das erste und das letzte ausgenommen, dorsal grob, ventral fein ausgezackt. Auf der dorsalen Oberfläche dieser Segmente zer-

streut, feine parallele Dornenreihen ; bei den Abdominalsegmenten sind sie auch ventral ausgebildet. Am fünften Thoracal- und ersten Ab-

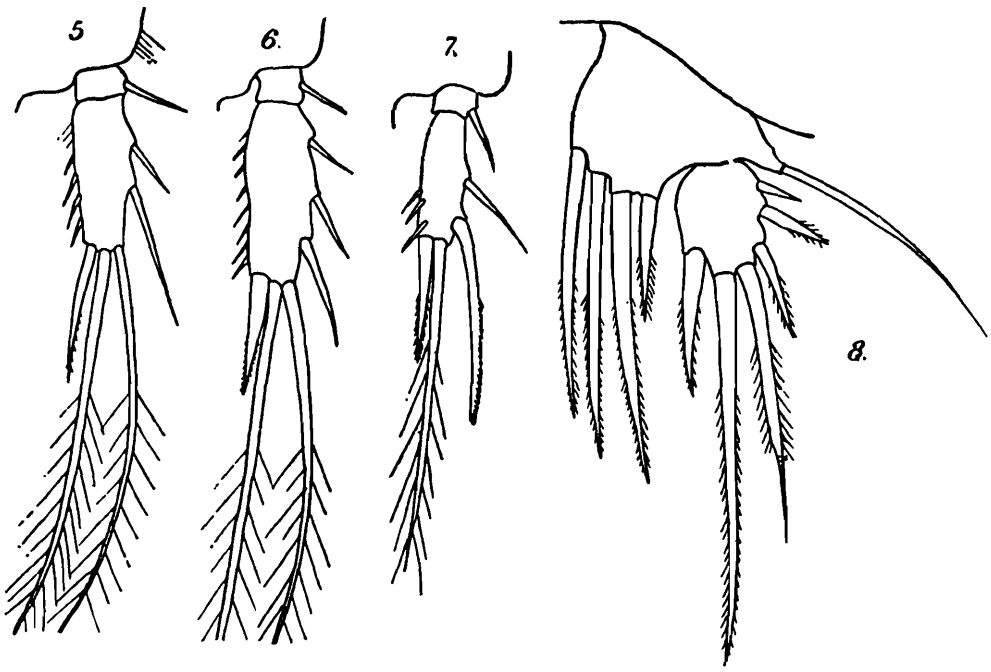


FIG. 5-8. *Canthocamptus bryophilus*, n. sp. ♀.—Fig. 5, Endopodit des zweiten Beinpaares.—Fig. 6, Endopodit des dritten Beinpaares.—Fig. 7, Endopodit des vierten Beinpaares.—Fig. 8, Fünfter Fuss.

dominalsegment eine kurze laterale Reihe grober Dornen, die am zweiten Abdominalsegment schwach auf die Dorsalseite übergreift.

Am dritten Segment greift sie auch ventral über und setzt sich dort in einer spärlichen Reihe von sehr schwachen und kurzen Dornen fort. Am letzten Abdominalsegment sind lateral 4-5 und ventral nur 1 Dorn vorhanden.

Analoperkel breit, wenig vorspringend und mit vielen feinen Dörnchen besetzt. Furka lang ; grösste Länge zur grössten Breite=2 : 1. Von den Endborsten nur die mittlere stark entwickelt, die aussere schwach, die innere auf der Ventralseite der grossen inserierend, kurz und S-foermig gekrümmt. Die proximale Borstengruppe des Aussenrandes aus einer Borste bestehend ; die distale aus zwei Borsten zusammengesetzt. Der Innenrand in der distalen Hälfte bewimpert. Dorsale Chitinleiste schwach ausgebildet, nicht in einen Zahn endigend.

Erste Antenne achtgliedrig ; der Sinneskolben des vierten Gliedes überragt das Antennenende um die Länge der zwei Endglieder. Nebennast der zweiten Antenne eingliedrig, mit vier Borsten.

Endopodit des ersten Beinpaares dreigliedrig, überragt seinen Exopoditen um die Länge des dritten Gliedes. Endopodit des zweiten Beinpaares zweigliedrig. Das erste Glied mit einem Dorn an der inneren distalen Ecke ; das zweite Glied mit zwei Innenrandborsten und apical mit zwei langen Borsten und einem Dorn. Der Aussenrand mit 6-7 kleineren Dornen. Endglied des Exopoditen mit 5 Borsten und Dornen. Endopodit des dritten Beinpaares dem des zweiten ähnlich, nur besitzt der Innenrand drei Borsten statt nur zwei. Das vierte Beinpaar ist ebenfalls zweigliedrig ; das erste Glied mit einem distalen, inneren Eck-

dorn, das zweite Glied mit zwei Innenrandborsten und apical mit einem Dorn und einer Borste. Am Aussenrand nur 3-4 kleine Dörnchen. Endglied des Exopoditen des dritten und vierten Beinpaares mit 6 Borsten und Dornen.

Das erste Glied des fünften Beinpaares wenig vorgezogen mit vier dicken Borsten. Das zweite Glied oval, mit 6 Dornen und Borsten, von denen die dritte von innen von den anderen dadurch absticht, dass sie im letzten Viertel plötzlich dünn und unbewimpert wird.

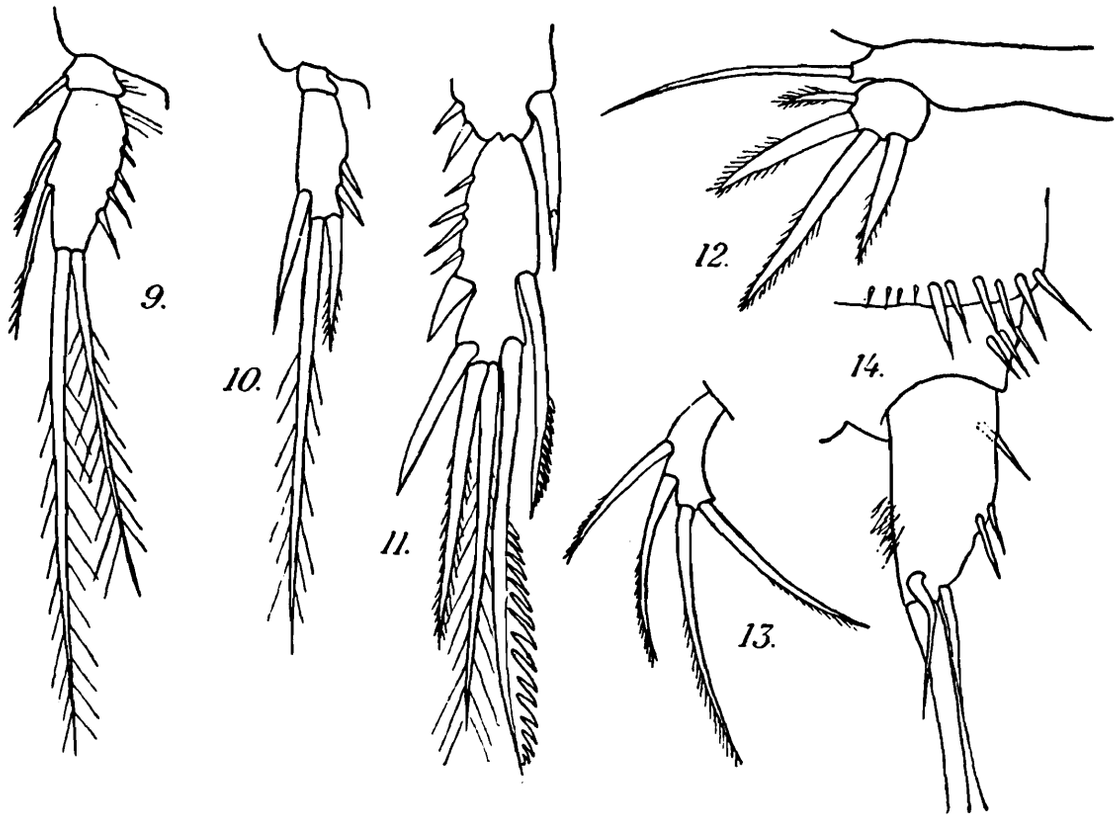


Fig. 9-14. *Canthocamptus bryophilus*, n. sp.—Fig. 9, Endopodit des zweiten Beinpaares ♂.—Fig. 10, Endopodit des vierten Beinpaares ♂.—Fig. 11, Endglied des Exopoditen des vierten Beinpaares ♂.—Fig. 12, Fünfter Fuss ♂.—Fig. 13, Nebenast der zweiten Antenne.—Fig. 14, Furka ♀.

Das Männchen ist nur ein bisschen kleiner als sein Weibchen; die Thoracal und das erste Abdominalsegment gleich bewehrt wie beim Weibchen. Beim zweiten Abdominalsegment greifen die lateralen Dornenreihen stark auf die Ventralseite über ohne sich jedoch zu berühren. An den zwei folgenden Segmenten findet sich diese Reihe ventral ununterbrochen. Das letzte Abdominalsegment mit jederseits nur zwei Dornen. Analoperkulum wie beim Weibchen. Furka kurz im Vergleich zu der des Weibchens, konisch, mit drei Endborsten, von welchen die mittlere am stärksten, die innerste am schwächsten entwickelt ist. Dorsal keine Chitinlamelle.

Endopodit des zweiten Beinpaares dem des Weibchens ähnlich, nur spitzer endend und mit zwei Endborsten. Endopodit des dritten Beinpaares ohne Eckdorn am ersten Gliede. Die dornartige Verlängerung des zweiten Gliedes mit zwei ziemlich weit voneinander entfernten Widerhaken. Das dritte Glied lang, cylindrisch, apical mit einer kürzeren und einer längeren starken Sinnesborste bewehrt. Der Eckdorn des zweiten Gliedes des Exopoditen fast so lang wie das Endglied.

Der Endopodit des vierten Beinpaares ohne Eckdorn am ersten Gliede ; das zweite Glied dem des Weibchens ähnlich, nur kleiner und mit nur einer Innenrandborste. Endglied des Exopoditen dieses Beinpaares mit 6 Dornen und Borsten, von welchen die zwei Innenrandborsten mit einer stark gezähnten Sinnesmembran versehen sind. Die Aussenranddornen sind normal entwickelt. Basale des fünften Beinpaares ohne Dornen, das Endglied kurz, mit drei grossen und einem kleinen Dorn.

Canthocamptus sewelli, n. sp.

(Figs. 15-22).

Untersuchtes Material :

Mehrere Weibchen und ein Männchen in der Probe, etiquettiert : Near Milestone 16½ from Darjiling (Teesta-Darjiling road) 21. XII. 26. leg. Hora.

Weibchen : Grösse 0,65 mm. mit den Furkalborsten, 0,5 mm. ohne diese Borsten. Sämtliche Körpersegmente mit Ausnahme des ersten mit parallelen Reihen äusserst feiner Dörnchen besetzt. Hinterrand der fünf ersten Segmente dorsal ausgezackt ; bei den Abdominalsegmenten ist der Hinterrand glatt. Am ersten Abdominalsegment jederseits eine kurze Reihe starker Dornen. Diese Reihen finden sich auch an den zwei folgenden Segmenten, nur sind sie ein wenig länger und ventral durch eine Reihe kurzer, kleiner Dörnchen verbunden. Am letzten Segment eine laterale Reihe starker Dornen und ventral, beiderseits der Mittellinie, bei der Basis der Furkaläste, je eine Reihe von 5 langen Dornen.

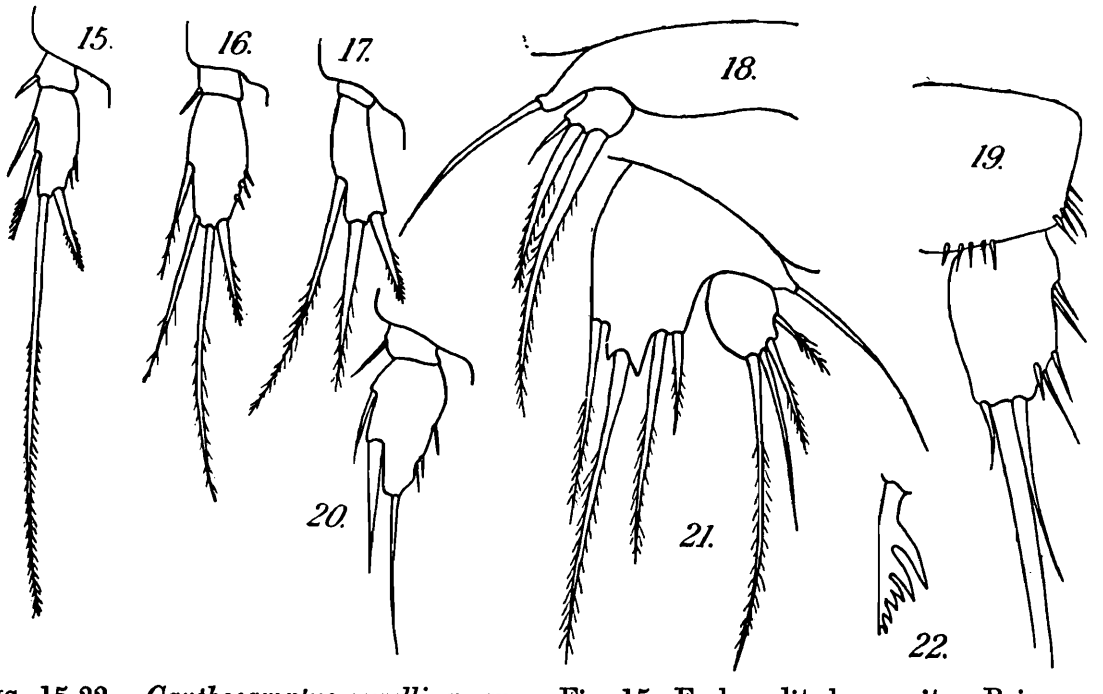


FIG. 15-22. *Canthocamptus sewelli,* n. sp..—Fig. 15, Endopodit des zweiten Beinpaares ♀.—Fig. 16, Endopodit des dritten Beinpaares ♀.—Fig. 17, Endopodit des vierten Beinpaares ♀.—Fig. 18, Fünfter Fuss ♂.—Fig. 19, Furka ♀.—Fig. 20, Endopodit des zweiten Beinpaares ♂.—Fig. 21, Fünfter Fuss ♀.—Fig. 22, Apicaler Dorn des Endgliedes des vierten Exopoditen ♂.

Analoperkel kaum ausgebildet, mit einer schwachen mittleren Einbuchtung und mit einer grossen Anzahl, (ca. 25-30) kleiner stumpfer

Zähne bewehrt. Furkaläste 1,6 mal so lang wie breit, schwach konisch. Von den Endborsten ist nur eine stark entwickelt. Am Aussenrand zwei Dornengruppen; Innenrand glatt. Die dorsale Chitinleiste stark entwickelt und in einen langen Zahn endigend, an dessen Basis die geknöpfte Borsten inseriert.

Erste Antenne achtgliedrig; der Sinneskolben des vierten Gliedes überragt das Endglied. Nebenast der zweiten Antenne eingliedrig, mit 4 Borsten.

Endopodit des ersten Beinpaares dreigliedrig, nur wenig länger als der Exopodit. Endopodit des zweiten Beinpaares zweigliedrig; erstes Glied mit einem Dorn an der inneren, distalen Ecke, klein; zweites Glied mit zwei Innenrand und zwei apicalen Borsten. Am Aussenrande zwei kleine Dörnchen. Endopodit des dritten Beinpaares dem vorhergehenden gleich, nur grösser und die distale Borste des Innenrandes nahe der Spitze inserierend.

Endopodit des vierten Beinpaares klein, das erste Glied ohne Dornen, das zweite Glied mit einer Innenrandborste und zwei apicalen Dornen. Am fünften Beinpaar ist der innere Teil des Basale stark vorgezogen, mit vier Borsten besetzt und überragt ein wenig das zweite Glied, das rundlich oval ist und ebenfalls vier Borsten trägt.

Das Männchen ist nur wenig kleiner als das Weibchen. Das erste Abdominalsegment mit lateralen Dornenreihen; am zweiten bis vierten Segment ist die Dornenreihe auch ventral vorhanden, nur sind die ventralen Dornen dichter zusammengedrängt und deshalb weniger stark. Das fünfte Segment, Analoperkulum und Furka wie beim Weibchen, nur sind die Dornen des Analoperkulums und die äussere Furkalborste länger.

Endopodit des zweiten Beinpaares kurz, das erste Glied mit einem Dorn an der inneren, distalen Ecke, das zweite Glied verhältnissmässig breit, mit einer dünnen und einer dickeren Innenrandborste, einer schlanken apicalen Borste und einigen Dörnchen am Aussenrande. Die dornartige Verlängerung des zweiten Gliedes des dritten Endopoditen erreicht das Ende seines Exopoditen und ist mit vier Widerhaken versehen; das Endglied mit zwei Sinnesborsten, einer sehr kleinen apicalen und einer grösseren, die auf der distalen Ventralfläche des Gliedes inseriert. Der Exopodit dieser Gliedmasse mit sehr langem, das Ende des dritten Gliedes beinahe erreichendem Dorn an der äusseren distalen Ecke des kurzen zweiten Gliedes. Der erste äussere Dorn des dritten Gliedes klein, schwach S formig; von den zwei Innenrandborsten nur eine entwickelt. Endopodit des vierten Beinpaares wie beim Weibchen. Das Endglied des Exopoditen kurz, mit 6 Borsten und Dornen. Von den drei Dornen ist der dritte, apicale, geweihförmig umgewandelt. Erstes Glied des fünften Fusses eine unbewehrte Lamelle; das zweite Glied ein Paralellogramm mit drei Borsten, von welchen die innere die grösste und die äussere die kleinste ist.

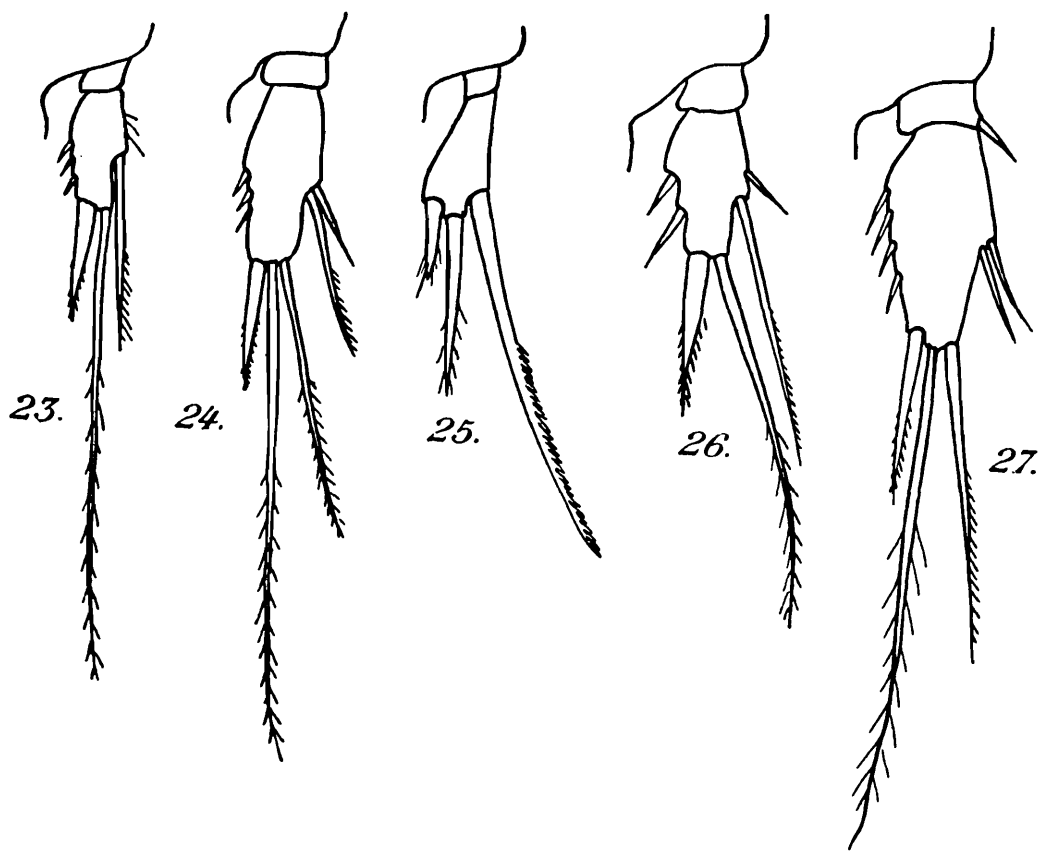
Canthocamptus sewelli subsp. **indicus,** n.

(Figs. 23-25).

Untersuchtes Material:

Mehrere Weibchen in der Moosprobe, etiquettiert: Between Kalimpong-road-station and Teesta-bridge (21. XII. 26), leg. Hora.

Der vorhergehenden Art sehr ähnlich ; die Unterscheidungsmerkmale sind folgende : Der dorsale Hinterrand auch der Abdominalsegmente ist gezähnt ; die feinen Dornenreihen der Cephalothoraxsegmente sind weniger stark ausgeprägt, können bisweilen auch fehlen. Die Dornen der abdominalen Dornenreihen sind kleiner, diese Reihen greifen am 1.-3. Segment auch schwach auf die Dorsalseite über. Analoperkulum schwach bogig, mit etwa 12 stumpfen Zähnen ; die dorsale Chitinleiste der Furka und der Zahn, in welchen sie endet, schwächer ausgebildet.



FIGS. 23-25. *Canthocamptus sewelli* subsp. *indicus*, n. ♀.—Fig. 23, Endopodit des zweiten Beinpaares.—Fig. 24, Endopodit des dritten Beinpaares.—Fig. 25, Endopodit des vierten Beinpaares.

FIGS. 26-27. *Canthocamptus sewelli* subsp. *eremita*, n. ♀.—Fig. 26, Endopodit des zweiten Beinpaares.—Fig. 27, Endopodit des dritten Beinpaares.

Erstes Glied des Endopoditen des zweiten Beinpaares ohne Eckdorn, zweites Glied mit nur einer Innenrandborste und apical einer Borste und einem Dorn. Erstes Glied des Endopoditen des dritten Beinpaares ohne Eckdorn, zweites Glied mit zwei auf gleicher Höhe inserierenden Innenrandborsten und apical mit einem Dorn und zwei Borsten.

Canthocamptus sewelli subsp. **eremita**, n.

(Figs. 26 μ 27).

Untersuchtes Material :

Eine grosse Anzahl Weibchen zwischen Algenfäden aus einem felsigen Flussbett bei Cheerapunji, Khasi Hills, Assam ; leg. R. B. S. Sewell.

Der vorhergehenden Art fast gleich, nur ein bischen grösser und mit einem Eckdorn am ersten Glied des Endopoditen des dritten Beinpaares.

C. sewelli und seine beiden Unteraten gehören der Gruppe des *C. elaphoides* an, und zwar sind sie mit den malayischen Arten *C. bronelicola* und *C. malayicus* ziemlich nah verwandt.

Eine auffallende Eigentümlichkeit einiger Arten der "*elaphoides*-Gruppe" ist die Männchenarmut. Sonst finden wir bei den meisten *Canthocamptus*-Arten die beiden Geschlechter in ungefähr gleich starker Anzahl vor, bei gewissen Arten der "*elaphoides*-Gruppe" hinge gen finden wir öfters unter 40-50 Weibchen nur ein einziges Männchen.

Sehr auffallend ist diese "geographische Spamandrie"[1] bei *C. grandidieri* und *C. bidens coronatus* Sars, wo das Männchen überhaupt noch unbekannt ist, trotzdem beide Arten eine sehr weite Verbreitung besitzen und schon sehr oft gefunden wurden. Bei *C. sewelli* fand sich 1 Männchen auf 40 Weibchen, bei seinen beiden Unterarten kein einziges Männchen, obwohl von *C. sewelli indicus* 30 und von *C. sewelli eremita* 55 Weibchen isoliert werden konnten.

Diese Eigenheit scheint jedoch nur bei den tropischen und subtropischen Arten aufzutreten, denn bei den europäischen Arten dieser Gruppe ist die Männchenarmut nicht so ausgesprochen: wir finden bei *C. phreaticus* und *C. putealis* 1 Männchen auf 5-10 Weibchen.

Eine Erklärung für das Auftreten der geographischen Spamandrie bei den südlichen Arten der *elaphoides*-Gruppe können wir nicht geben, da wir deren Lebens- und Fortpflanzungsverhältnisse noch nicht kennen.

Gattung **Maraenobiotus.**

Maraenobiotus insignipes subsp. **indicus,** n.

(Figs. 28—30).

Untersuchtes Material:

Zahlreiche Weibchen und Männchen aus der Moosprobe von Tiloknath, Kangra Valley, Punjab, 24. V. 26 (leg. Dr. Hora).

Unterscheidet sich von *M. insignipes* (nach Olofsson) durch den stärker ausgebildeten, eingliedrigen Mandibelpalpus und den Endopoditen des zweiten Beinpaares des Männchens, der keine Aussenrandborste trägt.

Maraenobiotus brucei subsp. **himalayensis,** n.

(Figs. 31, 32).

Untersuchtes Material:

Wenige Männchen und Weibchen aus der Moosprobe von Simla, W. Himalayas, 6-7,000 feet; Aug.-Sept. 1925. Moss, etc., on stones in a fall in the course of a streamlet, (leg. Dr. Chopra).

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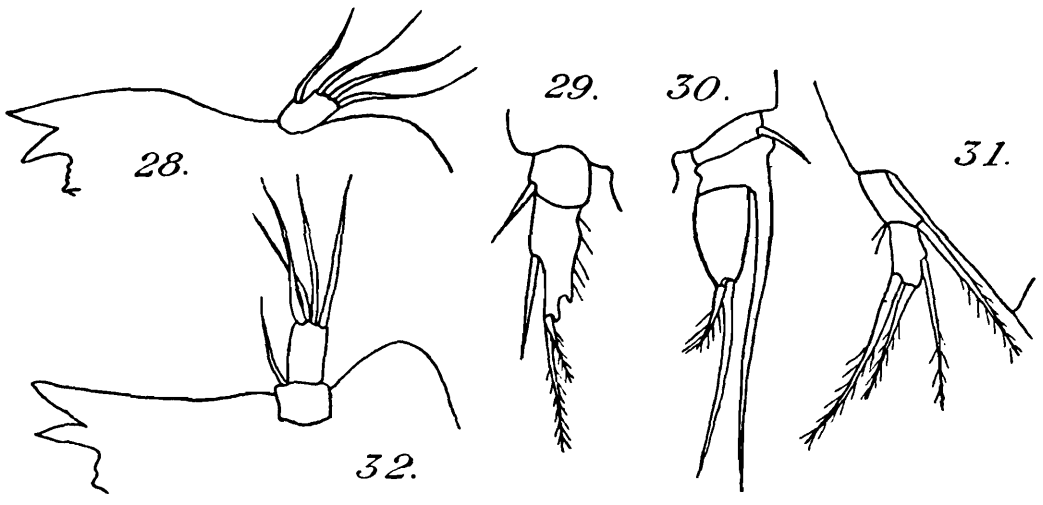
[1] Spamandrie = Männchenarmut; siehe VANDEL, A. La spamandrie (disette de mâles) geographique chez un Isopode terrestre. (*C.R. Acad. Sc. Paris*, T. 174, pp. 1742-1745; 1922).

Zahlreiche Männchen und Weibchen in der Moosprobe aus Asnir, near Junga, Simla Hills, 4,000 ft. Sept. 1925, (Simla Station 5), (leg. Dr. Chopra.)



FIGS. 28-30. *Maraenobiotus insignipes* subsp. *indicus*, n.—Fig. 28, Mandibel.—Fig. 29, Endopodit des zweiten Beinpaares ♂.—Fig. 30, Endopodit des dritten Beinpaares ♂.

FIGS. 31-32. *Maraenobiotus brucei* subsp. *himalayensis*, n.—Fig. 31, Nebenast der zweiten Antenne.—Fig. 32, Mandibel.

Von Olofsson's [1] Beschreibung von *M. brucei* weichen die Exemplare der obengenannten Fundorte in folgenden Punkten ab : Weibchen : Das dritte, vierte und fünfte Thoraxsegment weisen eine dorsale Dornenreihe auf. Die letzten vier Abdominalsegmente nahe am Hinterrand mit einer nur ventral abgebrochenen Reihe feinster Dornen versehen. Ausserdem trägt das erste Abdominalsegment noch in halber Höhe eine dorsale, auf beide Seiten hinübergreifende Dornenreihe.

Der Nebenast der zweiten Antenne ist deutlich zweigliedrig mit einer Borste am Ende des ersten Gliedes und einer Randborste und zwei apicalen Borsten am zweiten Gliede. Mandibelpalpus deutlich zweigliedrig mit einer Borste am ersten Gliede und vier apicalen Borsten am zweiten Gliede.

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[1] OLOFSSON, O. Beitrag zur Kenntniss der Harpacticiden-Familien Ectinosomidae Canthocamptidae (Gen. *Maraenobiotus*) und Tachidiidæ nebst Beschreibungen einiger neuen und wenig bekannten, arctischen Brackwasser und Süsswasser-Arten (*Zoologiska Bidrag från Upsala*, Bd. VI, S. 1-39, T. i-viii 1918).

ZUR KENNTNIS DER MIKROFAUNA VON BRITISCH INDIEN.

IV. Copepoda Cyclopoida.

Von Friedrich Kiefer, *Dilsberg (bei Heidelberg)*.

Den Anlass zu den folgenden Ausführungen gab die Untersuchung einiger Proben, die mir von Herrn Dr. P. A. Chappuis (Nr. 1-7) und vom Zoologischen Museum in Hamburg (Nr. 8 und 9) zur Bestimmung der Cyclopiden freundlichst zugesandt worden sind. Ich mache zunächst die betreffenden Fundorte und die daselbst von mir festgestellten Arten namhaft.

(1) Simla Hills (Indien), nasses Moos bei Simla.
Paracyclops fimbriatus (Fischer).

(2) Simla Hills (Indien), nasses Moos bei Asnir
Eucyclops spec. (1 stark verletztes Weibchen der *serrulatus*-Gruppe).

(3) Punjab, Tilok nath, Kangra Valley, Dr. Hora legit 24. V 1926.
Eucyclops permixtus, nov. spec.
Ectocyclops phaleratus (Koch) (meist unreife Stücke).

(4) Punjab, Chvan Khad, below Dharamsala, Kangra District, Dr. Hora legit 29. V 1926.
Ectocyclops phaleratus (Koch) (1 Männchen adult —4 juvenes).

(5) Darjiling, zwischen Kalimpong Road station und Teesta Bridge, Dr. Hora legit 21. XII. 1926.
Ectocyclops phaleratus (Koch) (1 Exemplar juv.).

(6) Darjiling, near Milestone 16½ from Darjiling (Teesta-Darjiling Road), Dr. Hora legit 21. XII. 1926.
Eucyclops indicus Kiefer.
Ectocyclops phaleratus (Koch) (einige, meist Juvenes).

(7) " Calicut " (ohne weitere Angaben)
Mesocyclops leuckarti (Cls.).
„ *hyalinus* (Rehberg).

(8) Lucknow (Vorderindien), N. Annandale legit (Zoolog. Museum Hamburg Nr. K8457).
Cyclops varicans Sars.
Mesocyclops leuckarti (Cls.).

(9) Süsswasser-Teiche bei Point de Galle, Südküste von Ceylon, Dr. Driesch legit
Cyclops robustus Sars.

Durch die zwei in diesen Proben gefundenen neuen Arten (*Eucyclops indicus* und *permixtus*) erhöht sich die Zahl der bis jetzt aus Indien bekannten Cyclopiden auf 18 — eine Zahl, die gewiss nicht auch nur annähernd den wirklichen Bestand jenes reich gegliederten, gewaltigen Gebietes angibt. Wenn man dazu noch bedenkt, dass ein gut Teil der älteren Bestimmungen nicht über alle Zweifel erhaben ist, so ersch-

einen unsere sicher begründeten Kenntnisse der indischen Cyclopidenfauna überaus ärmlich und lückenhaft. Ich kann das vielleicht am besten dadurch aufzeigen, dass ich eine kurze Zusammenstellung aller bis jetzt für Indien (=Vorderindien einschliesslich Ceylon) genannten Arten gebe. Dabei wird sich dann Gelegenheit zu mancherlei kritischen und ergänzenden Bemerkungen bieten.

GENUS **Macrocyclops** Claus.

Macrocyclops distinctus (Richard) (?).

Vorkommen: Ceylon, Teich bei Kandy (Gurney, 1916, p. 337, t. I, f. 6).

Obwohl es durchaus möglich ist, dass diese Art in Indien lebt, scheint es mir doch einigermassen fraglich, ob gerade die dem englischen Forscher vorgelegenen Tiere dazu gehören. Gurney gibt zwei Merkmale an, durch die sich die ceylonischen Stücke von den europäischen unterscheiden, nämlich die geringere Körpergrösse und das geringere Längen-Breitenverhältnis der Furkaläste, während in andern Teilen, zum Beispiel in der Form des vierten Schwimmfusses und der Verbindungsmembran der Füsse dieses Paares, völlige Uebereinstimmung herrschen soll. Da aber nicht die zuletzt genannten Merkmale die wichtigsten für unsere Art sind, sondern vielmehr andere wie die Bewehrung der Endglieder der weiblichen Vorderantenne, die Bewehrung des Innenastes vom vierten Schwimmfusspaar, das Receptaculum seminis und die Behaarung der Innenränder der Furka, über diese Verhältnisse aber weder mit Worten noch in Abbildungen etwas ausgesagt ist, so kann ich das Vorkommen des *M. distinctus* in Indian doch noch nicht als ganz gesichert betrachten.

GENUS **Eucyclops** Claus.

Eucyclops serrulatus (Fischer) (?).

Vorkommen: Calcutta, Tank of the Maidan, (Gurney, 1907, p. 22).
Calcutta, Zoologischer Garten („ „ , p. 23).
Chakradharpur, verschiedene Stellen (Gurney, 1907, p. 23, 24).
Ceylon, Sümpfe der Umgebung des Mahaveliganga-Flusses (Daday, 1898, p. 21).
Ceylon, Peradeniya (Gurney, 1916, p. 337).

Angesichts der Tatsache, dass in älterer Zeit fast jeder Cyclope mit einer " serra " am Aussenrand der Furkaläste als " serrulatus " angesprochen worden ist und dabei Formen miteinander vermengt worden sind, die heute als unzweifelhaft selbständige Arten betrachtet werden, muss man die oben zitierten Angaben samt und sonders mit Fragezeichen versehen. Selbst wenn der typische *Eucyclops serrulatus* in Indien wirklich vorkommen sollte (und das ist sehr wohl möglich, ja sogar wahrscheinlich), so ist doch schon jetzt sicher, dass daneben auch noch andere, ihm zum Verwechseln ähnliche Formen leben, wie das Beispiel des neuen *Eucyclops permixtus* deutlich zeigt.

Eucyclops permixtus, nov. spec.

(Figs. 1-5).

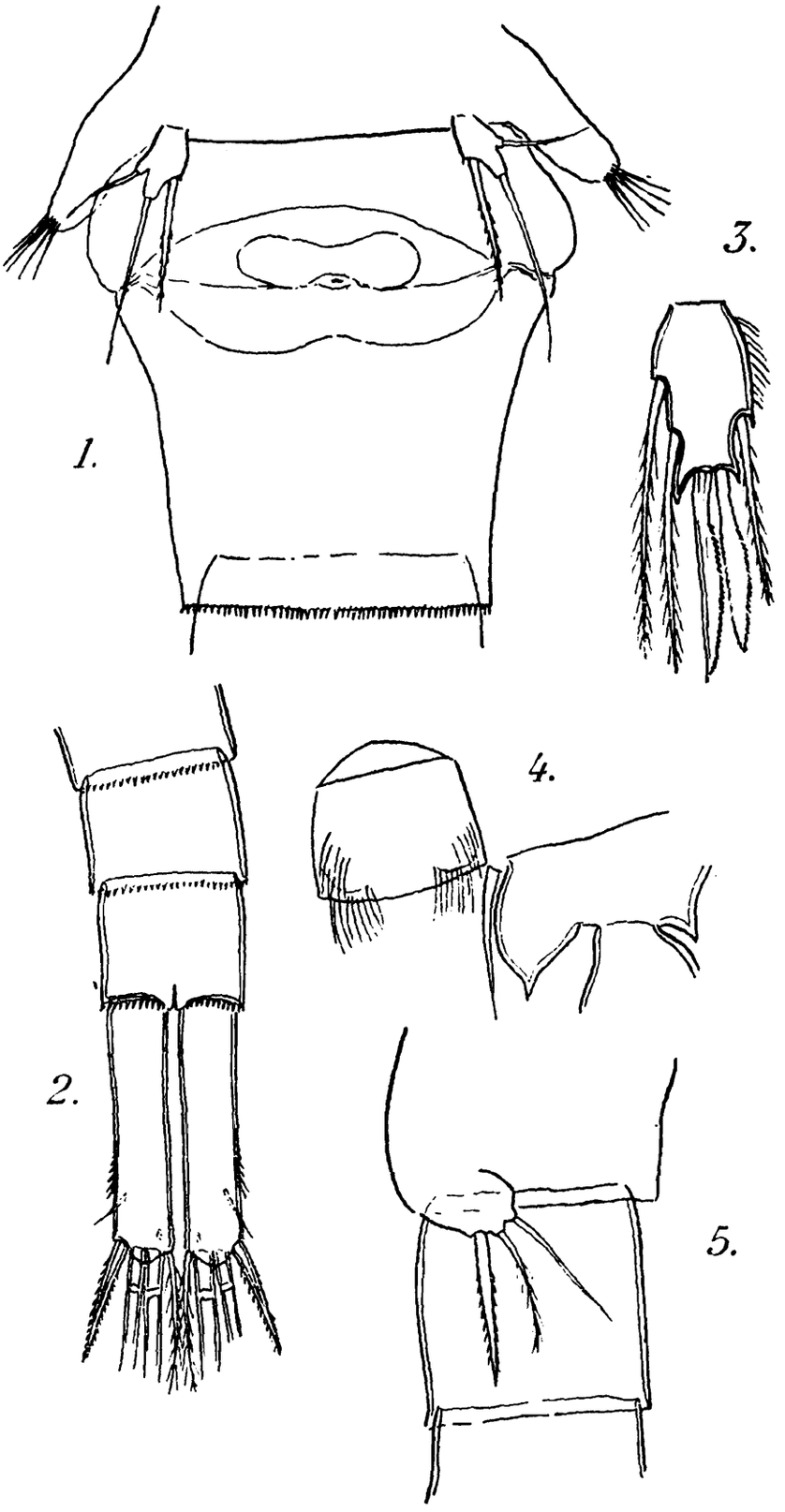
Vorkommen: Punjab (vergleiche oben Nr. 3).

Das Weibchen: Im allgemeinen Aussehen besitzt unsere Art grösste Aehnlichkeit mit dem typischen *E. serrulatus*. Das letzte Thoraxsegment trägt jederseits einen Besatz ziemlich langer Borsten (Fig. 1). Die Form des Genitalsegmentes ist am besten aus der beigegebenen Figur 1 zu ersehen. Der Hinterrand dieses Segmentes ist ebenso wie der der beiden folgenden Abdominalringe sehr fein ausgezackt. Das letzte Segment ist so lang wie das vorhergehende. Sein Hinterrand trägt ventral über der Basis der Furkaläste jederseits etwa 12 mittelstarke Dörnchen. Die Furkaläste sind nicht ganz fünfmal so lang wie breit. Sie werden parallel gehalten. Ihr Innenrand ist kahl; der Aussenrand dagegen besitzt eine Säge. Diese wird von wenigen Stachelchen gebildet, von denen die distalen merklich länger sind als die übrigen (Fig. 2). Die Endborsten verhalten sich bei einem der beiden Tierchen von innen nach aussen wie 51 : 325 : 195 : 43μ. Die Befiederung der beiden mittleren Borsten besteht aus sehr feinen, dicht stehenden Dörnchen und erscheint homonom. Die zwölfgliedrigen Vorderantennen sind kurz; sie erreichen den Hinterrand des Cephalothorax (=1. Vorderleibsegment) nicht. Die drei Endglieder sind mit je einer sehr schmalen, ganzrandigen Hyalinmembran versehen. Die Seitenborste des Endgliedes entspringt in der Mitte. Die Dornformel der Schwimmfussaussenastendglieder ist die normale, also 3.4.4.3. Alle Glieder der Schwimmfüsse sind verhältnismässig kurz. Das Endglied des 4. Innenastes weist folgende Eigenheiten auf: Länge und Breite verhalten sich etwa wie 37 : 23μ; seine beiden Enddornen sind 50 und 43μ lang; sie sind kräftig, gerade und lanzettförmig. Eine solche Form zeigen auch die Dornen des 4. Aussenastes, während die Dornen der übrigen Aeste mehr oder weniger normal beschaffen sind (Fig. 3). An der Verbindungsmembran der Füsse des 4.Paares bemerkt man einen Besatz langer, dünner Haare (Fig .4). Das rudimentäre Füsschen ist einigermassen schlank. Der Dorn des Innenrandes ist knapp doppelt so breit wie die Endborste und nur ein wenig kürzer als diese. Die Borste des Aussenrandes erscheint ziemlich kurz (Fig. 1). Das Receptaculum seminis war bei dem einen der Tierchen noch leidlich gut zu erkennen und hatte das in Figur 1 wiedergegebene Aussehen. Die Länge beträgt (ohne Endborsten) etwa 800-820μ.

Das Männchen: Es erreicht eine Länge von nur etwa 700μ. Die Furkaläste sind verhältnismässig kürzer als beim Weibchen; ein Ast ist nämlich nur rund 4 mal so lang wie breit. Eine Serra ist nicht vorhanden; auf der Höhe der Seitenrandborsteninsertion bemerkt man jedoch am Aussenrand je 2-3 kurze Dörnchen. Die Genitalklappe ist mit 2 Borsten und einem Dorn bewehrt. Ueber ihr Längenverhältnis untereinander und im Vergleich zur Länge des zweiten Abdominalsegmentes unterrichtet am einfachsten die beigegebene Figur 5.

Die eben beschriebene Form besitzt Merkmale, die an solche bei verschiedenen andern Arten der *serrulatus*-Gruppe erinnern; am meisten Aehnlichkeit besteht ohne Zweifel zwischen unserer Form und den

afrikanischen Arten *Eucyclops euacanthus* (Sars) und *E. fragilis* (Kiefer), die ich erst kürzlich eingehender gekennzeichnet habe (Kiefer



Figs. 1-5.—*Eucyclops permixtus*, n. sp.

1. Letztes Thorax und Genitalsegment ♀.
2. Ende des Abdomens mit Furka, ♀ (ventral).
3. Endglied von Enp.$_4$.
4. Verbindungsmembran P$_4$.
5. P$_6$ ♂ (von der Seite).

1927.). Die zusammenstellung der Merkmale bei den indischen Tieren (von denen mir leider nur 2 Weibchen und 1 Männchen vorlagen) gibt diesen aber ein so besonderes Gepräge, dass ich sie als Vertreter einer

selbständigen Art betrachte. Es ist jedenfalls sehr bemerkenswert, dass nun die Gruppe der *euacanthus*-ähnlichen Eucyclopen, die bisher erst aus dem äquatorialen Afrika bekannt war, auch als in Indien vorkommend sich erweist.

Eucyclops indicus Kiefer.

(Figs. 6-9).

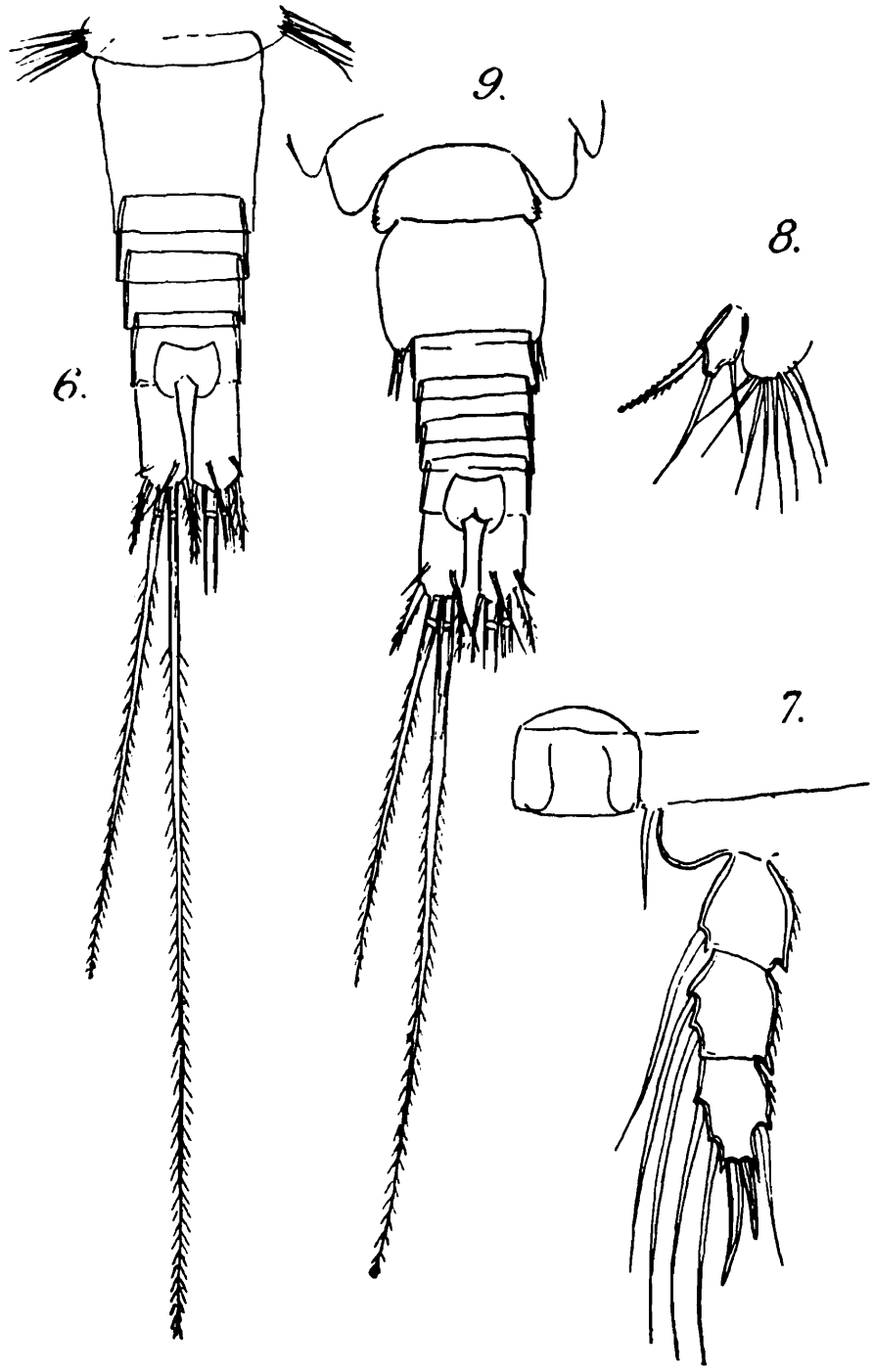
Vorkommen: Darjiling (vergl. oben Nr. 6 und Kiefer 1927).

Die vorläufige Beschreibung dieser Art soll durch folgendes erweitert und ergänzt werden.

Das Weibchen: In seiner äusseren Form gleicht es mehr einem *Eucyclops prasinus* oder auch einem *Cyclops* der *bicolor*—oder *varicans*—Gruppe als einem *Eucyclops s. str.* Der Körper ist sehr klein; er wird noch nicht ganz ½mm lang (480μ). Das letzte Thoraxsegment trägt einem Besatz langer, starker Borsten (Fig. 6). Das Genitalsegment ist vorn kaum breiter als hinten; der Uebergang vom einen Teil in den andern erfolgt nicht durch eine plötzliche scharfe Einschnürung, sondern ganz allmählich (Fig. 6). Die Abdominalsegmente werden nach hinten zu gleichmässig schmäler und kürzer. Der Dornenkranz am ventralen Hinterrand des Analsegmentes besteht jederseits aus wenigen, allerfeinsten Stachelchen, die nur sehr schwer richtig zu erkennen sind. Auszackungen der Hinterränder der Hinterleibsringe konnte ich nicht beobachten. Die Furkaläste sind kurz. Bei einem der Tierchen verhält sich Länge zur Breite wie 35 : 16μ, beim andern wie 35 : 17μ; ein Ast ist also nur wenig über zweimal so lang wie breit Innen- und Aussenrand sind ohne Härchen oder Dörnchen. Die Seitenrandborste ist etwas auf den Rücken verlagert und kurz. Die vier Endborsten verhalten sich beim einen der beiden Tierchen (von innen nach aussen) wie etwa 28 : 260 : 175 : 28μ (Fig. 6). Ihre Befiederung besteht aus feinen Härchen und ist homonom. Die zwölfgliedrigen Vorderantennen erreichen zurückgeschlagen eben den Hinterrand des Cephalothorax. Ob die drei Endglieder je eine sehr feine hyaline Längsmembran besitzen, konnte ich leider nicht mit genügender Sicherheit ausmachen. Die Schwimmfüsse haben gedrungene Glieder und zwar jeder Ast deren drei. Die Aussenastendglieder besitzen 2.3.3.3 Dornen (Dornformel) und je 5 Borsten. Während also unsere Art hinsichtlich der Beborstung durchaus in den Rahmen der *Eucyclops*-Gruppe passt, weicht sie in der Bedornung völlig davon ab. Denn die typische Dornformel dieser Gruppe lautet 3.4.4.3, und nur bei einer bisher bekannten Art ist sie anders, nämlich bei *Eucyclops fragilis* mihi, wo sie 3.3.3.3 heisst. Am Endglied des vierten Innenastes verhält sich Länge zur Breite wie etwa 23 : 17μ; die Länge der beiden Enddornen ist 26 bezw. 18μ (Fig. 7). Das eingliedrige rudimentäre Füsschen besitzt einen Aussenranddorn, der nur unmerklich stärker ist als die Endborste. Alle drei Anhänge sind nicht sehr längenverschieden (Fig. 8). Das Receptaculum seminis war leider nicht mehr zu erkennen. Eierballen trug auch keines der beiden Tierchen.

Das Männchen: Es lag mir nur ein einziges Stück vor. Dieses gehört zu den kleinsten Cyclopen überhaupt; denn es erreicht nur

eine Länge von ungefähr 400μ. Das letzte Thoraxsegment lässt jederseits einen Besatz feinster Börstchen erkennen (Fig. 9). Die Fur-



Figs. 6-9.—*Eucyclops indicus* Kiefer.

6. Letztes Thoraxsegment und Abdomen ♀ (dorsal).
7. Enp_4.
8. P_5. mit dem beborsteten Aussenteil des letzten Thoraxsegmentes.
9. Abdomen ♂ (dorsal).

kaläste sind verhältnismässig kürzer als beim Weibchen (29 : 16μ). Die vier Endborsten messen (von innen nach aussen) 28, 236, 145 und 25μ. Ueber Bau und Bewehrung der Fusspaare ist nichts Besonderes zu sagen. Die Genitalklappenbewehrung besteht wie gewöhnlich aus drei Anhängen, die nahezu gleich lang sind und zwar etwa so lang wie das zweite Abdominalsegment (Fig. 9).

Es erhebt sich nun die Frage, welcher der beiden Untergattungen von *Eucyclops* die eben gekennzeichnete Art zugewiesen werden muss. An *Eucyclops prasinus*, den Typ der Untergattung *Tropocyclops*, erin-

nern eine ganze Reihe von Merkmalen und zwar ausser der geringen Körpergrösse noch die Form des Genitalsegmentes, die Kürze der Furkaläste und das Fehlen der Säge an den furkalen Aussenrändern. Ich möchte aber *E. indicus* trotzdem nicht in die Untergattung *Tropocyclops* stellen, sondern reihe ihn in die Gruppe der eigentlichen *serrulatus*-Aehnlichen ein. Dafür sprechen folgende Gründe :—

(*a*) Das rudimentäre Füsschen sieht in seiner ganzen Gestalt dem der *serrulatus*-Formen *s. str.* unzweifelhaft ähnlicher als dem des *E. prasinus ;*

(*b*) die Glieder der Schwimmfussäste, insbesondere das Endglied des vierten Innenastes, sind bei *E. indicus* kurz, kürzer sogar als bei den allermeisten andern *serrulatus*-Formen, während sie und vor allem das Endglied des vierten Endopoditen bei *E. prasinus* ausserordentlich schlank sind ; und dasselbe gilt in noch höherem Grade von den Enddornen des fraglichen Gliedes, die bei *prasinus* aussergewöhnlich verlängert sind ;

(*c*) schliesslich könnten auch noch die Länge der weiblichen Vorderantennen (bei *indicus* wie bei vielen *serrulatus*-Formen kurz, bei *prasinus* dagegen langgestreckt) und die Länge der mittleren Furkalendborsten (bei *indicus* lang—bei *prasinus* verhältnimässig kurz) zur Begründung meiner Ansicht herbeigezogen werden. Seiner Besonderheiten wegen ist *Eucyclops indicus* jedenfalls eine der bemerkenswertesten Arten seiner Gattung.

Eucyclaps prasinus (Fischer).

Vorkommen : Calcutta, Kyd Street Tank (Gurney, 1906, p.279).
Calcutta, Tank of the Maidan (Gurney, 1907, p.23).
Calcutta, Zoologischer Garten (Gurney, 1907, p.23).
Ceylon, Peradeniya, Kandy (Gurney, 1916, p.337).
Ceylon, Sümpfe von Madatugama und der Umgebung des Kalawewa-Sees (Daday, 1898, p. 21).

Eucyclops prasinus ist eine in den Tropen (Südamerika, Afrika und nach den wenigen vorliegenden Angaben offenbar auch Indien) weit verbreitete Art. Da es aber keiner der oben angeführten Forscher für nötig fand, die von ihm beobachteten Tierchen näher zu beschreiben, so sind bei der offensichtlichen und weitgehenden Aehnlichkeit zwischen *Eucyclops indicus* und *E. prasinus*, Zweifel daran, ob es sich bei jenen Bestimmungen auch wirklich immer um typischen *prasinus* handelte, nicht ganz zu unterdrücken.

Paracyclops fimbriatus (Fischer) (?).

Vorkommen : Ceylon, Sümpfe von Mount-Lavinia und der Umgebung des Mahaveliganga-Flusses (Daday, 1898, p. 21).
Calcutta, Museum Tank (Gurney, 1907, p. 22).
Simla Hills (vergl. oben Nr. 1).

Wie ich es schon verschiedene Male ausgesprochen habe, ist *Paracyclops fimbriatus* ohne Zweifel eine Sammelart. Ich bin zur Zeit daran, sie zusammen mit einigen andern Artengruppen zu revidieren. Aber wegen Materialmangels konnte leider noch nicht zu einem befriedigenden Ergebnis gelangt werden. Deshalb möchte ich mich an dieser Stelle auch jeder weiteren Besprechang unserer Art enthalten.

Ectocyclops phaleratus (Koch).

Vorkommen: Calcutta, Kyd Street Tank (Gurney, 1907, p. 21).
Punjab, Darjiling } (vergl. oben Nr. 3, 4, 5, 6).
Ceylon, Sümpfe von Madatugama und der Umgebung des Mahaveliganga-Flusses (Daday, 1898, p. 21).

Abgesehen von der geringeren Körpergrösse konnte ich keine nennenswerten Sondermerkmale an den von mir beobachteten indischen Tieren gegenüber den mitteleuropäischen feststellen. Obwohl im tropischen Ostafrika noch eine zweite, mit *phaleratus* nahe verwandte *Ectocyclops*-Art vorkommt (*E. compactus* Sars), ist es doch wahrscheinlich, dass die oben angeführten Funde verlässlich sind. In den mir zur Untersuchung übergebenen Proben wurde *phaleratus* öfter als irgend eine der andern Arten gefunden.

Cyclops strenuus Fischer (?).

Vorkommen: " In the Kang Kul collection " (Gurney, 1906, p. 279).

Cyclops " strenuus " ist in älteren Faunenlisten stets ein sehr " unsicherer Kantonist ", denn wenn keine Beschreibung der betreffenden Tiere gegeben ist, weiss man nicht, welche der verschiedenen *strenuus*-Formen, die heute als durchaus berechtigte selbständige Arten unterschieden werden, dem Autor vorgelegen hat. So lässt sich leider auch mit der oben angeführten Angabe Gurneys nichts anfangen. Das Vorkommen des *Cyclops strenuus* in Indien darf also noch einigermassen bezweifelt werden. Denn die Art (im engeren Sinne sowohl als auch ihre nächsten Verwandten) ist nach unseren bisherigen Kenntnissen in den nördlichen gemässigten Gegenden zwar weit verbreitet und auch schon in den Subtropen (z. B. Nordafrika) festgestellt worden; aus den Tropen wurde sie aber noch nicht mit genügender Sicherheit nachgewiesen. Es ist indessen sehr wahrscheinlich, dass *C. strenuus* oder einer oder der andere seiner Verwandten auch in Indien (in seinem nördlichen Teil und in höher gelegenen Gewässern wohl noch am ehesten) aufgefunden wird.

Cyclops viridis (Jurine).

Vorkommen: " In the Kang Kul collection " (Gurney, 1906, p.279).

Da eben über *C. strenuus* Gesagte gilt in entsprechendem Sinne auch für *C. viridis*. Auch für diese Art müssen wir noch eine sicher begründete Bestätigung ihres Vorkommens in Indien abwarten.

Cyclops robustus Sars.

syn. *Cyclops vernalis* Poppe & Mrazek, 1895, p. 18.

Vorkommen : Ceylon, Süsswasser-Teiche der Südküste bei Point de Galle (Poppe & Mrazek, 1895, p. 18).

Auch *Cyclops vernalis* der älteren Autoren muss wohl in den allermeisten Fällen als eine Sammelart betrachtet werden, da der *C. robustus* Sars nicht als selbständige Spezies angesehen und deshalb mit dem Namen seines nächsten Verwandten belegt wurde. Das gilt nun auch, wie ich durch Nachuntersuchung der Originalprobe finden konnte, für den ceylonischen " *C. vernalis* " Dieser ist nämlich in Wirklichkeit *C. robustus.* Leider waren in dem betreffenden Gläschen nur sehr wenige Tiere, so dass ich bloss 2 davon einer eingehenderen Untersuchung unterziehen konnte. Während ihre Dornformel typisch war, also 3.4.4.4 lautet, weichen die beiden Stücke hinsichtlich der Beschaffenheit der übrigen Schwimmfussanhänge voneinander sowohl als auch vom typischen *C. robustus* (wie ihn Sars 1918 gekennzeichnet hat) ab. Das eine Exemplar müsste in Anlehnung an Thallwitz, der die sächsischen Formen der *vernalis-robustus*-Gruppe eingehend vergleichend untersucht hat, als *C. robustus* var. *setiger* bezeichnet werden ; denn an keinem Gliede seiner Schwimmbeine findet sich eine in einen Stachel oder Dorn umgewandelte Borste. Das zweite Exemplar bildet aber dazu den äussersten Gegensatz ; denn bei ihm findet sich eine recht grosse Anzahl transformierter Borsten am vierten, dritten und zweiten Schwimmfusspaar. Danach wäre das betreffende Tierchen als *C. robustus* var. *armata* Thallwitz zu bezeichnen.

Cyclops languidus Sars (?).

Vorkommen : Ceylon, Sümpfe van Madatugama und der Umgebung des Kalamewa-Sees (Daday, 1898, p.21).

Da Daday den Fund eines als *languidus* angesprochenen *Cyclops* lediglich mitteilt, ohne irgendwelche nähere Kennzeichnung der Tiere zu geben, muss ich bei der bekannten Oberflächlichkeit der Copepoden-Bestimmungen dieses Autors noch sehr bezweifeln, ob ihm tatsächlich typischer *languidus* vorgelegen hatte. Gerade in der jüngsten Zeit sind von *languidus* sowohl wie von *languidoides*, der lange mit *languidus* zusammengeworfen wurde, nicht wenige Unterarten abgetrennt worden. Es kann also nur an neuem Material festgestellt werden, welche dieser Formen eventuell in Indien vorkommt.

Cyclops minutus Claus (?).

? syn. *Cyclops diaphanus*, Gurney, 1907, p. 32.

Vorkommen : Chakradharpur (Gurney, 1907, p. 32).

Schmeil hat unter " *diaphanus* " den *Cyclops* verstanden, den Claus als " *minutus* " beschrieben hatte. Und seinem Vorgehen haben sich in der Folgezeit die meisten Copepodenforscher angeschlossen. So kann also angenommen werden, dass *C. diaphanus* in vielen Fällen mit *minutus* identisch ist. Seit ich nachzuweisen versucht habe, dass der Fischersche *Cyclops diaphanus* eine durchaus ungenügend ge-

kennzeichnete, nicht sicher wiederzuerkennende Form sei und daher am besten überhaupt gestrichen werde, sieht man sich immer wieder einmal vor die Aufgabe gestellt, einen *C.* " *diaphanus* " mit einer der " guten " Arten zu identifizieren. Wie angedeutet, wird dafür ja häufig *C. minutus* Claus in Frage kommen. Wenn der betreffende Autor jedoch, wie im vorliegenden Falle auch Gurney, keine näheren Angaben über seine Tiere macht, so ist eine solche Annahme immerhin doch sehr unsicher. Denn einmal ist erwiesen, dass mancher Forscher eine andere Form als den Clauschen *minutus* als " *diaphanus* " bestimmt hat (zum Beispiel *C. diaphanus* Rühe 1914=*C. necessarius* Kiefer; *C. diaphanus* Lande 1890 und *C. d.* Richard 1891=*C. bicolor* Sars (vergl. Kiefer 1926 !); *C. diaphanus* Sars 1918=*C. nanus* Sars usw.); zum andern sind gerade in neuerer Zeit noch einige Arten bekannt geworden, die wohl mit *C. minutus* verwechselt werden können und vielleicht auch schon verwechselt worden sind (z.B. *C. dengizicus* Lepeschkin, *C. monacanthus* Kiefer u.a.). So wäre es gar nicht ausgeschlossen, dass der Gurneysche *diaphanus* von Chakradharpur zur folgenden Art *C. dengizicus* gehört.

Cyclops dengicicus (Lepeschkin).

syn. *Cyclops buxtoni*, Sewell, 1924.

Vorkommen: Chilka-See (Station 128), (Sewell, 1924, p. 798).

Ich habe nachgewiesen, dass der 1921 aufgestellte *C. buxtoni* Gurney aus Mesopotamien mit *C. diaphanus* var. *dengizica* Lepeschkin identisch ist. Diese Lepeschkinsche, aus Innerasien stammende Form ist ohne Frage eine selbständige Art. Sie ist neuestens auch im Gebiet des Suez-Kanals gefunden worden, besitzt also offenbar eine weite Verbreitung.

Cyclops bicolor Sars.

Vorkommen: Chilka-See," fresh-water pond on Barkuda Island " und zwei Stellen am Südende des Sees " in Rambha Bay " (Sewell, 1924, p. 797).

Die Sewellsche Bestimmung soll nicht angezweifelt werden. Bei neuen Funden wird aber darauf zu achten sein, ob wirklich typischer *C. bicolor* vorliegt oder am Ende eine ihm nur sehr ähnliche, nahe verwandte Form, wie sie in jüngster Zeit aus Ost-, West- und Südafrika beschrieben worden sind (*Cyclops pachycomus* Sars, *falsus* Kiefer, *caudatus* Sars, *linjanticus* Kiefer u.a.).

Cyclops varicans Sars (?).

Vorkommen: Calcutta, Museum Tank—Tank of the Maidan—Zoologischer Garten (Gurney, 1907, p. 23).
Chakradharpur (Gurney, 1907, p. 23).
Ceylon, Peradeniya—Kandy—Anaradhpura (Gurney, 1916, p. 337),
Lucknow (vergl. oben Nr. 8).

Für *C. varicans* gilt in entsprechendem Sinne dasselbe wie für *Paracyclops fimbriatus*. Ich halte es für besser, über meinen eigenen Fund

(ein einziges Weibchen !) erst dann zu berichten, wenn ich es genauer in der Gruppe der *varicans*-Aehnlichen einzureihen vermag. An dieser Stelle erlaube ich mir nur zu empfehlen, künftighin *varicans*-ähnliche Formen nicht gleich von vornherein und so obenhin als " *varicans* " auszugeben, sondern sie zuvor erst einmal eingehend (d.h. messend) zu untersuchen.

Mesocyclops leuckarti (Claus).

Vorkommen : Calcutta, Kyd Street Tank—Tank of the Maidan—Zoologischer Garten (Gurney, 1906, p. 279 ; 1907, p. 21).
Port Canning, Ganges-Delta (Gurney, 1907, p. 21).
Chakradharpur, verschiedene Fundorte (Gurney, 1907, p. 21).
Chilka-See, verschiedene Fundorte, auch solche mit höherem Salzgehalt bis zu einer Dichte von 1·02825 (Sewell, 1924, p. 798 – *Mesocyclops obsoletus*).
Ceylon, Sümpfe von Madatugama, der Umgebung des Kalawewa-Sees und des Maha-veliganga-Flusses (Daday, 1898, p. 21).
Ceylon, Colombo-See (Apstein, 1907, p. 220).
Ceylon, Gregory-See (Apstein, 1910, p. 674).
Ceylon, Peradeniya (Brehm, 1909, p.222).
Ceylon, See von Kandy und Peradeniya (Burckhardt, 1913, p. 343).
Ceylon, Peradeniya—Kandy—Anaradhpura (Gurney, 1916, p. 337).
?Ceylon, (*Cyclops* sp.—Brady, 1886, p. 296, t.38, f.2-4).
" Calicut " (vergl. oben Nr. 7).
Lucknow (vergl. oben Nr. 8).

Danach ist *Mesocyclops leuckarti* Claus der in Indien bis jetzt am häufigsten beobachtete Cyclopide, wie denn die Gattung *Mesocyclops* überhaupt in den Tropen quantitativ und qualitativ reicher vertreten ist als in den gemässigten Gebieten.

Mesocyclops hyalinus (Rehberg).

Vorkommen : Ceylon, Kandy—Mahintele—Anaradhpura (Gurney, 1916, p. 337).
" Calicut " (vergl. oben Nr. 7).

Mesocyclops oithonoides (Sars) (?).

Vorkommen : Chakradharpur (Gurney, 1907, p. 23).
Chilka-See (Sewell, 1924, p. 799).

Nach meinen bisherigen Erfahrungen ist *Mesocyclops hyalinus* in den Tropen die häufigste und verbreitetste Form der Untergattung *Thermocyclops*. In den vielen Proben, die ich schon untersucht habe (aus Südamerika, Afrika, Indien, Sunda-Inseln, Neuseeland) ist mir

noch gar nie typischer *M. oithonoides* unter die Augen gekommen. Bei näherem Zusehen handelte es sich stets um *M. hyalinus* oder eine diesem sehr nahestehende Form. So muss ich die Richtigkeit der "*oithonoides*"-Bestimmungen Gurney und Sewells vorerst noch etwas anzweifeln.

Wenn man das zusammenfasst, wass wir Sicheres von der Cyclopidenfauna Indiens wissen, so ist das also doch ganz ausserordentlich wenig. 18 Arten und davon ein nicht geringer Teil mehr oder weniger zweifelhaft! Und in andern, besser durchforschten, aber verhältnismassig viel Kleineren Gebieten finden sich 30 und mehr gute Arten Es wird also für alle diejenigen, denen es möglich ist, in Indien zu sammeln, vorweg natürlich für die in Indien ansässigen Zoologen, eine dankenswerte Aufgabe sein, künftighin der niederen Süsswasser-Lebewelt und insbesondere den Copepoden mehr Aufmerksamkeit zu schenken als bisher. Die geringe darauf verwendete Mühe wird sich ohne Zweifel durch schöne wissenschaftliche Erfolge bezahlt machen.

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THE AQUATIC AND AMPHIBIOUS MOLLUSCA OF THE NORTHERN SHAN STATES, BURMA.

By H. Srinivasa Rao, *M.A., D.Sc., Assistant Superintendent, Zoological Survey of India.*

(Plates XII—XIV.)

Prefatory Note.

The present paper is the outcome of a survey of molluscs in the Northern Shan States for a period of about three months. It is chiefly based on the collection of freshwater and amphibious molluscs made in that country during November and December of 1926, and January 1927. I have also had before me Dr. Feegrade's collection of molluscs made in August and September of 1926 from Hsipaw and Lashio, and the Indian Museum collection of molluscs made in various parts of the Northern Shan States several years ago. I have also had for comparison the rich collection of freshwater molluscs from the Southern Shan States and other parts of Burma deposited in the Indian Museum. The drawings illustrating this paper were made under my supervision by Babu A. C. Chowdhury, Senior Artist in the Zoological Survey, with great care and precision and my sincere thanks are due to him.

Contents.

Introduction.

History of the Mollusc Survey.—In the year 1924 Dr. J. P. Cullen, Chief Medical Officer, Burma Corporation, Namtu, Northern Shan States, reported the occurrence at the Namtu Hospital of eight cases of human Schistosomiasis in Chi ese coolies from Yunnan.[1] The

[1] Cullen, J. P., *Journ. Trop. Med. and Hyg.*, XXVII, pp. 337, 338 (1924). *Proc. Roy. Soc. Med. (Trop. Dis. Sect.)*, p. 85 (1924).

possibility of the spread of Schistosomiasis from China into Burma having been feared, the Director of Public Health, Burma, made a preliminary survey of the Chinese Frontier in the North of the Northern Shan States for known carrier snails of *Schistosoma* with little positive result. The advisability of a snail survey of the Northern Shan States having been suggested, the matter was entrusted to Lt.-Col. J. Taylor, Director, Pasteur Institute of Burma, who with the funds provided for this purpose by the Indian Research Fund Association, Simla, approached the Director, Zoological Survey of India, for help in conducting a survey of the molluscs of the Northern Shan States with a view to find out if any known carriers of *Schistosoma japonicum* occur in this region. With the approval of the Government of India it was decided that I should visit the Northern Shan States early in April 1926 for this purpose. When arrangements had been completed for carrying out a survey the news was received that the monsoon had already set in in the Northern Shan States and that a survey would be impossible at that time of the year, and in consequence my departure was postponed till after the monsoon.

Accompanied by Mr. R. Hodgart, Zoological Collector in the Zoological Survey of India, as assistant I left Calcutta on the 29th October 1926 and arrived in Rangoon on the 1st November. After consultation with the Offg. Director, Pasteur Institute, regarding the itinerary to be followed and the duration of the survey, we left for Lashio, the Headquarters of the Northern Shan States, which we reached on November 6th. Proceeding by slow marches we surveyed the country lying between Lashio and Namkham, the Frontier on either bank of the Shweli river between Namkham and Muse, and the Namtu valley between Hsenwi and Namtu. Dr. B. Chopra, my colleague in the Zoological Survey joined my party early in January 1927, and we together surveyed the area round about Mongyai, Mankat and Tangyan in South Hsenwi State, and in the vicinity of Hsipaw town. A map of the N. Shan States showing the route taken by the party and the more important places visited is included. I have to thank Babu R. C. Bagchi for reproducing the map.

It was also arranged to visit the trans-Salween Frontier of the Northern Shan States in the neighbourhood of the Kunlong ferry and Malipa (or Tawnio), but as the funds provided for the survey had been exhausted, the trip had to be abandoned at the last moment. We therefore returned to Rangoon on the 25th January 1927.

So far as the occurrence of Schistosome cercariae and of the known carrier-snails was concerned the results of the survey were negative. Every species of freshwater Gastropod collected in the Northern Shan States was carefully examined in the field for fork-tailed cercariae, but with the exception of *Indoplanorbis exustus* and *Melanoides tuberculatus* which harboured only Xiphidio-and Amphistome cercariae, all other species were free from any kind of Trematode parasites. The genus *Oncomelania*, species of which are known to be carriers in China and Japan, was not found in the area surveyed. Enquiries made at the Asiatic Hospital, Namtu, at the American Baptist Mission Hospital,[1] Namkham, and at the Civil Hospital, Lashio, show that no further cases of

[1] I am indebted to Dr. Seagrave in charge of the Mission Hospital for helpful information on this subject.

Schistosomiasis were recorded since Dr. Cullen's report in 1924, though the immigration of Chinese coolies from Yunnan into the Northern Shan States and particularly at Namtu has by no means diminished within the last three years.

The absence of the specific host of *Schistosoma japonicum*, the absence of cercariae closely allied to *S. japonicum* in any species of Gastropod molluscs collected in the area, and the lack of medical evidence as to the spread of Schistosomiasis since the report of its occurrence in 1924 are points which favour the opinion that there is likely to be no immediate danger of the introduction of the disease into Burma. However, the discovery by Sewell in 1919 of a species of cercaria morphologically identical with the cercaria of *S. japonicum* in *Indoplanorbis exustus* from Calcutta and the Wynaad in South India, and in *Limnaea acuminata* from Calcutta,leaves the question of the possible spread of Schistosomiasis in India and Burma still open.[1] So far as the present survey is concerned, though these two species were common in ponds and pools in the Northern Shan States and were carefully examined for cercariae, no larval trematodes which approach those of *S. japonicum* morphologically were found in the species. In fact this particular type of cercaria has not been recorded again in the species in India or anywhere else since its discovery in 1919.

If positive results are desired a thorough survey of the Frontier districts on the eastern boundary of the Shan States and of Upper Burma at all seasons seems to be necessary. The adaptive, if not the specific host of *S. japonicum* occurs in the Shan States, and the constant stream of Chinese coolies which comes in from adjacent infected Chinese provinces is more likely than not to carry with it the insidious parasite. Infection experiments on various species of aquatic molluscs such as those carried out in India by Kemp and Gravely,[2] and by Sewell [3] with regard to the suspected spread of Schistosomiasis from Egypt and Mesopotamia, should, I think, be conducted in Burma as well before it is assumed that the country is immune to the spread of *S. japonicum* from beyond the Chinese Frontier.

Acknowledgments.—To adequately express my gratitude for all the help I received in the course of the survey is a difficult task. For kindness and courtesy in the course of my tour in the Northern Shan States I have to thank Major C. de C. Martin, Officiating Director, and Lt.-Col. J. Morison, lately Director, Pasteur Institute, Rangoon. To Mr. F. S. Grose, Superintendent of the Northern Shan States, to Mr. P. M. R. Leonard, Assistant Superintendent at Kutkai, and to Mr. J. Poo Nyo, Headquarters Assistant Superintendent, Lashio, my thanks are due for transport arrangements and other facilities. To Mr. Leonard I am particularly indebted for the interest he took in my work throughout my stay within his jurisdiction. Major W. L. Brookes, Civil Surgeon, Lashio, not only kindly placed at my disposal all his tents for the use of my party in camp, but also permitted me to utilise the services of his Hospital staff at Lashio and at other centres in his division. For these

[1] Sewell, *Rec. Ind. Mus.*, XVI, pp. 425-429, pl. xxv (1919).
[2] Kemp and Gravely, *Ind. Journ. Med. Research*, VII, pp. 251-264 (1919).
[3] Sewell, *Ibid.*, VIII, pp. 118-124 (1920).

and for various suggestions my best thanks are due to him. To Dr. U. Lakshmayya, Sub-assistant Surgeon in the Civil Hospital, Lashio, I am greatly indebted for kind help in various ways. I have also to thank Major Clive, Battalion Commandant at Lashio, for placing the services of a Kachin interpreter at our disposal during our tour in South Hsenwi, and for useful suggestions as regards our itinerary. Dr. B. L. Slater, Chief Medical Officer, Burma Corporation, Namtu, helped me to obtain and consult large scale maps of the Northern Shan States and the adjoining Chinese Frontier districts, and provided facilities for my visit to Namtu and Bawdwin, and to him my sincere thanks are also due, Dr. E. S. Feegrade, Special Malaria Officer, Burma, placed at my disposal his collection of molluscs from Hsipaw and Lashio which has proved of great value in my investigations, and I must here express my gratitude for his kindness. Lastly I have to thank my colleague Dr. B. Chopra for his kind help during the survey in the States of S. Hsenwi and Hsipaw.

It is impossible to close this list of acknowledgments without referring to the services rendered by Mr. R. Hodgart to the Mollusc Survey in general and to me in particular. His energy was unremitting, and the success of the survey was in no small measure due to his ungrudging assistance.

Lt.-Col. Sewell and Dr. Prashad have gone through this paper and made valuable suggestions, and I take this opportunity to thank them sincerely.

Physical features.—The Northern Shan States comprise an administrative group in the Federation of Shan States and lie in the north-eastern corner of Upper Burma.[1] The area is bounded on the North and the East by the Yunnan province of China, on the South by the Southern Shan States, and on the West by the Mandalay and Ruby Mines districts of Upper Burma. It lies in the drainage area of the Irrawady and the Salween rivers, and includes in its river-system several large and small streams which are connected with the two principal rivers Nam Mao or Shweli and Myitnge or Namtu. Both these rivers empty themselves into the Irrawady. The Nam Paw, the Nam Hkai, and the Nam Yao are the principal large streams which join them. The only tributary to the Salween on its right bank which rises in the Northern Shan States is the Nam Pang which joins it in the Southern Shan States.

The country forms part of a plateau having a mean elevation of about 3,000 feet above sea level which extends from the Irrawady basin to the Salween in an East to West direction, and from the valley of the Shweli in the North to the plateau of the Southern Shan States into which it merges in the South. Relieving the monotonous features of the plateau are ranges of hills varying in elevation from 5,000—9,000 feet above sea level and running roughly in a North to South direction. La Touche's description of the general features of the country is very appropriate and I extract the following from his Memoir on the Geology of the Northern Shan States.[2] " Although the word plateau is generally

[1] For details as regards climate, rainfall, etc., reference should be made to the *Imp. Gaz. India, Provincial Series, Burma,* II, pp. 306-334 (1908).

[2] La Touche, *Mem. Geol. Surv. Ind.,* XXXIX, pp. 1-379 (1913).

used to designate the aspect of the country, it is by no means a dead level, in fact there is very little really level ground over the whole area. The surface may be more correctly described as undulating, not unlike that of the 'downs' of Southern England, with a tendency to the formation of more or less gently sloping expanses of even ground, but seldom actually level for any considerable distance." These features are particularly noticeable in the vicinity of Muse near the Chinese Frontier, of Kutkai in North Hsenwi, and of Mongyai, Mankat and Tangyan in South Hsenwi.

The rocks of the plateau are of limestone origin belonging to the Palaeozoic age, while those of the hills are very different in character and belong to the older Palaeozoic and Archaean age.

There are no lakes in the Northern Shan States, unless the coal basins of Lashio and Namma represent shrunken ones of the Tertiary period.

The vegetation of the country is varied, the hills and the deep river valleys bearing luxuriant forests of timber, and the uplands maintaining but the scantiest vegetation in the form of tall grass and low shrubs. The plains of the river valleys are cultivated, and bamboos thrive in great abundance.

General Character of the Fauna.—It is difficult to estimate the general character of the fauna from a short survey of the country in the cold season which is about the driest in the year. The Mammalia are probably well represented. Wild game such as tigers, bison, and elephants are said to occur in the jungles of the river valleys—but we did not come across any in the course of our marches though evidence of their occurrence was not wanting. Monkeys of sorts, chiefly the long-tailed species, and the small barking deer, seem to be common on the hills. The Reptilia and Amphibia are represented by a very few species, the only occurrence worth recording is that of newt larvae in the uplands of Kutkai. A few species of fish belonging to the Cyprinidae, Muraenidae, and Ophiocephalidae occur in streams, ponds and rice-fields. At the time of my visit the richness of the bird fauna was evident on the hills, in the river-valleys, and on the uplands. The aquatic birds are a great feature of the Shweli valley on the Frontier, though they are present in smaller numbers in the river valleys still further South. The insect fauna was relatively poor, but aquatic larvae of a few species of insects were quite abundant in streams and pools. Of the other groups of the animal kingdom, the sponges, the Coelenterates, and the Polyzoa were very rare. A few species of earthworms, leeches, Planarians, Gordiid worms and Rotifers were found. The Crustacea were represented by one species of crab and one of "shrimp" extremely scarce in number, and by one or two species of Copepods and Ostracods in large numbers. A few Isopods were taken in damp situations on the hills.

The Mollusca are well represented in the fauna. The land species were comparatively rare and found only in concealed positions in hilly tracts or in damp situations of the plains. A few species of snails and slugs were collected in various parts of the Northern Shan States, but are not dealt with in this paper. The freshwater and amphibious molluscs occur in different types of environment. Species were found in rivers and streams, in ponds and other types of stagnant water both of the

uplands and the valleys, in hill streams of the higher regions, and in moist places at the edge of streams.

48 species of molluscs (including 29 forms, races and varieties) belonging to 11 families and 26 genera are recorded from the Northern Shan States, but two species and a variety were not found in the course of the survey. 1 genus, 7 species, and 14 forms, varieties and races are new to science and all belong to the Gastropoda. The Lamellibranchs are all referrable to known species and include only 10 species belonging to 7 genera.

The following are the aquatic and amphibious molluscs recorded from the Northern Shan States, the numerals indicating the number of families :—

1. *Neritina* sp.
2. *Taia theobaldi* (Kobelt).
   Taia theobaldi f. *globosa*, nov.
   Taia theobaldi f. *niger*, nov.
   Taia theobaldi var. *leonardi*, nov.
   Taia theobaldi race *hsenwia*, nov.
   Taia aspercallosa, sp. nov.
   Taia aspercallosa var. *brookesi*, nov.
   Viviparus bengalensis f. *balteata* (Benson).
   Viviparus bengalensis race *doliaris* (Gould).
   Viviparus dissimilis (Müller).
   Viviparus dissimilis var. *decussatula* (Blanford).
   Viviparus dissimilis var. *peguensis* (Kobelt).
   Cipangopaludina lecythis (Benson).
   Cipangopaludina lecythis f. *crassior* (Annandale).
   Cipangopaludina lecythis var. *crassispiralis*, nov.
   Cipangopaludina lecythis f. *purpureus*, nov.
   Cipangopaludina lecythoides (Benson).
3. *Pila conica* (Gray).
   Pila conica f. *compacta* (Reeve).
   Pila theobaldi (Hanley).
4. *Bulimus pygmaea* (Preston).
   Hydrobioides nassa f. *distoma* Annandale.
   Hydrobioides nassa f. *rivulicola* Annandale.
   Hydrobioides namtua, sp. nov.
   Parafossarulus nana f. *elongata*, nov.
   Tricula taylori, sp. nov.
   Tricula martini, sp. nov.
   Tricula gregoriana var. *expansa*, nov.
   Tricula horae var. *major*, nov.
   Ekadanta shanensis, gen. et sp. nov.
5. *Acrostoma baccata* (Gould).
   Acrostoma baccata f. *bituberculata*, nov.
   Acrostoma baccata f. *pyramidalis* Theobald.
   Acrostoma baccata f. *lirata*, nov.
   Acrostoma baccata f. *recta* Nevill.
   Acrostoma kubja, sp. nov.
   Acrostoma iravadica (Blanford).
   Acrostoma baccifera (Theobald).
   Melanoides tuberculatus (Müller).
   Melanoides feegradei, sp. nov.
   Paludomus regulata Benson.
6. *Limnaea auricularia* (Linne).
   Limnaea andersoniana Nevill.
   Limnaea andersoniana f. *simulans* Preston.
   Limnaea andersoniana f. *brevios*, nov.
   Limnaea acuminata Lamarck.

Limnaea acuminata f. *patula* Troschel.
Limnaea acuminata f. *rufescens* Gray.
Limnaea acuminata f. *hians* Sowerby.
Limnaea yunnanensis Nevill.
Limnaea luteola f. *siamensis* Sowerby.

7. *Indoplanorbis exustus* (Deshayes).
Gyraulus convexiusculus (Hutton).
Gyraulus euphraticus (Mousson).
Segmentina calathus (Benson).

8. *Ferrissia verruca* (Benson).

9. *Succinea rutilans* Blanford.
Succinea daucina f. *burmanica*, nov.
Succinea elegantior Annandale.

10. *Indonaia bonneaudi* (Eydoux).
Indonaia caerulea (Lea).
Lamellidens lamellatus (Lea).
Trapezoideus foliaceous (Gould).
Trapezoideus dallianus (Frierson).
Parreysia bhamoensis (Theobald).

11. *Corbicula striatella* Deshayes.
Corbicula noetlingi v. Martens.
Sphaerium montanum Tapporone Canefri.
Pisidium clarckeanum G. & H. Nevill.

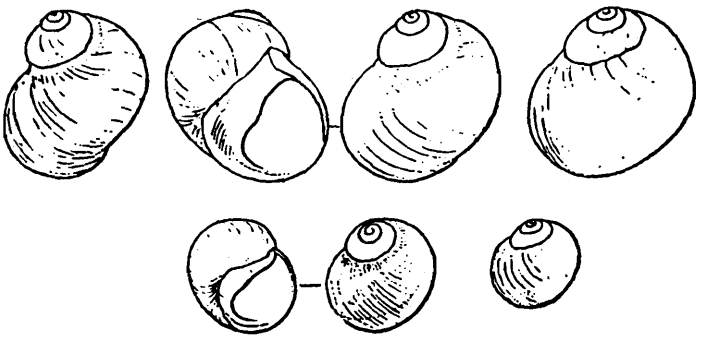
GASTROPODA.

Family Neritidae.

The members of this family are mostly inhabitants of the sea, river estuaries, and brackish-water areas. A few, however, live in fresh-water areas far removed from the sea or estuarine regions. The fresh-water forms are usually referred to the genus *Neritina*. Some authors, including von Martens, recognise a number of subgenera, while others raise them to the rank of distinct genera.

Neritina sp.

The only representative of the Neritidae found in the Northern Shan States was a species of *Neritina*, large numbers of which were picked up in a subfossil state in sand on the banks of the Namtu river at Hsenwi. The operculum was not found at all. The shell is perfectly



Text-fig. 1.—*Neritina* sp. A series of subfossil shells from Hsenwi : × 4.

bleached and the sculpture rather obscure. In its shell-form, and in the nature of the aperture the species seems to resemble *N. dubia* Chemnitz or *N. apicata* Recluz, but in size the shells are much smaller than those

of either of these species, the largest of them not exceeding 5 mm. in height. The form of the shell is subject to considerable variation; the columella is broad, slopes down towards the aperture, and has a minute triangular protuberance at about the middle of the columellar edge. The outer lip is thin. The shell has 3-3½ whorls.

The species probably occurs in a living state, but I have not been able to find any specimens in the hill-streams in the surrounding country. The main features of the species are shown in the accompanying drawing of a small series of shells.

Family VIVIPARIDAE.

Members of this family are common in the Northern Shan States and are represented by the genera *Viviparus*, *Taia* and *Cipangopaludina*. The first named genus occurs all over India, the second is peculiar to Burma, and the third occurs all over China, Japan, Burma, and Assam in India, and probably in the Malay Peninsula, the Philippines and adjacent islands. In the course of the survey six species of Viviparids were found in the North and South Hsenwi States alone, of which one has proved to be new to science. A few interesting new forms and races have also come to light.

Genus **Taia** Annandale.

1918. *Taia*, Annandale, *Rec. Ind. Mus.*, XIV, pp. 123,124 and 160.
1925. *Taia*, Annandale and Rao, *Rec. Ind. Mus.*, XXVII, pp. 118–120.

Only two species of this genus were found in the Northern Shan States. *T. theobaldi* is common throughout the States, but the plastic nature of the species is indicated by a number of forms, varieties and races which have to be recognised as new. The other species *T aspercallosa* and its variety *brookesi* are both new to science, and were found only in the Namtu valley of the North Hsenwi State. They represent a fresh line of evolution among the species included in the genus, but are not without intimate relationship with the dominant species, *e.g.*, *T theobaldi*.

Taia naticoides, a species found living in the Southern Shan States and *T* (*crassitaia*) *infracrassata* Annandale were both found in the Pleistocene beds of the Northern Shan States.[1] No specimens of either of the two species were found by the Mollusc Survey party in the area under investigation.

Taia theobaldi (Kobelt).

1865. *Paludina naticoides* var. *fasciata*, Theobald, *Journ. As. Soc. Bengal*, XXXIV, p. 274, pl. ix, fig. 1.
1918. *Taia theobaldi*, Annandale, *Rec. Ind. Mus.*, XIV, p. 126, pl. xv, fig.18; pl. xvi, fig. 1; pl. xviii, figs. 15-17.
1925. *Taia theobaldi*, Annandale and Rao, *Rec. Ind. Mus.*, XXVII, p. 122.

The description by Theobald in the paper cited above of a collection of Viviparid shells from the Shan States, seems to refer, to judge from the figures, to two distinct species, namely *T. theobaldi* and *T. naticoides*. At any rate, the variety *fasciata* of the latter is undoubtedly a distinct

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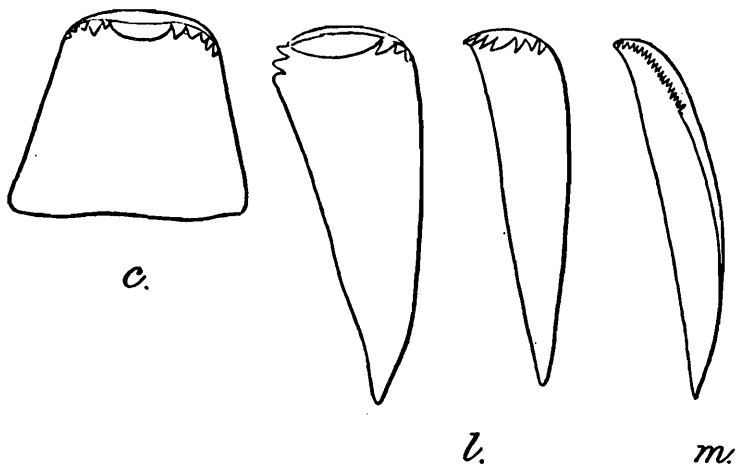
[1] Annandale, *Rec. Geol. Surv. Ind.*, L., pp. 22, 23 (1919).

species, which I refer to *T theobaldi*, while the variety *carinata*, which is represented in the Zoological Survey of India collection by a single specimen, is to be referred to *T naticoides*. The characteristic features of the latter species are very well seen in this specimen. Individuals of both the species were collected by Mr. F. Fedden in the year 1864-65, but the precise locality in the Shan States is not given. There are, however, in the Zoological Survey Collection specimens of both the species labelled "River Salween;" these probably formed part of Fedden's collection on which Theobald based his descriptions. The shells from the Upper Salween and Ava which Annandale (1918) referred to in the work cited above belong to *T theobaldi* rather than to *T. naticoides*.

Specimens of *T theobaldi* were by no means abundant in the parts of the Northern Shan States where they were collected, but there was little individual variation in the specimens from the same locality. On the other hand shells from different places show a great deal of variation in both form and sculpture, indicating thereby the inherent plasticity of the species in response to changes in environment.

The forma *typica* was collected in the following places in the Northern Shan States: Lashio and its environs including Old Lashio, on the Eastern slopes of the Loilun chain of hills, and at Hsenwi. It is usually found in sluggish, weedy streams. The shells are of a fair size, banded and have the oblique longitudinal sculpture well developed which masks the minute spiral sculpture. The three spiral ridges are fairly developed in individuals from Hsenwi and Lashio and bear in some instances minute tubercles which give them their resemblance to *T naticoides* race *noetlingi* (Kobelt).[1] There is often only a single spiral ridge in the middle of the bodywhorl as in the case of specimens collected on the Eastern slopes of the Loilun. The shells found at Old Lashio, and at Hsenwi on the banks of the Namtu river are very much worn and bleached, though in one of the latter the minute spiral sculpture is still conspicuous.



Text-fig. 2.—Radular teeth of *Taia theobaldi*. *c.* central; *l.* lateral; *m.* marginal.

The operculum and radular teeth are very similar to those figured by Annandale, though the latter are to some extent variable in size,

[1] Prashad has pointed out (*vide* footnote *Mem. Ind. Mus.*, VIII, p. 165, 1928) that Annandale's *T. naticoides* race *intermedia* is a synonym of *T. naticoides* race *noetlingi* (Kobelt).

and the number of cusps present on the teeth differs in different individuals.

The presence or absence of triangular processes on the mantle edge depends on the state of preservation of the animal. In many instances the mantle edge is even, and indentation is only exceptional.

The gill lamellae are of the type found in other species of *Taia*, but present considerable variation in proportions.

The number of individuals of both sexes collected from various localities and the number of embryos and eggs found are given below :—

Locality.	Males.	Females.	Full grown embryos.	Half grown embryos.	Eggs.
Lashio	16	12	3-4	10	12
Eastern slopes of Loilun ..	30	7	2	*Nil*	6
Hsenwi	4	13	2	10	15

The percentage of females present is therefore 31·5, 18·9, 76·4 respectively.

In a paper on the aquatic Gastropods of the Inlé watershed Annandale and Rao have suggested that in species which live in streams or in paludine conditions the number of females predominates over that of the males. *T theobaldi* is a form which lives in streams, and one would therefore expect to find the same proportion, but, except in one instance, this rule does not apply. The factors which affect the proportion of the sexes in various species are apparently not inherent in the species, but are presumably to be sought for in their environment which influences the individuals of a species at different periods of their existence. Further data are, however, necessary to express this relationship more precisely.

The embryos are, as a rule, banded and bear two or rarely three prominent spiral ridges in addition to a number of minute parallel spiral ridges. The last prominent spiral ridge corresponds to the keel in the middle of the bodywhorl.

The following are the measurements in millimeters of the largest shell from each locality :—

Locality.	Height of shell.	Greatest breadth of shell.	Height of aperture.	Greatest breadth of aperture.
Lashio	35	26	16	12
Streams near Hsenwi ..	33	26	16	13 } spire incomplete.
Old Lashio	33	25	17	13 } spire incomplete.
Eastern slopes of the Loilun range.	30	23	14	11
Namtu river, Hsenwi ..	28·5	20·5	13	9·5

Taia theobaldi appears to be the predominant species of *Taia* in the Northern Shan States. *T naticoides* is said to occur in parts of Upper Burma and the Northern Shan States. I have not been able to obtain a single specimen of the latter species either living or subfossil in the North and South Hsenwi States or in the Hsipaw State of the Northern Shan States. The species has been recorded living in the plains of the Inlé watershed, and in a subfossil state from the now extinct lakes of He-Ho and Hsin-Dawng. The absence of the species in the valley of the Shweli or Nam Mao on the Sino-Burmese frontier is noteworthy. Its original home is probably in the region of the Upper Salween and in parts of Southern China.

Taia theobaldi f. globosa, nov.

Individuals of this form have a relatively thick shell, short spire, and more or less globular bodywhorl. The spiral sculpture in the adult individuals is comparatively poorly developed whereas the longitudinal is well developed. The columella is narrow, smooth and shining, and the mouth of the shell broad and evenly rounded below and narrow above.

Dead shells of this form were obtained by Dr. Chopra and myself near the Nam Pang river in Mankat, and in the vicinity of a stream in Tangyan, both in the South Hsenwi State of the Northern Shan States. In fully developed individuals the oblique longitudinal sculpture obliterates the spiral except on the base of the bodywhorl. In the only shell collected at Mankat a trace of the spiral ridges is left in the middle of the bodywhorl. The whorls of the spire are worn on their surface and show no trace of the sculpture. Spiral colour bands are usually inconspicuous, but in worn adult shells as well as in very young specimens they are to some extent visible. In a large shell from Tangyan the umbilical area outside the columella is flattened, a shallow channel running forwards from the umbilicus.

The following are the measurements in millimeters of two large shells :

Locality.	Height of shell.	Greatest breadth of shell.	Height of aperture.	Greatest breadth of aperture.
Tangyan	28·5	23·0	13·5	11·0
Mankat	26·0	19·0	13·0	10·0

Type-specimen.—M. $\frac{12733}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

This form differs from *T theobaldi* chiefly in its globose bodywhorl, and in having a prominent longitudinal sculpture. Individuals approaching this form are known from Loian (near Kalaw), Taunggyi, and the Hsin-Dawng valley in the Southern Shan States. In these the spiral ridges are well developed, and the columella expanded and somewhat variable in width. The spiral bands are entirely absent.

Taia theobaldi f. niger, nov.

This is yet another form very closely allied to *Taia theobaldi.* It is small in size and has a relatively narrow spire with less rounded whorls. A thin black deposit is usually found on the shell which gives the form a more or less distinctive appearance. The spiral sculpture with the exception of the three ridges on the last whorl is obscured by the deposit. The spiral bands may be seen more or less distinctly when the deposit is rubbed off the shell or when the shell is held against light with the aperture facing the observer. The oblique longitudinal sculpture is conspicuously developed. There are usually six whorls. The columella is narrow and ridge-like, smooth and shining, with a bluish tinge. There is no flattened area outside the columella though a channel may or may not be present.

Type-series.—M. $\frac{12734}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Individuals of this form were obtained in streams round about Mongyin, a village about 14 miles East of Namtu town, N. Shan States.

The largest shell in the collection has the following measurements in millimeters :

Height of shell.	Greatest breadth of shell.	Height of aperture.	Greatest breadth of aperture.
25·0	19·5	12·0	9·0

There are no distinguishing features in the soft parts except that the enlarged cusp on the first lateral tooth of the radula is relatively small, and that there are six sharp cusps on each side of the central instead of the usual five.

Taia theobaldi var. leonardi, [1] nov.

The shell is regularly conoidal with 6-6½ gradually increasing convex whorls. The spire is roughly half as high as the entire shell, and its base bears the same proportion to the maximum breadth of the shell. The suture is transverse and moderately impressed. The shell is comparatively thin, and the mouth has no thickened outer lip. A single spiral ridge is very feebly developed near the middle of the last whorl. The minute spiral sculpture of the shell is exceedingly well developed and consists of a number of thin parallel ridges arranged close together. The ridges are, however, never straight and continuous, but present the appearance of a number of irregular wavy lines. The first 3 or 3½ whorls are relatively smooth, the minute spiral sculpture increasing gradually in prominence from the fourth to the last whorl. The oblique longitudinal sculpture is never prominently developed, though the tendency for forming varices near the aperture is often evident. The outline of the mouth is roughly elliptical, having the upper and lower ends somewhat produced. The columella is remarkably thin and narrow, and more or less straight in young individuals, but comparatively thick, broad and arched in the adults. The columella is reflected towards the umbilicus to form a callus which may or may not leave a small chink

[1] Mr. P. M. R. Leonard, Assistant Superintendent, Kutkai, drew my attention to these peculiar snails in the pool which he had visited sometime before, and I have great pleasure in associating his name with this new variety.

between it and the bodywhorl. The ground colour of the shell is a dirty yellow with conspicuous dark brown spiral bands.

The largest shell, which is not entire at the mouth, has the following measurements in millimeters.

Height of shell.	Greatest breadth of shell.	Height of aperture.	Greatest breadth of aperture.
34·0	25·0	19·0	14·0 (approximate).

Type-series.—M. $\frac{12735}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

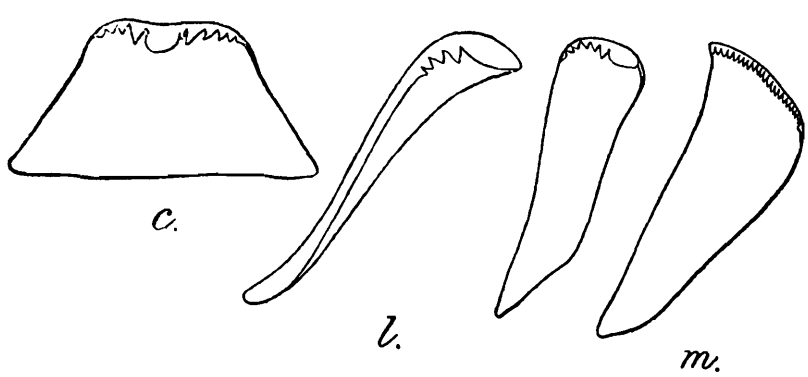
A few fresh shells were obtained at the edge of a large weedy pool, out of which a small stream was flowing, about 3 miles South-East of Kutkai, Northern Shan States. There was no trace of the animal inside any of the shells.

The variety is undoubtedly closely related to *Taia theobaldi* in general form, but differs in the texture and sculpture of the shell, and in the shape of the mouth.

Taia theobaldi race hsenwia, nov.

This race is commonly found in the streams of the Northern region of the North Hsenwi State. The chief feature of the race is in the sculpture of the shell. The minute spiral sculpture is conspicuously developed and the columellar area is flattened outside the callus with or without an umbilical channel leading forwards. The spiral ridges are very feebly, if at all, developed. The spiral bands when obscured by calcareous deposits on the outside of the shell may be seen through the aperture with the shell held against light. There is considerable variation in the thickness and size of the shells, in the nature of the umbilicus and the columella, and in the distinctness of the spiral bands, but in general facies and sculpture the race is distinct from the forma *typica*.

There are no constant differences in the soft parts. A number of individuals was collected on the Kutkai plateau, at Pangnim, and at Mongyu on the outskirts of the Shweli valley. They were found in sluggish streams with a muddy bottom covered over by a growth of weeds or by rotting vegetation.



Text-fig. 3.—Radular teeth of *Taia theobaldi* race *hsenwia* from the Nam Teng R., Kutkai. *c.* central ; *l.* lateral ; *m.* marginal.

The specimens from Mongyu are conspicuously banded and have their longitudinal and spiral sculpture well developed. The columella is arcuate, smooth and shining, convex behind and somewhat flattened

anteriorly. There is no real umbilical channel though a shallow groove is left between the sloping outer edge of the fold of the columella and the bodywhorl. Living individuals were found in a weedy stream.

The individuals from Pangnim were taken in a muddy stream the bottom of which was covered by vegetable debris. Most of them were, however, picked up in a pool at the edge in which the water was flowing very slowly. The shells had a calcareous deposit which could not be scraped off with ease, and could be dissolved only very slowly in weak acid. Near the outer edge of the bodywhorl are found oblique longitudinal ridges, three to five in number, which give the last whorl a scalariform appearance.

The specimens from the Kutkai plateau were taken in weedy streams and rivers flowing through more or less level country. They are of varying size, thickness and colour, but in the predominance of the spiral sculpture over the oblique longitudinal, in the obsolete spiral ridges, and in the flattened and rugose nature of the umbilical channel, they are alike. Those from the Nam Teng river near Kutkai have a stouter build and a thicker shell, and have half a whorl more. Apart from their individual variability they should be treated as conforming to a distinct type with features which are intermediate between this race and the species *Taia aspercallosa* described below.

A few dead and bleached shells from the banks of a stream close to Sukmun (on the Burma Corporation Railway) hold a similar position with regard to *T theobaldi* and the species described below.

Type-series.—M. $\frac{12737-41}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

The following are the measurements in millimeters of the largest shell from each of the localities :

Locality.	Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.	Breadth of columella.
Pangnim ..	26·5	20·0	14·0	10·0	
Mongyu ..	25·5	18·0	13·0	9·5	..
Nam Teng R., Kutkai .	30·5	22·5	14·0	10·5	2·8
Mule-track between Hsenwi and Kutkai.	25·5	20·5	12·0	9·5	2·0

The proportion of male to female individuals collected in the various localities is variable. Most of the females were gravid and the uterus contained a number of eggs and embryos in various stages of development. The embryos were banded and had spiral ridges.

Locality.	Male.	Female.	Full-grown embryos.	Half-grown embryos.	Eggs.
Pangnim	9	18	1-3	1-3	2-8
Mongyu ..	2	5	2	..	4
Kutkai-Hsenwi road ..	10	8	1-2	2-4	3-5
Nam Teng R., Kutkai ..	..	7	2	1 or none	4-5

The percentage of females is, therefore, 66·6, 71·4, 44·4, and 100 respectively. While in this race the proportion of female individuals is high, in the forma *typica* the number of males exceeds that of the females.

Taia aspercallosa, sp. nov.

The shell is of relatively small size, and of a roughly ovate or conico-ovate shape. There are, as a rule, 6-6½ moderately convex whorls in the full-grown individual which increase rather gradually. The spire is nearly as high as the last whorl, though its breadth at base is about ⅔ the maximum breadth of the latter. The shell is thick, particularly near the edge of the aperture. It is solid in appearance and rather hard to break. The suture is more or less transverse and little impressed. The predominant sculpture is spiral, consisting of a number of minute parallel ridges, three of which are much more prominent than the others. The spiral sculpture of the embryos apparently persists in the adult with the difference that only three ridges are greatly developed, while the others remain unchanged. In the adult the median ridge on the last whorl is nearer to the one above than to the one below. It is very faint on the ventral side of the penultimate whorl and is practically absent on the dorsal surface. On the third and fourth whorls only one ridge, that is, the one nearest to the suture persists, while on the first and second whorls there is no trace of the ridges at all. Apart from the ridges the whorls of the spire have their spiral sculpture very minute, and consequently appear to be smooth to the naked eye. The prominence of the first, *i.e.*, the topmost spiral ridge, gives the whorls an angular appearance just below the suture. The outermost part of the last whorl near the aperture is somewhat plicated as a result of the greater development of the oblique longitudinal sculpture in this region.

The mouth of the shell is oval in outline, narrowed posteriorly, distinctly arched on the outer side, and rounded anteriorly. The columella is narrow, much narrower than it is in *T. theobaldi*, and very little reflected to form a callus. In the young shell, however, the columella is relatively broader than it is in the adult and is reflected to form a callus which leaves a chink in the umbilical area. At a certain stage in the growth of the individual, it is probable that the development of the columella does not keep pace with that of the extra-columellar umbilical area, which becomes flattened on a level with the columella and rather coarsely incised. A narrow channel leading forwards from the more or less occluded umbilicus is present on the side of the flattened area away from the aperture.

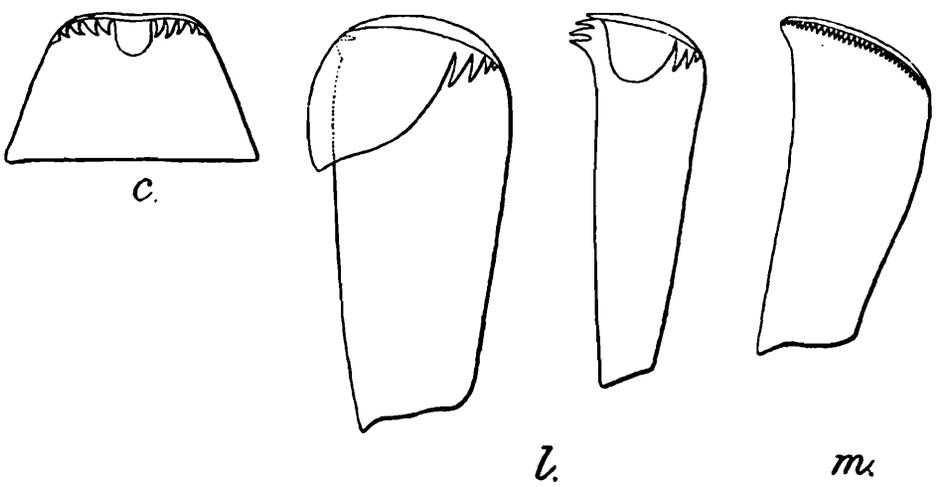
The shell is banded, but not as prominently as in *T. theobaldi* and its forms. The colour of the shell is a light chestnut-brown contrasted by rather darker coloured spiral bands. The main spiral ridges are of a yellowish hue, and alternate with the colour bands on the spire. Some shells have a very thin black deposit on the ventral surface.

The operculum is similar to that of *T. theobaldi*. The animal is generally of a brown colour, the foot and sides of the head, and the edge of the mantle having orange-coloured spots. The anterior half of the

head has yellow spots on a grey background, while the posterior half is of a chocolate-brown colour with yellow specks.

No processes were seen on the mantle edge. The gill-lamellae are long, narrow, finger-shaped structures with their base of attachment only slighter wider.

The radular teeth are subject to variability in individuals. The central has a median squarish cusp and five recurved hook-like cusps on each side. The central cusps of the laterals are proportionately broader and longer than in specimens of *T theobaldi* and its forms.



Text-fig. 4.—Radular teeth of *Taia aspercallosa*. *c.* central ; *l.* lateral ; *m.* marginal.

Precise details as regards the ratio of male to female individuals are not available owing to the small number of specimens obtained. Three living individuals available for study were all females and contained two full-grown embryos and 3-6 eggs each. The embryos are faintly banded near the suture between the last and the penultimate whorls.

The largest shell obtained has the following measurements in millimeters :—

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.	Thickness of columellar area.
25·0	20·5	12·0	9·5	2·5

Type-series.—M. $\frac{12742}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

A few living specimens were taken in a shallow tributary stream of the Namtu river, in the jungle between Mongpa and Mongyin in the North Hsenwi State. The bottom was muddy and the molluscs were sticking to a few large stones submerged in the bed of the stream. There was very little vegetation in the stream, except some slimy algae growing on submerged stones which were covered by a thick layer of mud.

This species is undoubtedly closely related to *T theobaldi*, but differs in the consistency of the shell, in the sculpture, in the structure of the columellar area, and in the proportions of the radular teeth. It is

probably a direct offshoot of the race *hsenwia* which seems to have taken the place of the forma *typica*, at any rate, in some parts of the Northern Shan States.

Taia aspercallosa var. brookesi,[1] nov.

The shell of this variety is thick, elongate-ovate, and has six fairly convex whorls. The spire is somewhat worn and is about half as high as the entire shell, while the penultimate whorl at base is $\frac{3}{5}$ as broad as the last whorl at its widest point. Oblique longitudinal varices near the edge of the mouth, and the spiral ridges are well developed. The minute spiral sculpture is somewhat feebly developed and is inconspicuous except on the base of the last whorl. There are three main spiral ridges which are relatively broad and convex on the last and penultimate whorls. The middle ridge is nearer to the one above than to the one below it. Secondary ridges, which are comparatively thin and thread-like, are often developed on the last and the penultimate whorls, between the suture and the first primary ridge, and between the first and the second primary ridges. The suture is moderately impressed. The mouth of the shell is broadly ovate, relatively rounded, and slightly produced above. The last whorl near the region of the mouth descends slightly below the last primary ridge on the penultimate whorl, and the inner and outer margins of the aperture above join together independently of the last whorl with which they are usually fused in other allied species. The aperture appears to be therefore rather discrete. The columella is very thin and not at all expanded. The area outside the columella is flattened, as in *T aspercallosa*, in two shells only, while in the third there is no distinct flattened area, and the channel from the umbilicus runs close to the columellar ridge.

Type-series.—M. $\frac{12743}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Three shells in subfossil condition were picked up in sand on the banks of the Namtu river, at Hsenwi, Northern Shan States.

The largest specimen has the following measurements in millimeters :—

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
24·5	19·0	12·0	9·0

In having distinct spiral ridges, and in the form of the columella the variety is closely allied to *T aspercallosa*, but differs in having secondary spiral ridges, a descending bodywhorl, and a relatively rounded aperture. In its prominent spiral ridges the present variety resembles the Sumatran *Viviparus grossicosta* v. Martens, but the latter has a relatively narrow spire with less convex whorls, a much more rounded mouth, and a very thin and narrow columella.

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[1] I have much pleasure in associating with this variety the name of Major W. L. Brookes, Civil Surgeon, Lashio, to whom I am indebted for kindly help.

Genus **Viviparus** Montfort.

1920. *Vivipara*, Annandale, *Rec. Ind. Mus.*, XIX, p. 112.

Prashad [1] has discussed at some length the precise nomenclature of this genus, and I agree with his conclusions with regard to the proper designation.

In the paper cited above Annandale divided the known Indian species of the genus into four groups, namely (1) the Viviparae Bengalenses, (2) the Viviparae Oxytropides, (3) the Viviparae Dissimiles, and (4) the Viviparae Sindicae. Of these the group Oxytropides must now be left out of consideration as the species representing it has received the generic name *Dactylochlamys*.[2] The other species, *V. microchaetophora* Annandale referred to this group by its author appears to belong, from what is known of its external features and anatomy, to the Bengalenses group rather than to the Oxytropides. The Oxytropides and the Sindicae groups do not occur in Burma. The Sindicae group is perhaps not distinct from the Dissimiles as pointed out by Prashad (*loc. cit.* p. 163). Representatives of the Bengalenses and Dissimiles groups are, however, recorded from the Shan States and other parts of Burma, and include only two species, *e.g.*, *V. bengalensis*, and *V. dissimilis*, with their forms, varieties and races.

Viviparus bengalensis f. **balteata** (Benson).

1921. *Vivipara bengalensis* race *balteata*, Annandale, *Rec. Ind. Mus.*, XXII, p. 273, pl. i, fig. 8.

A few shells of this form were picked up at the edge of roadside pools at Hsenwi, the headquarters of the Sawbwa of the North Hsenwi State. Apparently they have been washed down to the roadside from the adjacent rice-fields. They are of the elongate type and exceed 25 mm. in height. The aperture is regularly ovate, and the umbilicus not completely closed. The spiral bands are not of equal width, and not at all thickened.

This form is said to occur in parts of Assam. So far as I know it is recorded for the first time from Burma.

Viviparus bengalensis race **doliaris** (Gould.)

1884. *Paludina bengalensis* subsp. *doliaris*, Nevill, *Hand List Moll. Ind. Mus.* II, p. 22.
1921. *Vivipara bengalensis* race *doliaris*, Annandale, *op. cit.*, p. 273, pl. i, fig. 9.
1925. *Vivipara bengalensis* race *doliaris*, Rao, *Rec. Ind. Mus.*, XXVII, p. 100.

A few shells of this race were collected in streams and pools on either side of the Shweli river near Selan and Muse on the Sino-Burmese Frontier. Except one or two shells which approach the adult in size (27 mm. high, 23 mm. broad), the rest are all young. They, however, show the characters of the race quite clearly, in fact much more clearly than the specimens hitherto figured in published works. A thickened spiral band is developed about the middle of the last whorl, only in two specimens taken on the

[1] Prashad, *Mem. Ind. Mus.*, VIII, p. 160 (1928).
[2] Rao, *Rec. Ind. Mus.*, XXVII, p. 132 (1925).

southern bank of the Shweli river at Muse, but the characteristic biangulate outline of the last whorl, and the broad umbilical channel are well seen in all the shells, young or adult.

As Blanford observed this race seems to be intermediate in character between *V bengalensis* and *Dactylochlamys oxytropis*. The distribution of the race in Burma, which is its headquarters, seems to be rather wide.

Viviparus dissimilis (Müller).

1774. *Nerita dissimilis*, Müller, *Vermium Historia*, II, p. 184.
1852. *Paludina remossi*, Küster, Martini and Chemnitz's *Conch. Cab. Paludina etc.*, I, p. 26, pl. v, figs. 17, 18.
1876. *Paludina dissimilis* and *Paludina remossii*, Hanley and Theobald, *Conch. Ind.*, p. 33, pl. lxxvii, figs. 3, 4, 8, 9.
1884. *Paludina dissimilis*, Nevill, *Hand List Moll. Ind. Mus.*, II, p. 27.
1909. *Vivipara remossi*, Kobelt, Martini and Chemnitz's *Conch. Cab. Paludina etc.*, I, pt. ii, p. 273, pl. lv, figs. 10-12; pl. lvii, figs. 8, 9 ; as *Vivipara remossii* on p. 284, pl. lvi, figs. 13-15.
1915. *Vivipara dissimilis*, Preston, *Faun. Brit. Ind., Freshw. Moll.*, p. 87.

Amongst the many species of *Viviparus* occurring in India and Burma, *V. bengalensis* appears to be extremely variable, and perhaps next in point of variability comes *V dissimilis*. As a result of this inherent variability in the latter species a large number of forms has been described with characters which grade into one another almost imperceptibly, and it is probable that some of the forms, at any rate, do not belong to the present species. It is, however, beyond the scope of this paper to discuss the point, and I shall confine my remarks only to the forms obtained in the Northern Shan States.

The individuals of the species from different localities vary in size, in the form of the whorls and of the mouth, and in the texture and colour of the shell.

Shells of large size, having their spire usually eroded, are 18-26 mm. high and 14-20 mm. broad, and have 3-4 complete whorls, while those of small size having the spire entire are 17-22 mm. high, and 14-18 mm. broad, and have 6-6½ whorls. The proportion in height, breadth, and convexity of the different whorls is subject to considerable variation. In general appearance some examples approach *V. quadratus*, while others seem to come near *V crassa*, but the resemblance is only superficial. The suture is nearly always transverse, and may be lightly or deeply impressed. The shell is never so thick as it is in *Taia theobaldi* or in *V quadratus*, but may be thin and hyaline, or moderately thick and opaque. The texture and colour of the shell seem to vary with the medium in which the species lives. The composition and rate of flow of water, the growth of algae and other organisms on the shell surface, and the amount of suspended matter in water have apparently some influence on the texture of the shell and its colour. The colour of the shell is usually a shade of olive modified into light green or brown, and in extreme instances into a smoky black colour. The light-coloured spiral band may be clearly seen on the last whorl of some shells ; it is faint in some, while in others it may be detected only when examining the aperture against light. The sculpture consists of a number of oblique longitudinal lines, which have a tendency to form varices on the last whorl. The bodywhorl is generally angulate in the middle, but this

character is variable. The mouth is obliquely directed in relation to the main axis. It is usually regularly ovate, but often expanded near the middle of the outer lip. The margin of the mouth is, as a rule, black. The umbilicus is only exceptionally open. The operculum fits exactly into the mouth of the shell, and has often a spongy ridge round its periphery.

The following short description of the animal is based on my field notes. The ground colour of the animal is black. The foot and mantle are marked with large yellow spots, and the tentacles have bands of the same colour and a few spots. Orange-coloured spots are found on the head.

The mantle does not show any special features. A few processes are present on the edge in some well-preserved specimens, but their occurrence seems to be dependent on the state of preservation. Annandale did not observe any processes on the mantle in adult individuals of the species.[1]

The radular teeth also show considerable variation. In several examples examined by me the median cusp of the central tooth has a rectangular outline and presents a more or less straight free edge. In the radulae examined by Annandale this cusp was rounded. It is probable that the cusps are liable to considerable wear.

The gill-lamellae conform to the type common in members of the Dissimiles group,[2] but vary within certain limits. They are neither as broad as those of *V bengalensis* nor quite as narrow as those of species of *Taia.*

The right tentacle of the male is enlarged as in other species of Viviparidae and serves as a ready means of differentiating the sexes. There are usually two full-grown embryos in the uterus, and several oval or polygonally compressed eggs. In one individual 19 embryos, 7 full-grown and 12 half-grown, and over a hundred eggs were found in a single female, but this seems to be an exceptional instance. The percentage of males present in the collection from the Northern Shan States seems to be particularly high, though exception to this condition is found in a few cases. The snails were collected almost at random from various widely separated localities, and where large numbers were found a larger proportion of individuals was taken.

Several individuals of this species were collected at various places on the Chinese Frontier, at Mongyin, Hsenwi, Old Lashio, and Inailong in the North Hsenwi State, and at Mongyai and Tangyan in the South Hsenwi State. These three areas, separated by large stretches of hilly country extending over 60 miles and having an average altitude of about 2,000 feet, are comparatively level tracts with rice-fields, shallow channels and pools, situations which are favourable for the growth and multiplication of the members of this species. At the time of my visit to the Northern Shan States I found that while in certain parts of the country species of *Taia* were dominant in numbers, in others *V dissimilis* was very common. On the Chinese Frontier, and in the South Hsenwi and Hsipaw States no species of *Taia* was found. Between the Chinese

[1] Annandale, *Rec. Ind. Mus.*, XIX, p. 113 (1920).
[2] Rao, *Rec. Ind. Mus.*, XXVII, p. 130, fig. 2*g*. (1925).

Frontier and Lashio species of *Taia* occurred along with *V dissimilis* in comparative abundance. As the two species live in different types of environment, and have different habits, this discontinuity in distribution is to be expected in a country having diverse geographic areas. *T theobaldi* lives at the edge of rivers and weedy streams, or other areas of running water, while *V dissimilis* prefers a muddy bottom in stagnant areas of water, in very sluggish channels, and in rice-fields. *V. dissimilis* nearly always occurs with species of *Pila* and *Cipangopaludina* which live in similar environment.

The accompanying table shows the localities in which the species was collected, the number of snails taken, the number of males and females, and the percentage of both sexes :

Locality.	Total number of individuals collected.	Number of males.	Number of females.	Percentage of		Remarks.
				Males.	Females.	
W. bank of Shweli R., Namkham.	87	68	19	78·2	21·8	1-2 embryos, 12 eggs.
N. bank of Shweli R., Namkham.	15	9	6	60·0	40·0	19 embryos, over 100 eggs.
Tengyueh, opposite Kawngmu.	16	9	7	56·25	43·75	
Selan	6	4	2	66·6	33·3	
Chinese Frontier, opposite Selan.	13	8	5	61·54	38·46	
Mengmao, opposite Muse.	15	5	10	33·3	66·6	No embryos. Large number of small eggs.
Muse	10	6	4	60·0	40·0	
Hsenwi	3	..	3	..	100·0	
Mongyin ..	11	6	5	54·5	45·5	
Old Lashio ..	31	25	6	80·6	19·4	
Mongyai { In streams	17	12	5	70·6	29·4	
Mongyai { In a tank	8	3	5	37·5	62·5	
Tangyan ..	14	6	8	42·9	57·1	

The species is widely distributed all over North India and the greater part of Burma. Most of the specimens collected in the Northern Shan States in the months of November and December 1926, and in January 1927 were found in a torpid condition, the operculum tightly closing the mouth of the shell. This process of hibernation seems to afford an effective means of protection against the cold of the Northern Shan States during the winter months.

Viviparus dissimilis var. **decussatula** (Blanford).

1869. *Paludina dissimilis* var. *decussatula*, Blanford, *Proc. Zool. Soc. London*, p. 445.

1876. *Paludina heliciformis*, Hanley and Theobald, *Conch. Ind.*, p. 33, pl. lxxvii, figs. 7, 10.

1884. *Paludina dissimilis* subvar. *decussatula*, subsp. *heliciformis*, subvar. *viridis*, Nevill, *Hand List Moll. Ind. Mus.*, II, p. 30.

1909. *Vivipara dissimilis decussatula*, Kobelt, Martini and Chemnitz's *Conch. Cab. Paludina*, p. 286, pl. 54, figs. 17, 18 ; pl. 58, figs. 9-12.

1915. *Vivipara* (*Idiopoma*) *heliciformis* var. *viridis*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 94.

This variety seems to be very poorly represented in the Northern Shan States. Only two subfossil shells in a bleached condition were found on the sandy bank of the Namtu river at Hsenwi. The shells are eroded at the apex, and have a white surface. The markings of sculpture are faint, and the slight ridges below the suture and a little below the middle of the last whorl appear to be a distinct feature. One shell from the Lower Chindwin district has similar features. One or two prominent lines of growth are present on the bodywhorl near the edge of the mouth. The columella is rather incomplete and leaves the umbilicus open. The decussating lines characteristic of the variety are feeble in the individuals collected, and can be made out only with the help of a strong magnifying lens.

Shells of this variety from Kabyuet and Bhamo in Upper Burma collected by the late Dr. J. Anderson, and shells from Kin-u in Lower Chindwin are present in the Zoological Survey collection. They are complete specimens and show the distinguishing features fairly well. They are somewhat thick and are of an olivaceous green or brown colour. Dark oblique longitudinal markings which are often curved are present on the bodywhorl.

The occurrence of two spiral ridges on the last whorl of the shells from Hsenwi is perhaps a departure from the normal characteristics of the variety, but with so few specimens from a single locality a new varietal name would be an unjustifiable burden on literature in the present state of confused synonymy.

Viviparus dissimilis var. peguensis Kobelt.

1909. *Vivipara variata* var. *peguensis*, Kobelt, Martini and Chemnitz's *Conch. Cab. Paludina*, p. 378, pl. lviii, figs. 7, 8.
1915. *Vivipara variata* var. *peguensis* Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 89.

This is a dwarfed form of *V dissimilis* with a small globose shell, fewer whorls, and an elongate mouth which is not at all expanded about the middle of the outer lip, and is much less inclined to the main axis of the shell than it is in the forma *typica*. In the examples from the Northern Shan States a ridge is developed in the middle of the last whorl to a varying degree, but in some it is not very apparent. The spire is eroded in most specimens, and the shell has usually 3-4 whorls. The height of the aperture is nearly always half the total height of the shell. The shell is thin and hyaline and its natural colour is obscured by muddy deposits and algal growth. The spiral band is absent, and the rim of the mouth is black.

Among 41 specimens collected there were 33 males and 8 females, the percentage of males being 80·5.

Several individuals were taken by Dr. Chopra and myself in a weedy stagnant pool on the side of the railway line two miles East of Hsipaw town. They were found along with other species of molluscs such as *Limnaea luteola* forma *typica*, *Indoplanorbis exustus*, and *Paludomus regulata*.

They closely resemble the topotypes from Moulmein preserved in the Zoological Survey collection, but differ in proportions.

Nevill's manuscript name *peguensis* was given to this variety by Kobelt who published a description of it in the work cited, but the latter referred it to *V variata* which appears to be a distinct South Indian race of *V dissimilis*.

The members of this variety seem to bury themselves in mud amongst the roots of the waterweeds, and thus tide over the dry weather.

Genus **Cipangopaludina** Hannibal.

1912. *Cipangopaludina*, Hannibal, *Proc. Malac. Soc. London*, p. 194.
1920. *Lecythoconcha*, Annandale, *Rec. Ind. Mus.*, XIX, p. 114.
1921. *Lecythoconcha, id., ibid.*, XXII, p. 552.
1923. *Lecythoconcha, id., Journ. As. Soc. Bengal*, (N. S.), XIX, p. 411.
1925. *Lecythoconcha*, Rao, *Rec. Ind. Mus.*, XXVII, p. 133, figs. 3a, b, c.
1928. *Cipangopaludina*, Prashad, *Mem. Ind. Mus.*, VIII, p. 163.

As has been pointed out by Prashad in the work cited above, rules of priority require that Annandale's euphonious generic name *Lecythoconcha* should be substituted by Hannibal's *Cipangopaludina* in which are included species like *Paludina malleata*, *P. lecythoides*, etc., from the Far Eastern regions. Hannibal made Reeve's *malleata* the type-species of his subgenus. The exact relationship of his subgenus to Pilsbry's *Idiopoma* is not quite clear. Pilsbry [1] proposed the subgenus *Idiopoma* for a number of species of *Vivipara* in which the operculum was peculiarly modified, and made his species *V henzadensis* from Lower Burma the type of the subgenus. Hannibal appears to have given *Idiopoma* a generic rank and to have subordinated *Cipangopaludina* to that genus. Judging from Pilsbry's figure of the type-species it seems obvious that the characters of *Idiopoma* are well within the limits of variability of the Dissimiles group. The main conchological characters of *Cipangopaludina* are sufficiently distinct to give it the status of a genus. To these should be added the anatomical features described by Annandale, and on which he founded the genus *Lecythoconcha* with Benson's '*Paludina lecythis*' as the type-species.

Cipangopaludina lecythis (Benson).

1921. *Lecythoconcha lecythis*, Annandale, *Rec. Ind. Mus.*, XXII, p. 553, pl. v, and pl. vi, figs. 1, 2.
1923. *Lecythoconcha lecythis*, Annandale, *Journ. As. Soc. Bengal*, (N. S.), XIX, p. 413.

A complete synonymy of the species has been given by Annandale in his account of the Manipur molluscs. Individuals from the Northern Shan States approach the 'rice-field phase' of Annandale or the var. *ampulliformis* of Eydoux and Souleyet, but are subject to considerable variability as regards outline of the shell, convexity of whorls, depth of suture, and texture of the shell. The distinctive character of the protoconch of this species is not noticeable in all specimens from the Shan States, as in many of them the spire is eroded, or in some instances the periostracal layer is rubbed off the apical whorl of the shell. Shells from the Northern Shan States are usually of a comparatively small size and do not exceed 35 mm. in height and 30 mm. in breadth.

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[1] Pilsbry, *Proc. Acad. Nat. Sci. Philadelphia*, LIII, pp. 188, 189, pl. v, fig. 1 (1901).

There are no constant differences in the soft parts between the species and their forms. Variability in proportions of the radular teeth and the gill-lamellae occurs as usual.

The secondary sexual character of the tentacle in the male is not as pronounced as it is in members of the genus *Viviparus* and *Taia*. In the shell, however, the difference in size of both the sexes seems to be more or less constant, the adult male being usually smaller than the adult female. In the uterus there are, as a rule, 15-20 equal-sized embryos with unbanded shells, and several eggs. There are three rows of primary and several rows of secondary chaetae present on the last whorl of the full-grown embryo, but they are inconspicuous on the upper whorls. The proportion of male individuals to females in collections from different localities is not constant. This is shown in the following table :—

Locality.	Number of individuals examined.	Number of males.	Number of females.	Percentage of males.
Namkham	4	1	3	25
Namkham-Kawngmu Road	23	18	5	78·3
Selan	7	4	3	57·1
Muse ..	23	9	14	39·1
Kutkai	2	1	1	50·0
Hsenwi	3	1	2	33·3

The average percentage of males present in the entire collection is about 55. In three out of seven instances the percentage of females is high, in one it is equal. Taking the Frontier localities alone (the first four in the list) it is found that in a lot of 57 examples collected the number of males is 32, and the percentage 56. It is probable that in this species the males and females are found in more or less equal numbers as the average percentage shows.

Cipangopaludina lecythis f. **crassior** (Annandale).

1923. *Lecythoconcha lecythis* f. *crassior*, Annandale, *Journ. As. Soc. Bengal*, (N. S.), XIX, p. 413.

With some hesitation I refer to this form two shells taken in a sub-fossil condition in sand on the banks of the Namtu river at Hsenwi. They are of relatively small size, and have their last whorl incomplete and comparatively swollen. The spire is complete and proportionately narrow, and the suture regularly transverse and well-impressed. The shells are worn, but the longitudinal sculpture in one of them is quite distinct. The columella is smooth and shining.

The shells exhibit a few points of difference from the type which would probably justify their being considered a distinct form, but in view of their being incomplete and few in number I refer them tentatively to this form.

Cipangopaludina lecythis f. **purpureus**, nov.

Certain examples from Nakyaung in the jungle between Mongpa and Mongyin have a relatively thick shell, and their spire and the last whorl, in one or two instances, are tinted a light purple. The sculpture is coarse, and there are often incised lines near the edge of the aperture. They seem to approach in some respects the form *crassior* Annandale, the range of which is known to extend from Bhamo in Upper Burma to Yunnan in China, but the latter has a thinner shell and a less coarse sculpture, and differs in outline. In view of these differences I propose the name *purpureus* for these shells. The occurrence of the form *purpureus* in the valley of the Namtu river which is connected with the Salween system in its upper reaches is probably an indication of its relationship to the f. *crassior* with its headquarters in China.

Type-series.—M. $\frac{12750}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Cipangopaludina lecythis var. **crassispiralis**, nov.

A few specimens obtained from rice-fields and connected channels at Mongyin, North Hsenwi State differ from *C. lecythis* in certain features of the shell. The periostracum over the spire is worn off in all the shells and it is difficult to make out the nature of the protoconch. The shell is thin and of a dull brownish colour which is apparently due to a thin muddy deposit over an otherwise olivaceous green surface. It is more conoidal than globose and has less swollen whorls. In addition to the peripheral ridge, which is relatively prominent, there are a few very fine but not prominent secondary ridges on the bodywhorl which, in adult specimens, are clearly seen in the ventral view on the lower half of the last whorl below the peripheral ridge. In younger individuals they are also seen in the dorsal view, and in one or two instances on the penultimate whorl as well. The longitudinal markings are more prominent in the older shells. In other respects they do not differ from the forma *typica*.

The following are the measurements in millimeters of a medium-sized shell, and the largest shell with a broken outer lip :—

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
23·0	21·0	14·5	11·0
26·5	24·0	16·0	12·0

The soft parts do not show any striking differences except in the radular teeth. The median cusp of the central and the laterals are relatively broad and rounded. The teeth on the marginals are longer and narrower than in *C. lecythis*, but the two outermost are different in having a triangular outline and in having their distal extremity directed towards the central of the radula, unlike the others which are more or less parallel and are directed obliquely upwards.

Out of ten specimens examined only three are males. The percentage of females is therefore high. There are usually more than five or six full-grown equal-sized embryos and several eggs.

Type-series.—M. $\frac{12752}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

The present variety differs from the forma *typica* in the presence of thin spiral ridges on the last and penultimate whorls, and in the features of the radula.

In *V crassispiralis* Annandale from the Manipur valley there are similar but more solid and prominent ridges on the last three whorls. It is not known what factors in the environment induce the development of these ridges in two species belonging to two different genera. The phenomenon of the formation of solid ridges on shells of different members of the Viviparidae, is little understood though recent work on this problem by Annandale,[1] and by Prashad [2] has thrown some light on this subject.

Spiral rows of chaetae are found on young shells and in full-grown embryos of many species of *Cipangopaludina*, but there has hitherto been no record of secondary ridges, so far as I am aware, in adult individuals of *C. lecythis* or any of its forms. I therefore regard this character in the shells from Mongyin to be of sufficient importance to give them a distinct varietal status.

Cipangopaludina lecythoides (Benson).

1923. *Lecythoconcha lecythoides*, Annandale, *Journ. As. Soc. Bengal*, (N. S.), XIX, p. 414.

A single bleached shell found at the edge of a sluggish stream at Hsenwi is referable to this species. It agrees closely with the lectotype selected by Annandale from Cantor's collection of shells of this species from Chusan deposited in the Indian Museum. It is smaller than the lectotype and is 34 mm. high and 27 mm. broad, and the aperture is 19 mm. high and 14·5 mm. broad. The protoconch is slightly worn but complete, and forms a knob-like projection just above the middle of the second whorl. It does not agree in this respect with the characteristic feature of the lectotype. The whorls are relatively less swollen, and the margin of the aperture slightly incomplete on the outer side. The peripheral ridge on the last whorl is feebly developed.

Family AMPULLARIIDAE.

This family is represented in the Northern Shan States by only two species, both belonging to the genus *Pila*. Individuals of both the species were found in more or less flat country adjoining river valleys. Most of them were taken in rice-fields and shallow channels. They were not found in abundance, especially living specimens, at the time of collection.

Pila conica (Gray).

1925. *Pila conica*, Prashad, *Mem. Ind. Mus.*, VIII, p. 79, pl. xv, figs. 4-8.

A complete synonymy of this and the following species is given by Prashad in the paper cited.

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[1] Annandale, *Rec. Ind. Mus.*, XXII, pp. 243-266, pl. iii (1921). *See* also *Proc. Roy. Soc. London*, XCVI, pp. 59-76 (1924).

[2] Prashad, *Mem. Ind. Mus.*, VIII, pp. 253-319, pls. xx-xxiv (1928).

The species seems to be very variable in colour and form, and shells from any one locality clearly show this. Shells which approach var. *compacta* Reeve may be picked out from any collection of shells of *P. conica* in the Northern Shan States, and where the var. *compacta* occurs in large numbers a few true *P. conica* are always found.

A few shells were obtained at Hsenwi and Old Lashio in the North Hsenwi State, and at Hsipaw in the State of the same name. No living specimens which can be referred strictly to the forma *typica* were found. The species was not found on the Shan-Chinese Frontier. Its distribution seems to be restricted to L. Burma and to regions South and South-East of it as far as Sumatra and Java.

Pila conica f. compacta (Reeve).

1925. *Pila conica* var. *compacta*, Prashad, *Mem. Ind. Mus.*, VIII, p. 50, pl. xv, figs. 9, 10.

In view of the fact that individuals of *P. conica* and its variety occur together in every locality in which they were collected, I regard the latter as no more than a form of *P. conica* which has a wide distribution in Burma. A parallel instance is to be found in the Indian Limnaeids, in which plasticity is so pronounced that a number of allied forms of the common species *L. acuminata* is found in the same place and in identical environment.

Several shells were taken at Hsenwi and Old Lashio in the North Hsenwi State. A few were also collected by Dr. Chopra and myself at Mongyai in the South Hsenwi State and at Hsipaw. Living specimens were obtained at Hsenwi, Hsipaw, and Mongyai. They were mostly of small to medium size and were found in rice-fields and connected channels, and in weedy ponds. It is probable that this form extends its range to countries from which the species has been recorded.

Pila theobaldi (Hanley).

1925. *Pila theobaldi*, Prashad, *op. cit.*, p. 77, pl. xv, fig. 3.

A few shells of this species were obtained in the vicinity of Muse on both sides of the Shweli river. Those from the North bank are actually from Mengmao in Chinese territory and were found at the edge of weedy streams and pools. They are of fairly large size and have their spire complete. The colour varies from an olivaceous green to shades of yellowish brown. The spiral bands and lines are well-developed, but are less conspicuous in older shells. Longitudinal lines are present on the shell, chiefly on the last whorl, but they are never coarse. The surface of the last whorl is often slightly malleated.

Individuals of the species from the South bank of the Shweli river were found in rice-fields in Muse. They are relatively more globose and have swollen whorls and an eroded spire. The sculpture is coarse and the shell often has conspicuous lines of growth and a faintly malleated surface. The spiral bands are rather obscure in fully grown individuals, but can often be observed through the aperture with the shell held against light. In younger shells they are less conspicuous than in those from the Chinese side of the Shweli river.

The species has been previously recorded from Upper and Lower Burma.

Family RISSOIDAE.

There seems to be no agreement amongst authors as to the family name. Malacologists in America have adopted the name Amnicolidae, and those in Europe the name Paludestrinidae for the fresh and brackish-water forms, and have separated from them the very closely allied marine forms under the name Rissoidae. In his admirable work on the Hydrobiinae published as long ago as 1865 Stimpson accepted the name Rissoidae for the marine as well as the brackish and fresh-water species, giving reasons for doing so, and suggested its division into a number of subfamilies.[1] In recent years Annandale adopted the same course.[2] The family Amnicolidae as defined by present day American Malacologists does not seem to exclude brackish-water or even marine species. The Rissoidae (*s.s.*), which consists of marine and estuarine forms only, is considered to be distinct from the Amnicolidae, though the members of both the families are in many respects similar in external features and internal morphology.[3] I have followed Annandale in adopting the family name Rissoidae for the reasons stated by him in the work cited.

The Indian and Burmese fresh-water species of this family are in a state of confusion and stand in need of a thorough revision in the light of knowledge gained in recent years. The work of Annandale and his colleagues in India has gone some way in reducing the confusion, but a great deal more remains to be done. Five subfamilies, the Buliminae the Amnicolinae, the Triculinae, the Stenothyrinae, and the Lithoglyphinae are represented in the Burmese region. Of these the first three only occur in the Shan States.

Subfamily BULIMINAE [4].

A strict application of the rules of priority in Zoological nomenclature often results in changes, however unfortunate, in the names of well known genera and species. Pilsbry and Bequaert (*op. cit.* pp. 214, 215) have suggested in their recent paper on the aquatic molluscs of the Belgian Congo that the generic name *Bithynia* should be dropped in favour of *Bulimus* which had been proposed by Scopoli as early as 1777 for four Linnaean species previously included in *Helix*. The genotype had not been selected by Scopoli, and the authors of the genera *Limnaea*, *Succinea* and *Bithynia* were presumably not aware of Scopoli's genus which included them. Pilsbry and Bequaert favour the selection of *Helix tentaculata* as the type-species of *Bulimus*, as the other three Linnaean species had been made the types of very well known and widely distributed genera, namely *Limnaea* and *Succinea*, several years before *Bithynia* was proposed by Leach. It must be pointed out, however, in support of this procedure that Poiret had, in 1801, rightly referred

[1] Stimpson, *Smithsonian Misc. Coll.* No. 201, pp. 1-12 (1865).

[2] Annandale, *Amer. Journ. Hygiene*, Monographic Series No. 3, p. 274 (1924).

[3] Pilsbry and Bequaert, *Bull. Amer. Mus. Nat. Hist.*, LIII, pp. 212, 213 (1927).

[4] In a recent paper entitled "Revision des systems der Hydrobüden and Melanüdan" (*Zool. Jahrb.* (*Abt. f. Syst.*), *LV*, pp 351-399, pl. viii, 1928) Joh. Thiele has discussed the position of various genera included in the Hydrobüdae Unfortunately the paper arrived too late to be referred to in the text.

the Linnaean species *H. tentaculata* to *Bulimus* though his view does not appear to have been accepted by the later authors who examined the species.[1]

The following genera are represented in the Shan States : *Bulimus*, *Hydrobioides*, *Paranerita*, and *Parafossarulus*. *Amnicola* (*s.s.*), if it occurs at all within the limits of the Indian Empire, does not belong to this subfamily, but the subgenus *Alocinma* Annandale and Prashad described from Seistan in Persia is a member of this subfamily. It probably serves as a link between *Pseudamnicola* and *Bulimus*.

The Indian and Burmese species of *Bulimus* can be separated into two groups according to the form of the shell. The globular and subglobular species are to be referred to the subgeneus *Alocinma* and the more or less elongate species to *Bulimus* (*s.s.*). I have followed Annandale except in the inclusion of *A. alticola* Annandale in *Alocinma*.[2] This species which has a distinctive operculum is to be referred to *Bulimus* and probably to the subgenus *Gabbia* Tryon.[3] The operculum is very different from that of the type-species of *Alocinma*, and the shell is distinctly elongate oval.[4] The distribution of *Alocinma* in India is more or less wide, but that of *Bulimus* seems to be rather restricted. *Paranerita* has a limited distribution in the Shan States, while the occurrence of *Parafossarulus* in Burma has been recorded by Annandale and Rao.[5]

Genus **Bulimus** Scopoli.

1927. *Bulimus*, Pilsbry and Bequaert, *Bull. Amer. Mus. Nat. Hist.*, LIII, p. 21.

Bulimus pygmaea (Preston).

1908. *Bithynia pygmaea*, Preston, *Rec. Ind. Mus.*, II, pp. 45-46, fig. 3.
1915. *Bithynia pygmaea*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, pp. 76-77.

Larger specimens from the Northern Shan States agree in essential features with the type-specimens deposited in the Indian Museum. In size they are larger than the type-specimen and have more convex whorls. The mouth is more elongate, and the spiral nuclear part on the operculum much less conspicuous. The shells are of a light yellow colour.

The following are the measurements in millimeters of the largest shell from Kutkai, Northern Shan States.

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
4·0	3·0	2·0	1·5

The species was found living, and the soft parts including the radular teeth agree very closely with those of *Bulimus* (*Alocinma*) *sistanica* Annandale and Prashad.

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[1] Poiret, J. L. M., *Coq. fluv. et terr. du depart. de l'Aisne et aux envir. de Paris*, p. 61 (Paris, 1802). I have not been able to verify the reference as this work is not available in Calcutta.

[2] Annandale, *Rec. Ind. Mus.*, XIX, pp. 42-44 (1920).

[3] Pilsbry and Bequaert, *Bull. Amer. Mus. Nat. Hist.*, LIII, p. 215 (1927).

[4] Annandale, *Rec. Ind. Mus.*, XIV, pp. 122, 123, pl. xiv, figs. 6, 6a (1918). Also XVIII, pl. iii, figs. 1-5 (1919).

[5] Annandale and Rao, *Rec. Ind. Mus.*, XXVII, p. 115 (1925).

Several specimens were obtained in weedy streams in North Hsenwi at Mongyu near the Chinese Frontier, Kutkai, Lashio and environs. Except those from Kutkai the specimens were relatively small in size, slightly produced at the anterior end of the mouth, and sinuate in the middle of the inner lip. They seem to be immature, and agree with the type-specimen except in proportions.

The species is apparently very variable and widely distributed in the Shan States. Preston, in his original description of the species and in the Fauna volume, recorded the species from 'Myetmyo, Burma,' obviously a misprint for Thyetmyo in Lower Burma. The original locality label, which is still preserved with the type-specimens, is quite distinct.

The species appears to come within the limits of Walker's third group of '*Bithynia*,' but the carina around the umbilicus and the angle in the lip at the anterior end are much less developed than in the Oriental species included by Walker in the group of *B. goniomphalos*.[1]

Genus **Hydrobioides** Nevill.

1925. *Hydrobioides*, Annandale and Rao, *Rec. Ind. Mus.*, XXVII, p. 112.

This genus is represented in the Northern Shan States by two species, *H. nassa* which has a limited distribution and is restricted to level regions or river valleys in the Shan plateau, and *H. namtua* a new species found in a subfossil state on the banks of the Namtu river at Hsenwi.

Hydrobiodes nassa f. **distoma** Annandale.

1918. *Hydrobioides nassa* subsp. *distoma*, Annandale, *Rec. Ind. Mus.*, XIV, p. 120, pl. xiii, figs. 1, 1a and 2.

Several living individuals which I refer to this form were obtained in a weedy tank close to the Inspection Bungalow at Mongyai in South Hsenwi, and also in pools and sluggish streams in Mengmao, Chinese Frontier on the North bank of the Shweli river near Muse. In the Southern Shan States the form was found in a subfossil condition.

Hydrobioides nassa f. **rivulicola** Annandale.

1918. *Hydrobioides nassa* subsp. *rivulicola*, Annandale *op. cit.* p. 119, pl. xiii, figs. 6, 6a.

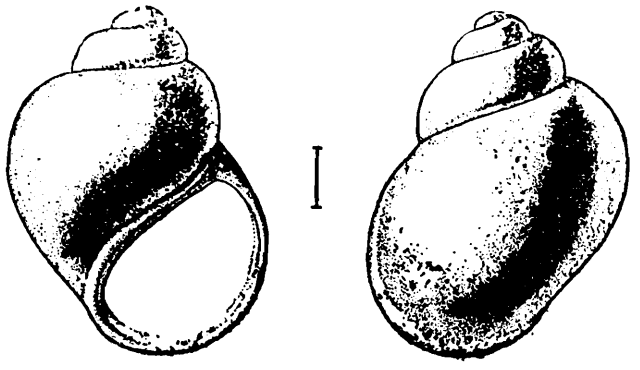
Several living specimens were taken in road-side pools and sluggish streams choked with weeds at Hsenwi and at Mongyai.

Hydrobioides namtua, sp. nov.

The shell is small, ovate, with $3\frac{1}{2}$-4 rapidly increasing and moderately convex whorls. The bodywhorl is large, oblique and approximately twice as high as the spire and $1\frac{1}{2}$ times as broad as base of spire. The apex is blunt, and the suture deep and oblique with the shell outside slightly flattened or sloping downwards. The aperture is ovate and the peristome moderately thick with a triangular thickened area above

[1] Walker, *Amer. Journ. Hygiene*, Monographic Series No. 8, p. 231 (1927).

the apex of the aperture. The outer lip is relatively thin. The columella is well developed, coarse, and somewhat thickened, with a short narrow slit-like groove outside it. The mouth is polished inside, and has an uninterrupted shallow groove between the edge of the peristome and the thickening inside the lip. The operculum, which was not found, probably fits exactly into the groove. The shell-sculpture is feeble, but oblique longitudinal lines can be seen on the surface. Though the columella is minutely longitudinally striated, traces of transverse lines can be detected, which are apparently a continuation of the oblique longitudinal lines on the ventral surface of the shell.



TEXT-FIG. 5.—*Hydrobioides namtua.* A large shell from the type-series.

Some of the smaller shells have the characteristic groove inside the lip, but in other respects they vary considerably, that is to say, in the depth and direction of the suture, in the degree of flattening outside it, and in the convexity of the whorls.

The measurements in millimeters of the type-specimen, and a small shell are given below.

	Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
Type-specimen	6·0	4·5	3·0	2·0
Small shell	3·5	2·8	2·0	1·5

Type-specimen.—M. $\frac{12802}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

A few shells without opercula were found in a subfossil condition in sand on the banks of the Namtu river at Hsenwi.

From the nature of the columella and the mouth it is obvious that the species belongs to *Hydrobioides*. In the absence of a thickening on the outer lip it approaches *H. nassa*, f. *avarix*, and in the presence of a groove inside the mouth it comes near *H. nassa*, but differs in having the groove nearer the edge of the peristome than it is in the latter species, and in having a less conical spire with relatively swollen whorls, and a deeper suture.

Genus **Parafossarulus** Annandale.

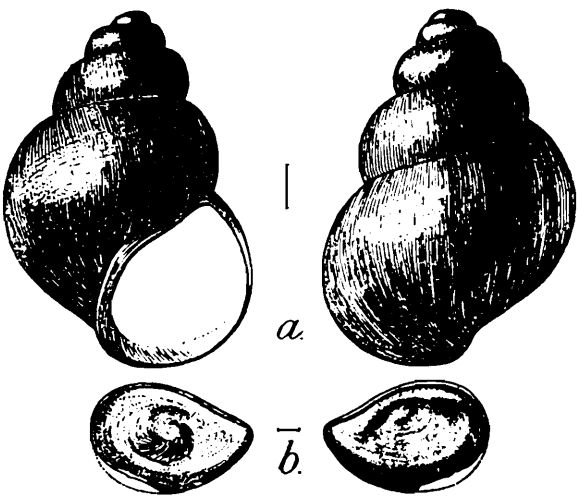
1924. *Parafossarulus*, Annandale, *Proc. Malac. Soc. London*, XVI, p. 28.
1925. *Parafossarulus*, Annandale and Rao, *Rec. Ind. Mus.*, XXVII, p. 115.
1927. *Parafossarulus*, Walker, *Amer. Journ. Hygiene*, Monographic Series, No. 8, p. 212.

The genus *Parafossarulus* represented by the type-species *P. striatulus* (Benson) is just as distinct from *Hydrobioides* as *Digoniostoma* is from

Bulimus, and I agree with Walker in raising Annandale's subgenus to the rank of a genus closely allied to *Hydrobioides*.

Parafossarulus nana f. elongata, nov.

As its name indicates this form is longer than the forma *typica* and has an additional whorl. The suture is well impressed, and the whorls distinctly convex. The aperture is wider and longer and slightly expanded near the anterior end, and the outer lip is relatively thin and arcuate. The spiral sculpture is minute, but slightly more prominent than it is in the forma *typica*. The operculum is elongate-ovate, rather thin with the central area not marked off by an external ridge. It is spiral in the centre and concentric outside. The nucleus lies near the inner side in the middle.



TEXT-FIG. 6.—*Parafossarulus nana* var. *elongata*. *a*. Fresh shell from Lashio. *b*. operculum of the same.

The following are the measurements in millimeters of the type-specimen, M. $\frac{12804}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
4·5	3·0	2·3	1·5

The soft parts are not known.

Two shells with their opercula intact were obtained in a small pond in the Police Garden at Lashio. They were taken along with several individuals of *B. pygmaea*.

In the form of the shell, in having a thickened columella, in the general form and structure of the operculum, and in the minute spiral sculpture it is closely related to *P. nana*, but differs in having a whorl more and the mouth expanded with the operculum thinner and devoid of an external ridge.

Subfamily TRICULINAE.

An excellent account of this subfamily has been given by Annandale in his paper on the molluscan hosts of the human blood fluke in China and Japan.[1]

[1] Annandale, *Amer. Journ. Hygiene*, Monographic Series No. 3, pp. 276-287, pl. xxxvi, figs. 1-11 (1924).

This subfamily is undoubtedly closely related to the Amnicolinae not only in the form of the shell and the nature of the operculum, but also in certain features of the internal organs. It differs in having a simple " verge " or penis. This character seems to be constant in all the genera included in the subfamily, and constitutes the chief distinguishing feature. Annandale's Hydrobiinae is synonymous with Triculinae.[1]

The members of the subfamily seem to have a restricted distribution in India, Burma, China and Japan.

Genus **Tricula** Benson.

1865. *Tricula*, Stimpson, *Smithsonian Misc. Coll.* No. 201, p. 41.
1921. *Tricula*, Prashad, *Rec. Ind. Mus.*, XXII, pp. 67-69.
1925. *Tricula*, Annandale & Rao, *Rec. Ind. Mus.*, XXVII, p. 115.

This genus has been recorded chiefly from the mountainous regions of India, Burma and China. The European genus *Bithinella* Moquin-Tandon, which was considered to be synonymous with *Tricula*, has been separated from the latter on conchological as well as anatomical grounds.[2] The type-species *T montana* has not been found again since its discovery in 1843.

The species of *Tricula* are, as a rule, found in weedy streams at moderate altitudes, the only known exception being *T gravelyi* Prashad from still creeks in the plains.

In the Shan States the genus is represented by four species none of which occurs within the limits of the Indian peninsula. Two species and two varieties of previously known species are here described as new.

Key to the known species of *Tricula* from India and Burma.

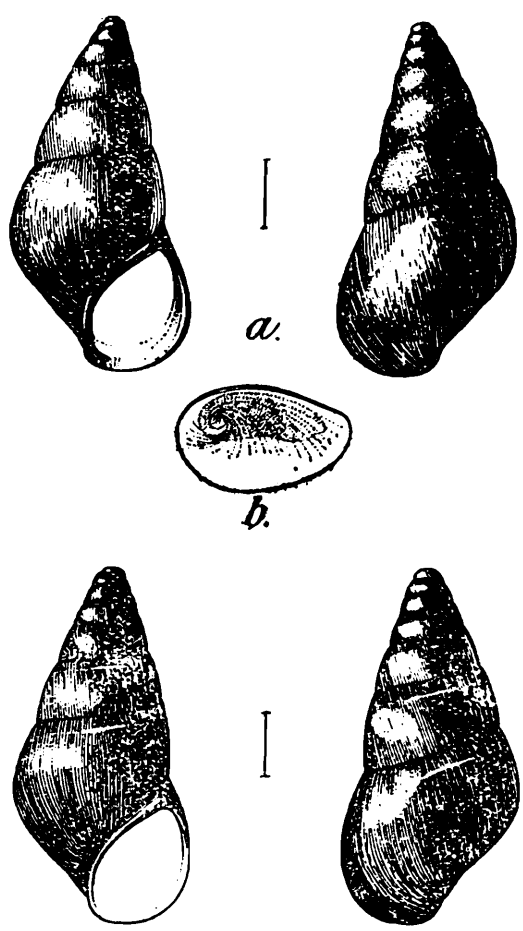
A. Outline of shell conspicuously broken by the suture—
- I. Outline of aperture rounded. Edge of lip of uniform thickness .. .. *T. gravelyi.*
- II. Outline of aperture oval. Edge of lip not uniformly thickened—
  - α. Whorls of shell rather narrow; the anterior margin of the aperture projecting considerably in advance of the outline of the last whorl in ventral view .. .. *T. montana.*
  - β. Whorls of shell broad; anterior margin not so conspicuously projecting—
    1. Shell opaque and coloured when fresh; edge of lip thickened .. .. .. *T. martini.*
    2. Shell hyaline when fresh; edge of lip not thickened .. .. .. *T. gregoriana.*

B. Outline of shell not conspicuously broken by the suture—
- I. Shell exceeding 5 mm. in height, aperture elliptical and produced above and below .. *T. taylori.*
- II. Shell not exceeding 5 mm. in height; aperture oval and not so produced .. .. *T. horae.*

[1] Annandale, *Rec. Ind. Mus.*, XXII, p. 2 (1921).
[2] Annandale, *Amer. Journ. Hygiene*, Monographic Series No. 3, p. 278.

Tricula taylori,[1] sp. nov.

The shell is larger than any known species of *Tricula*, elongate-ovate, and turrited. It is half as broad as high, and its spire in dorsal view is slightly longer than the height of the bodywhorl. There are 6-7½ gradually and evenly increasing whorls with more or less straight sides. The apex is minutely mamillate in full-grown shells. The last whorl is oblique and narrow at its commencement in dorsal view, but broadens out distally trumpet-like. The suture is slightly oblique, but appears to be more or less transverse in ventral view. The whorls are not at all swollen. The last whorl is, however, more convex than the one above it. The outline of the spire is very little interrupted by the suture which is feebly impressed. There is a slight peripheral keel on the last whorl which gives it an angular appearance in ventral view. The aperture is elliptical in shape, oblique, acuminate at both ends, but narrower above than below. The peristome is more or less uniformly thickened and expanded just outside the pointed anterior end. The lower part of the outer lip is arched and sharp at the periphery. A prominent triangular area is formed above the aperture by the union of the inner



TEXT-FIG. 7.—*Tricula taylori*. *a*. Fresh shell from Lashio. *b*. operculum of the same. The lower figure represents a dead and bleached shell from the same locality.

and outer lips. The columellar callus is thick and unusually broad. It narrows slightly a little below the level of the umbilicus, but broadens out again before it joins the outer lip. A distinct narrow channel runs

[1] The species is named after Lt.-Col. J. A. Taylor, Director of the Pasteur Institute, Rangoon, at whose instance the Mollusc Survey of the Northern Shan States was undertaken.

down just outside the columellar fold from the more or less closed umbilicus to the anterior end of the shell. On the side away from the columella it is bounded by a broad arched ridge on the last whorl. The shell and the columella are unusually thick, but the former is translucent. The spiral portion of the columella is seen through the shell as a well-defined spiral band immediately below the suture. The shell is porcellaneous, but in life is covered by a delicate, horny, periostracal membrane which is removed by the action of caustic potash. The light brown colour of the shell in life is due to deposits of mud, etc., on the shell in the natural habitat. In dead shells the membrane is lost under natural conditions. To the naked eye the shells present a smooth appearance, but when examined under a strong lens or a binocular microscope the surface appears to be rough, and the sculpture consists of minute longitudinal striae. The operculum is horny and paucispiral. Its inner or columellar side is more or less straight and slightly thickened from the edge to the nucleus, and its outer side evenly arched and thin.

The animal when fully expanded is about half as long as the entire shell, and carries its operculum more or less at right angles to the foot. The foot is bell-shaped, broad and arcuate anteriorly and rather bluntly produced at its antero-lateral angles, and narrower and rounded posteriorly. The proboscis is elongate-obovate and emarginate in front. Its anterior end slightly overhangs the margin of the foot. The tentacles are long and filiform with minutely swollen tips. The eyes are relatively large and situated at the outer base of the tentacles. The animal progresses with a jerky movement. The mouth is an elongated vertical slit on the anterior face of the proboscis.

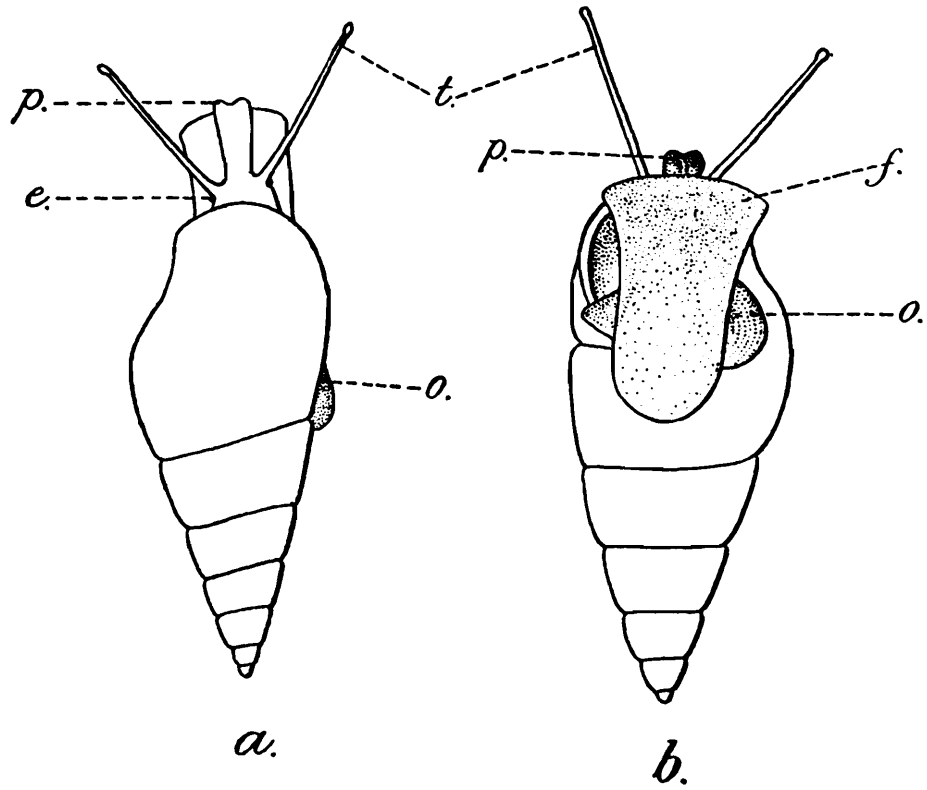
The lingual membrane is narrower than it is in *Hydrobioides*. The radular teeth resemble chiefly the type characteristic of the genus *Tricula*, but vary considerably, so that in some features they approach those of the genus *Hydrobioides* and the closely allied *Digoniostoma*. The central is hat-shaped and has its basal angles bluntly produced outwards and downwards. In this respect it differs from the characteristic central tooth of the members of the subfamily Triculinae. The central has often two denticles, and sometimes three, on the sides of the disc. The inner is slightly larger than the one immediately outside, and the outermost very minute. There are five cusps on the upper margin of the central, the middle one being much enlarged and bluntly triangular. The inner lateral more or less resembles that of *Hydrobioides nassa* and has the third tooth from the inside enlarged. The outer lateral, however, is much narrower and has fewer elongate and sharp cusps and differs but little from the marginal except in proportions.

The gill-lamellae have a broad base of attachment and their distal margin is only slightly produced, if at all. The stomach has a chitinous lining on the inside as in some species of Viviparidae. The ' verge ' is simple, sickle-shaped and found coiled up immediately behind the head.

One of the type-series has the following measurements in millimeters.

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
6·0	3·0	3·0	2·0

Type-series, No. M. $\frac{12806}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).



TEXT-FIG. 8.—*Tricula taylori*. *a*. dorsal, and *b*. ventral views of the living animal in an expanded condition. *e*. eye; *f*. foot; *o*. operculum; *p*. proboscis; *t*. tentacle.

Several living specimens were taken in a small stream on the Reservoir road in Lashio, headquarters of the Northern Shan States. They were found in mud and amongst tiny gravel or broken twigs at the bottom of the stream, but were quite inconspicuous. The few dead shells found were bleached and cream-coloured. Dr. Feegrade collected a few dead and bleached shells at Hsipaw on the banks of a hill-stream in September 1926.

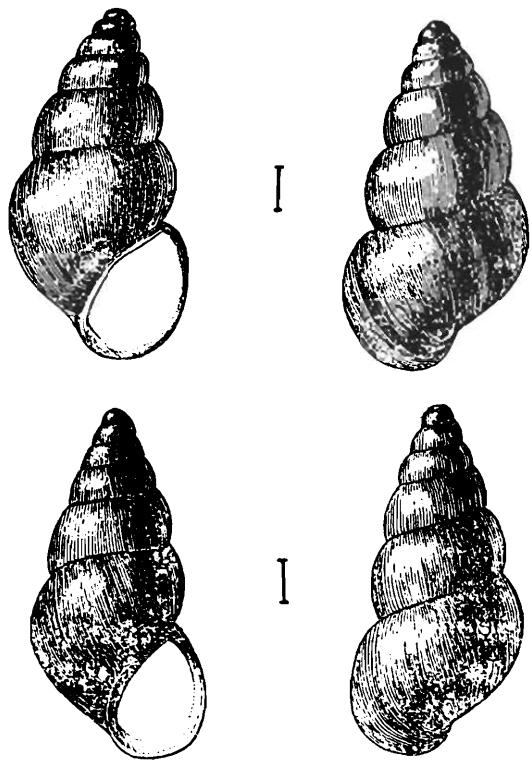
Anatomically this species does not differ materially from other species of *Tricula*, but the shell exhibits striking differences in the structure of the peristome and the columella. It has a superficial resemblance in form to the Southern Chinese *Delavaya rupicola*, *Parapyrgula coggini*, and perhaps to one or two fossil species of *Prososthenia* from the Miocene beds of Eastern Europe, but in conchological as well as anatomical characters it has nothing in common with any of the Delavayidae or the Pleuroceridae. Its resemblance to *Oncomelania formosana* Pilsbry and Hirase from Formosa is possibly more deceptive than the instances mentioned, but the shells of the two species can be easily separated when examined with a lens. The latter species has a distinct varix on the outer lip, the whorls are swollen, the mouth rounded, and the columellar region very different from that of the former.

Tricula martini,[1] sp. nov.

The shell is elongate, turrited, and somewhat abruptly narrowed above $\frac{2}{3}$ the height of the shell from the anterior end giving the spire an

[1] I have great pleasure in naming this species after Major C. de C. Martin, Officiating Director of the Pasteur Institute, Rangoon, at the time of my visit to the Northern Shan States, who rendered every possible help to the Mollusc Survey party.

oblique appearance. It has 6-6½ whorls which increase gradually in size. The whorls are evenly convex in the middle, and the last has no peripheral angle. The apex of the spire is blunt and rounded, and the protoconch is minutely mamillate. The suture is well-impressed and more or less transverse. The apical whorls are flattened outside the suture, but the lower whorls less so than the apical. The aperture is oblique, narrowly ovate, with the peristome continuous. The inner lip is straight up to a point slightly below the umbilicus where it is sharply rounded to meet the broadly arcuate outer lip. The anterior part of the mouth is moderately expanded. The collumellar callus is very little, if at all, reflected, and leaves the umbilicus open. The outer lip is slightly sinuate above in lateral view, or is, in rare instances, straight. The shell is uniformly thick and porcellaneous, but the marginal portion of the outer lip is sometimes abruptly thinned with the result that a slight rim formed away from the free margin suggests the appearance of a varix. The colour of the shell varies from a light lemon-yellow to brown, and the margin of the peristome is edged by a line of deep-brown colour. The sculpture consists of minute longitudinal lines on the entire shell which is relatively thick. The operculum is narrowly ovate, thin, and hyaline, and is capable of retraction within the mouth.



TEXT-FIG. 9.—*Tricula martini.* Fresh shells of type-series from Kutkai.

The following brief note on the living animal was made in the field :—

The animal is of a chocolate brown colour, and has short tapering tentacles and a moderately long proboscis which extends beyond the foot when the animal creeps forward. There is a black eye-spot at the outer base of each tentacle with a lunate yellow mark on the inner half. The foot is short, broad, blunt at the lateral angles, and broadly rounded behind.

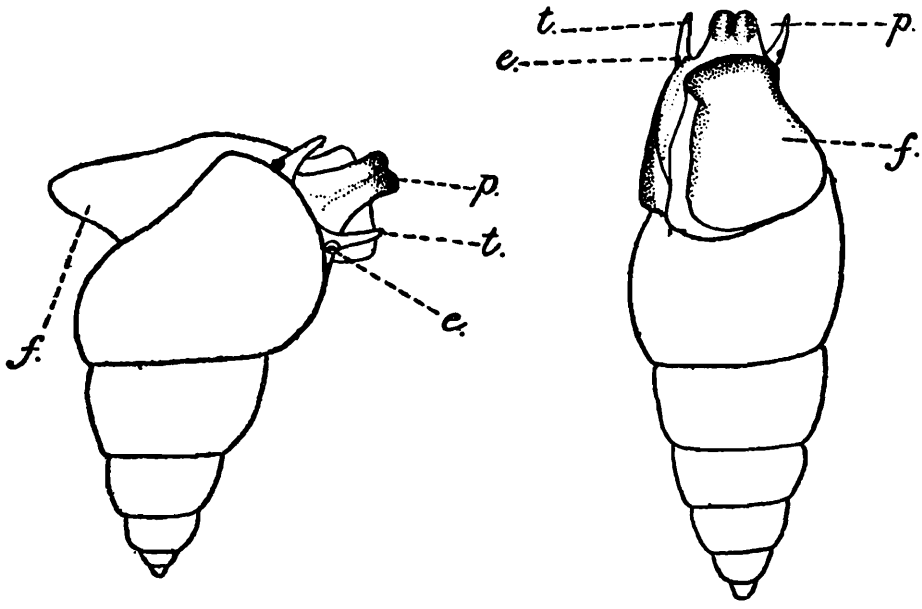
The radular formula is 2. 1. 1. 1. 2. The central has three cusps on its upper margin, the median one being larger and sharper. On the anterior face of the tooth there is usually a single pointed denticle at the base on each side, but a very minute second denticle can be seen in good light. The lateral has several teeth of which the third from the inside is much enlarged, conical and pointed. The marginals have fewer teeth.

The gill and the ' verge ' are of the type common in other species of the genus.

The measurements in millimeters of the largest shell in the type-series are given below.

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
4·0	2·0	1·5	1·0

Type-series.—M. $\frac{12807}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).



Text-fig. 10.—*Tricula martini.* Dorsal and ventral views of two different animals in a partially expanded condition. *e.* eye; *f.* foot; *o.* operculum; *p.* proboscis; t. tentacle.

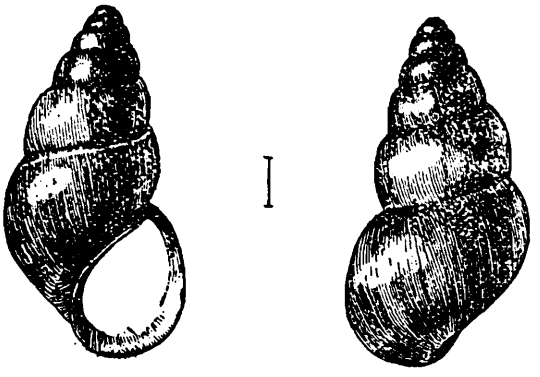
Several living specimens were taken at Kutkai, in a small channel flowing into the Nam Teng river and choked with lilies, grass and other weeds. A few were also found at the edge of Nam Khai stream.

The species is closely allied to *T gregoriana* from the Mekong valley, but differs in having a thicker shell, a deeper suture and more convex whorls, in the nature of the peristome, and in sculpture and colour. In the slight obliquity of the spire at apex and the depth of the suture it approaches the Chinese *T humida*, but differs in having the peristome adherent to the last whorl, and in the dentition.

Tricula gregoriana var. **expansa,** nov.

The shell is higher and broader in proportion when compared to *T. gregoriana,* elongate-ovate and relatively broad at the anterior end.

It has 6-6½ whorls which appear to be telescoped in the spire due to a greater degree of flattening outside the suture. The aperture is broadly ovate, often broadest below the middle of the outer lip which projects above the level of the columella. When compared to *T gregoriana* the outer lip is more sinuate above in lateral view and more expanded below, the columellar callus is a little more reflected over the umbilicus, the sculpture is relatively rough though the shell-surface is polished, and the colour of the shell is pale cream in the fresh condition and white when bleached.



Text-fig. 11.—*Tricula gregoriana* var *expansa.* Fresh shell of type-series from Mongyu.

One of the type-series has the following measurements in millimeters :—

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
5·0	2·5	2·3	1·5

Several living specimens were collected at Mongyu, near the Chinese Frontier, in the only stream of the locality which was at the time overgrown with grass and a species of *Potamogeton.* The snails were found sticking to the weeds.

Tricula horae var. **major,** nov.

Shells of this variety agree very closely in general facies with those of *T horae,* but differ from them in size and texture, in having a minute flattened apical whorl, in having a narrow mouth which is not expanded anteriorly, in the columella being relatively thin and less distinct, and in the outline of the last whorl being less sinuate below in dorsal view.

Type-series.—M. $\frac{12809}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

The largest shell in the collection has the following measurements in millimeters :—

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
4·8	2·5	2·3	1·5

Three shells were picked up in a subfossil state in sand on the high banks of the Nam Sawn river about a mile East of Mongyin on the borders of the Tawngpeng and North Hsenwi States. Their surface is somewhat worn, and the sculpture is therefore obscure. The operculum is not preserved and the margin of the outer lip is broken up in places.

T horae is known only from a deposit of calcareous particles at the head of the He-Ho gorge in the Southern Shan States. The present variety seems to have a restricted distribution like the species. It is noteworthy that on the banks of the Namtu river at Hsenwi where a large variety of subfossil shells was obtained in sand no species of *Tricula* was found. It is probable that the species *T horae* and the variety here described do not occur in the living condition in the Shan States.

Subfamily AMNICOLINAE.

There is considerable divergence of opinion as to the limits of this subfamily. According to Walker,[1] and Pilsbry and Bequaert (*op. cit.*, pp. 213-221) the subfamily includes forms with a thin, horny, spiral operculum capable of being withdrawn some distance within the aperture. This appears to be the generally accepted view in America as well as in Europe. Annandale included in this subfamily all the Indian and Burmese species which he referred to the subgenus *Alocinma.*[2] In an earlier paper on the generic revision of the Indian freshwater Rissoidae he had rightly placed *Alocinma* in the subfamily Bithyniinae (the present Buliminae).[3] In his view the subgenus *Alocinma*, though different from the American genus *Amnicola* in having a thick, calcareous, concentric operculum, is closely allied to it genetically.

I have adopted the accepted view in Europe and America as regards the definition of the subfamily, and therefore exclude *Alocinma* from it, but agree with Annandale that the occurrence of the genus *Amnicola* within Indian limits is open to considerable doubt.

I include, however, in this subfamily the genus *Ekadanta* nov. which has several characteristic features in common with the members of the subfamily. The form of the shell and the nature of the radular teeth are, however, so different from those of *Amnicola* (*s.s.*) that it has been necessary to erect a new genus.

Genus **Ekadanta,**[4] nov.

The shell is unlike that of any American *Amnicola* that I have seen, and is conico-globose or ovate-conical, perforate, small, thin and with minute sculpture. The whorls increase gradually in size, the bodywhorl being never higher than the spire. The protoconch is depressed, and the suture transverse and well defined. The peristome is thin and rarely continuous. The umbilicus is open, and has a broad channel running forwards from it. The operculum is horny, very thin and transparent, and paucispiral with the nucleus excentrically situated on the inner side.

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[1] Walker, *Univ. Michigan Mus. Zool. Misc. Publications,* No. 6, p. 28 (1918). *Also Amer. Journ. Hygiene,* Monographic Series No. 8, p. 209 (1927).

[2] Annandale, *Amer. Journ. Hygiene,* Monographic Series No. 3, p. 276 (1924).

[3] *Id., Rec. Ind. Mus.,* XXII, p. 5 (1921).

[4] From two Sanskrit words Eka=one, and Danta=tooth.

The tentacles are flattened mound-shaped structures, and bear the eyes at their outer base.

The lingual ribbon is minute and narrow. The radular teeth are unique among the Amnicolinae in that the central has no lateral basal denticulations on the disc, but has only five cusps on the upper margin and a large median conical projection from the middle of the disc extending beyond the basal margin. The laterals are more or less alike in having a few enlarged cusps on the upper margin, and the marginal is much broader than the laterals and bears a large number of minute elongated cusps on the upper margin.

The gill-lamellae are attached to the inner face of the mantle by their broad base, and have their apex much abbreviated.

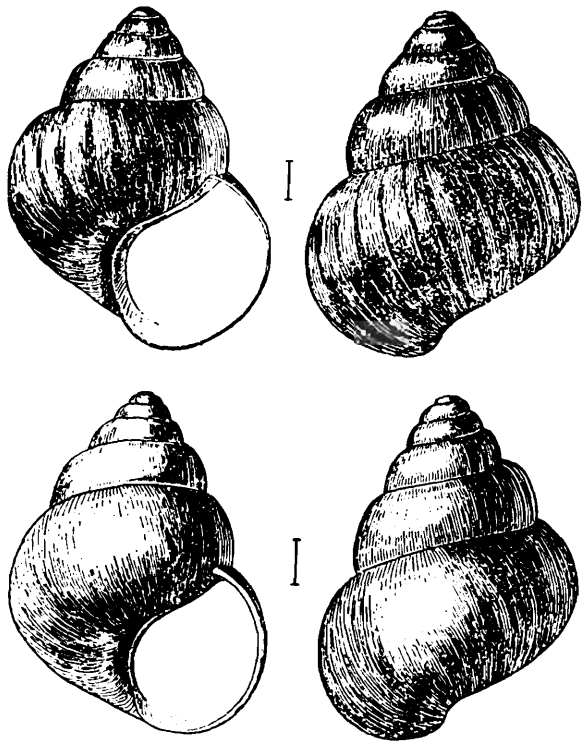
The genitalia appear to be of the usual Amnicoline type, but the nature of the ' verge ' is obscure.

Type-species. *Ekadanta shanensis*, sp. nov.

In the characters of the shell as well as those of the soft parts, particularly the radula, the present genus is unique in the subfamily Amnicolinae. It seems, however, to approach the American genus *Amnicola*.

Ekadanta shanensis, sp. nov.

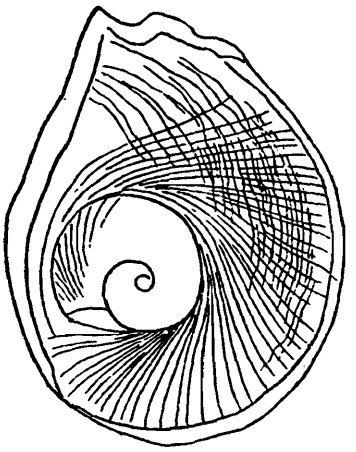
The shell is small, conico-globose to ovate-conical, about $1\frac{1}{2}$ times as high as broad, with $5\frac{1}{2}$-6 moderately convex, gradually increasing whorls, the bodywhorl being more convex than the whorls of the spire and about three times as high as the penultimate. The breadth at base



Text-fig. 12.—*Ekadanta shanensis*. Those figured above represent one of the type-series from Mongyu, and those below the single subfossil shell from Hsenwi.

of spire is $\frac{3}{4}$ the maximum breadth of the shell. The suture is well-defined and impressed, transverse, and the whorls outside it slightly flattened,

The apex of the spire is rather blunt with the protoconch depressed. The aperture is broadly oval, slightly oblique, not considerably higher than broad, narrowed above and evenly rounded below. The peristome is discontinuous between the posterior end of the aperture and the umbilicus, the outer and inner lips at this point being rarely connected by a very thin porcellaneous shell-substance hardly visible to the naked eye. The umbilicus is open, and has a broad channel running down next to the columella which is thin, slightly reflected and sinuate a little below the umbilicus. The shell is thin, translucent, amber-coloured, and has minute longitudinal striae. It is otherwise smooth to the naked eye and has often pale longitudinal bands on the surface of the shell, usually clearly seen on the bodywhorl, but obscure on the whorls of the spire. The operculum is horny, very thin and transparent, broadly ovate, paucispiral, with the nucleus excentrically situated on the inner side. A few broken longitudinal lines interrupt the free ends of the spiral lines above and on the outer side. The operculum is capable of being withdrawn into the mouth of the shell.

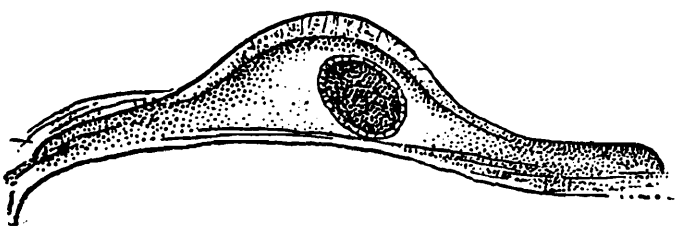


TEXT-FIG. 13.—Operculum of *Ekadanta shanensis.*

The following are the measurements in millimeters of one of the type-series :—

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
4·5	3·0	2·5	2·0

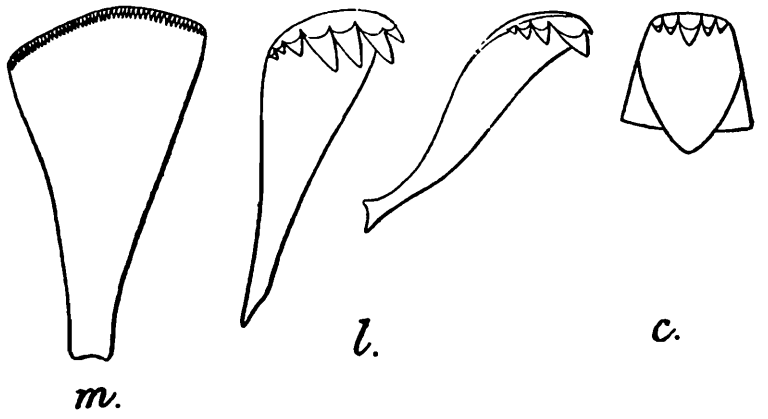
The tentacles are short, broad-based, flattened structures in a contracted and preserved state, and have an oval eye-spot at the outer base.



TEXT-FIG. 14.—*Ekadanta shanensis.* Side-view of tentacle with eye-spot.

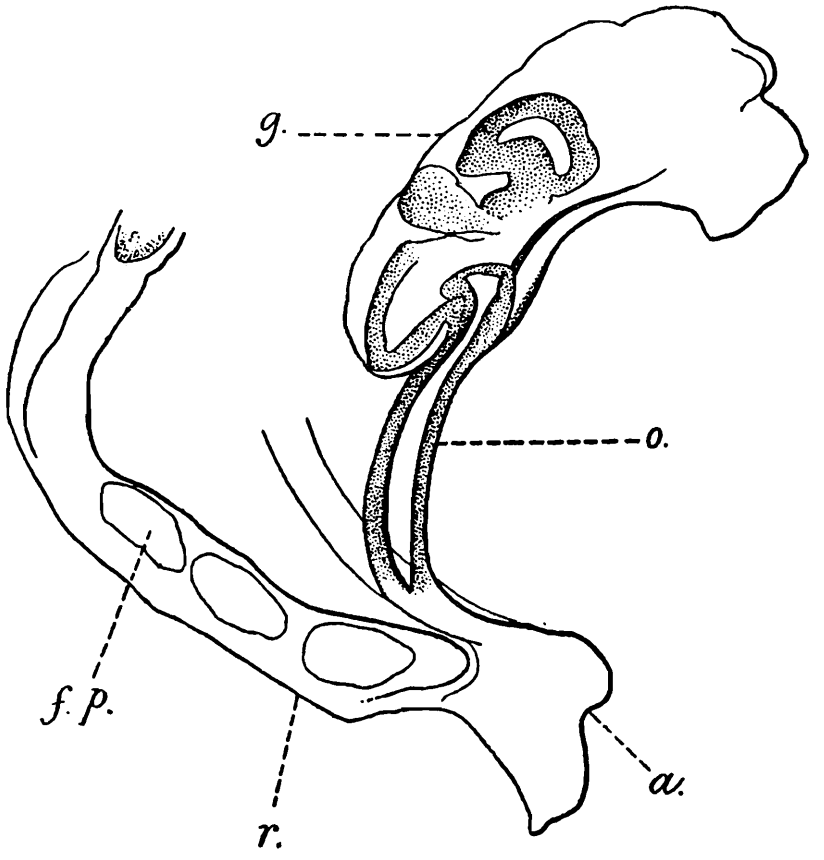
The dentition is quite characteristic of the species. The lingual ribbon is minute, narrow, with several transverse rows of teeth. The dental formula is 1. 2. 1. 2. 1. The central is roughly dome-shaped with the sides not markedly divergent. Its upper margin has a row of five conical cusps of which the median is enlarged and the lateral ones diminish gradually in size towards the periphery of the tooth. A large median conical projection is present on the disc extending beyond the basal margin of the central. The laterals are more or less similar in outline and equal in size but the first lateral has fewer enlarged cusps than the second. The basal part of the teeth is narrowed but the lower extremity is slightly expanded like the tail-fin of a fish. The marginal is very broad above and rather abruptly narrowed below. Its upper

margin is arched and obtusely angled in the middle, sloping gently on either side. It carries numerous minute elongate cusps. The lower part of the marginal is very thin and often obscure.



Text-fig. 15.—Radular teeth of *Ekadanta shanensis*. *c.* central; *l.* laterals; *m.* marginal.

The mantle is heavily pigmented with black granules and its margin is entire. The gill-lamellae are arranged transversely on the under surface of the mantle. They form a ridge, and are thin and short, and very much broader than high. The free margin may or may not have a minute projection.



Text-fig. 16.—Genitalia of *Ekadanta shanensis*. Distal portion only with associated structures. *a.* external opening of rectum; *g.* gonad; *f.p.* faecal pellets in the rectum; *c.* oviduct; *r.* rectum.

The genitalia appear to be of the usual Amnicoline type, but the nature of the 'verge' is not known, as both the specimens available for

examination were females.

Type-series.—M. $\frac{12805}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

A few specimens were collected in a weedy stream at Mongyu, a few miles from the Chinese Frontier. They were by no means numerous, and were found along with large numbers of *Tricula gregoriana* var. *expansa*. All but two were empty shells. They were however fresh. The animals were in a contracted state, and the external features could not be made out satisfactorily.

The species is unique in several features, and does not seem to be related to any of the known Indian, Burmese or Chinese species. It has probably a restricted distribution in the Shan States.

A single entire shell was picked up in sand on the banks of the Namtu river at Hsenwi. The operculum was not found. The shell is of a pale-brown or biscuit colour.

Family TIARIDAE (Melaniidae).

This family is well represented in the Northern Shan States by several species from the rivers and streams on the Chinese Frontier down to Hsipaw and South Hsenwi States. The species belong to the three genera *Acrostoma*, *Melanoides*, and *Paludomus*, and include two new species and two new forms.

Genus **Acrostoma** Brot.

1874. *Melania* (*Acrostoma*), Brot., *Conch. Cab.* pp. 6 & 17. *Melanoides* (in part), *id.*, *ibid.*, pp. 6 & 72.
1920. *Acrostoma*, Annandale, *Journ. Ind. Med. Research*, VIII, p. 107.
1920. *Acrostoma*, Annandale, *Rec. Ind. Mus.*, XIX, p. 109.
1921. *Acrostoma*, Prashad, *Rec. Ind. Mus.* XXII, p. 485.
1925. *Acrostoma*, Annandale and Rao, *Rec. Ind. Mus.*, XXVII, p. 117.

The position of this genus in the family and its limits in the Indian Empire are now fairly well-defined. The generic characters in the shell and operculum, and in the soft parts, chiefly the mantle edge and the radula are reliable and can be readily used to separate many species which had been referred hitherto to various other genera of the family. The geographical distribution of the genus in India proper is restricted to Assam and deltaic Bengal, and to South India. Burma seems to be its headquarters where several species thrive. Its range still further East is not definitely known, though certain species of *Melania* described from parts of China are referrable to this genus.

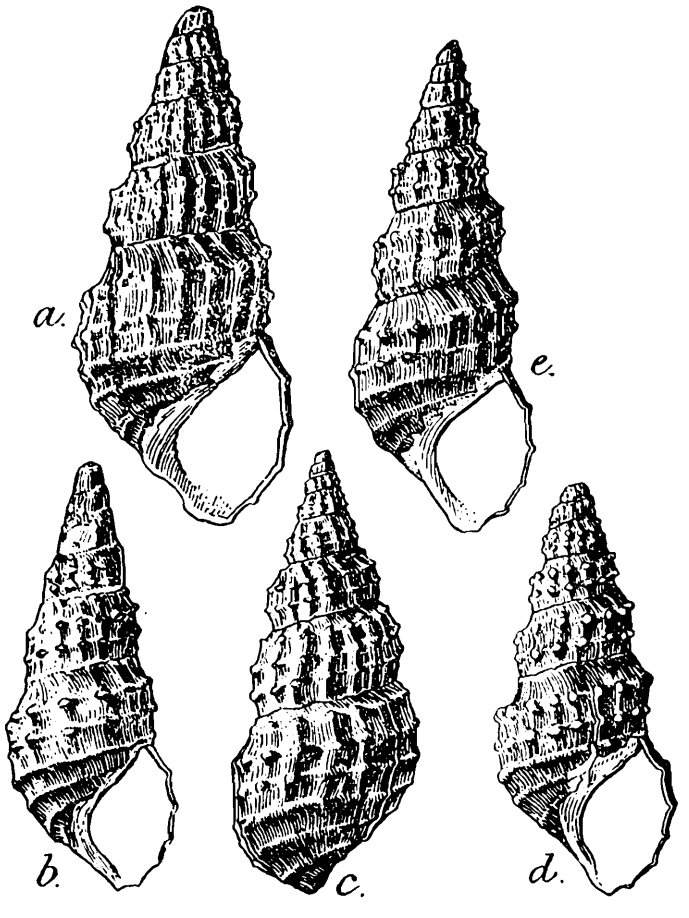
Acrostoma baccata (Gould).

1848. *Melania baccata*, Gould, *Proc. Boston Soc. Nat. Hist.*, II, p. 219.
1874. *Melania baccata*, Brot, *Conch. Cab.*, p. 81, pl. ix, fig. 6.
1876. *Melania baccata*, Hanley and Theobald, *Conch. Ind.*, p. 32, pl. lxxv, figs. 1, 2, 4.
1915. *Tiara* (*Melanoides*) *baccata*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 26.

Of the larger species of Tiaridae *A. baccata* seems to be common in the Northern Shan States, especially in level tracts at comparatively low elevations drained by rivers and large streams. This species is

closely related to *Acrostoma elongatum* Annandale which was described from the plains of Yanghwe, Southern Shan States, and is liable to be confused with it.[1] The latter, however, can be readily distinguished by its elongate-turrited shell with more prominent rows of tubercles, deeper suture, and less convex but more numerous gradually increasing whorls which appear to be discrete as a result of the elevation of the tubercular ridges, particularly those near the suture. Shells belonging to this species never attain the size of *A. elongatum* and do not usually exceed 50-60 mm. in height. The last whorl is relatively broad and convex. The operculum and the soft parts including the radular teeth do not exhibit striking differences in the two species.

Like *A. elongatum* the present species is variable in size and form and in the number of rows of tubercular ridges on the whorls. In the collection from the Northern Shan States there are specimens which have two, three, or very rarely four rows of tubercles on the upper whorls. The original description of the species based on specimens collected on the borders of Siam in Thoungyin river in Lower Burma seems to refer to shells having three rows of tubercles, and it may be convenient to treat



Text-fig. 17.—*Acrostoma baccata* f. *bituberculata*. *a. b. d. e.* Four different shells from Hsenwi showing variation in the type-series. *c.* represents the forma *typica* which is figured for comparison. Nat. size.

shells having three rows as representing the forma *typica*. As differences in the number of rows of tubercles are found in specimens of more or less

[1] Annandale, *Rec. Ind. Mus.*, XIV, p. 115 (1918). Also Annandale and Rao, *Ibid.* XXVII, p. 117 (1925).

the same size and from the same locality, they are, presumably, not due to changes in growth such as have been observed in many species of molluscs, but are correlated with some factors inherent in the species.

A large series of shells, dead as well as subfossil, was obtained on the banks of the Namtu river at Hsenwi and Hsipaw, on the banks of a stream near Tangyan, and at Lashio. In some of them the tubercles are very much worn and in others they are prominent. On the bodywhorl there are usually four rows of tubercles and three non-tubercular ridges below. The space between the suture and the first row is abbreviated.

Acrostoma baccata f. **bituberculata,** nov.

A large proportion of shells found in the Northern Shan States, especially those taken in a living condition, have two rows of tubercles in the middle of the whorls of the spire, three or four rows of tubercles and two or more non-tubercular ridges on the last whorl. This form is, however, distinguished from the forma *typica* primarily by the broader space between the suture and the first row of tubercles. The soft parts are similar to those of the forma *typica*.

Type-series.—M. $\frac{12769\text{-}12771}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

A few living specimens and several dead and subfossil shells were obtained from the Namtu river at Hsenwi and Hsipaw, and in a stream near Tangyan. Mr. Hodgart collected a dead shell close to a stream at Nahsai on the Namtu-Lashio road. The individuals collected by Dr. J. Coggin-Brown of the Geological Survey of India at Hsipaw some years ago belong to this form.

Acrostoma baccata f. pyramidalis Theobald.

1865. *Melania variabilis* var. *pyramidalis*, Theobald, *Journ. As. Soc. Bengal*, XXXIV, p. 274, pl. ix, fig. 7.
1884. *Melania* (*Melanoides*) *baccata*, Nevill, *Hand List Moll. Ind. Mus.*, II, p. 262.

Theobald's description of this form is based on specimens collected in a stream near Nam-Mah (Northern Shan States) none of which is contained in the Indian Museum collection. There are, however, two shells in this collection from the neighbourhood of the Salween river, Northern Shan States. One has the label " Upper Salwin, Shan States " and agrees closely with that figured by Theobald, while the other bears the label " Salween river," and has three tubercular rows on the upper whorls and four on the last whorl in addition to five non-tubercular ridges below.

This is a very distinct form with rapidly increasing whorls, the last of which is about as high as the spire and proportionately broad in the middle. The ornamentation is variable.

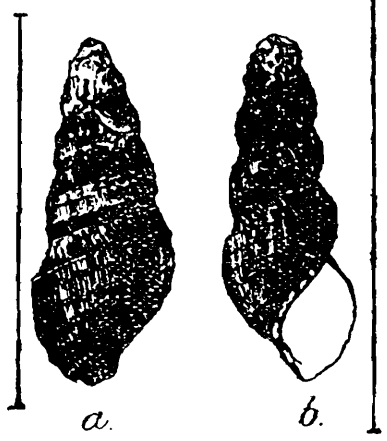
Several subfossil shells were found in sand on the banks of the Namtu river at Hsenwi. Dr. Feegrade obtained a large subfossil shell on land some distance from a hill-stream near Hsipaw. Most of the shells have the apex of the spire and part of the ornamentation eroded. The largest

shell obtained at Hsenwi has the following measurements in millimeters :—

Height of shell. (apex eroded).	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
47·5	28·0	25·0	14·0

Acrostoma baccata f. lirata, nov.

This is a more slender form than either the forma *typica* or the f. *bituberculata* ; the tubercular ornamentation is suppressed, at any rate, conspicuously on the bodywhorl, and the spiral sculpture takes the form of transverse ridges which are often slightly tubercular on the upper whorls. The whorls are convex in the middle and slope down towards the suture above and below. The shell thus resembles in form a twisted cord or rope. There are numerous well-defined vertical lines between the spiral ridges. The mouth is relatively short and its outer lip is rather deeply sinuate above. The spire is, as a rule, incomplete and the tubercles are worn out. In the radula the median cusp of the central is rather strongly developed. The soft parts do not differ from those of the forma *typica*.



TEXT-FIG. 18.—*Acrostoma baccata* f. *lirata*. *a, b*. Two different shells from Mankat.

Type-series.—M. $\frac{12773}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Several living individuals were obtained from tributaries of the Nam Pang river near Mankat, South Hsenwi.

Acrostoma baccata f. recta Nevill.

1884. *Melania* (*Melanoides*) *baccata* subvar. *recta*, Nevill, *op cit.*, p. 262.

This form is distinguished from the others by the less convex whorls, the deeper suture, and by the prominent knob-like tubercles. No specimens were found in the course of the Mollusc Survey. The only incomplete shell in the Indian Museum collection is from the Upper Salween.

Acrostoma kubja,[1] sp. nov.

The shell is ovate-elliptical, thick, broadest in the middle part and narrowing towards either end. It is of moderate size and well within the range of variation in size common in the genus, and has 3-3½ or, exceptionally, 4½ rapidly increasing whorls of which the last is convex and about four times as high as the spire, and nearly as broad as the aperture is high. The breadth at base of spire is about half that of the maximum breadth of the last whorl. The apex of the spire and very often the

[1] From a Sanskrit word meaning hunch-back.

periostracum on the latter are worn to some extent. The suture is slightly oblique and very little impressed. The aperture is large, elongate, lenticular in outline and pointed at both ends. The outer lip has an undulating appearance on account of the slightly projecting spiral ridges. The columella is broad at its origin above and narrows gradually towards the anterior end of the shell. Its fold is very thin and the free edge merges insensibly into the extra-columellar area immediately outside it. The sculpture consists of a number of transverse spiral ridges and minute vertical lines between them. Only three tubercular spiral ridges are seen on the penultimate whorl, while there are usually four of them on the bodywhorl in addition to 4 or 5 non-tubercular spiral ridges below. The middle ones are more or less equidistant, while those below are much nearer to one another. The tubercles when present are stout and blunt and often worn out to little circular eminences. The operculum is not preserved.

Type-series.—M. $\frac{12774}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Measurements in millimeters of two large shells from the type-series.

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
37·5	26·5	25·5	14·0
36·0	29·5	26·0	15·0

The description of the species is based on a small series of more or less complete shells collected in a subfossil condition by Dr. Feegrade in August 1926 in sand on the banks of a hill-stream near Hsipaw. The shells obtained by Dr. Chopra and myself from sand on the banks of the Namtu river at Hsipaw are incomplete and much worn.

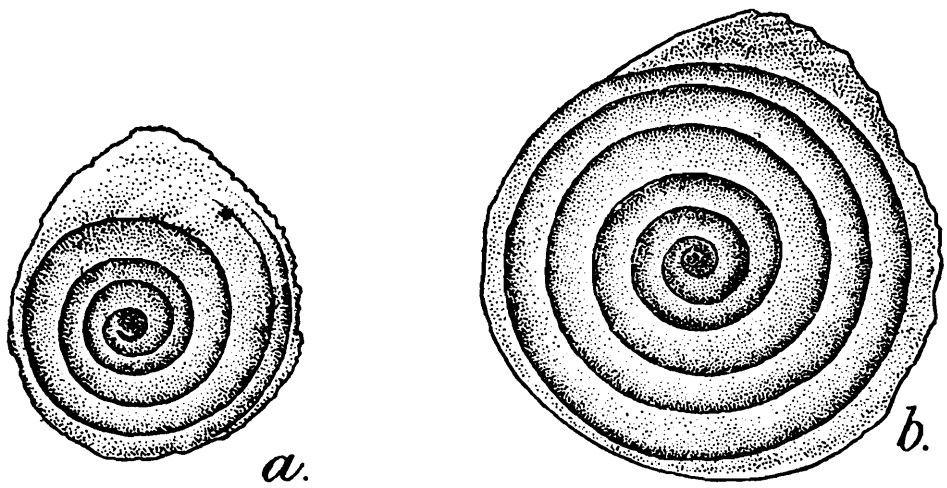
This species seems to be related to *A. baccata*, especially to the f. *pyramidalis*, but differs in having an abbreviated spire with fewer whorls, and in having a relatively large bodywhorl and a less prominent sculpture. The outline of the shell, the short spire, and the nature of the columella suggest the possibility of the genus *Paludomus* having evolved from hill-stream Melanids resembling the present species. It would be interesting to know whether the species occurs in a living condition in the Shan States. The operculum and the soft parts would provide the clue to its true affinities, but it is difficult to arrive at any conclusion from the shell alone.

Acrostoma iravadica (Blanford).

1869. *Melania iravadica*, Blanford, *Proc. Zool. Soc. London*, p. 445.
1872. *Melania iravadica*, Brot, *Notice Les Melanies de Lamarck conservees dans le Musée Delessert (Geneve)*, p. 34, pl. iv, figs. 12, 13.
1877. *Melania (Melanoides) iravadica*, Nevill, *Journ. As. Soc. Bengal*, XLVI, p. 33.
1915. *Tiara (Melanoides) baccata* var. *iravadica*, Preston, *op. cit.*, p. 27.

This species, while undoubtedly closely related to *A. baccata*, is quite distinct from it in size, in sculpture and in the operculum. I have been fortunate enough to extract the operculum from one of the shells collected by the late Dr. Anderson at Manwyne in the Tapeng valley, Yunnan,

and from which Blanford selected his type-series. I figure below the opercula of *A. baccata* and *A. iravadica* to show the differences which, in my view, are sufficient to give the latter a specific instead of a varietal status. The Indian Museum collection contains in addition a large series of shells from Upper Burma. Blanford's label shows that a series from Manwyne was selected to represent the types, but it seems that subsequently only one fairly large specimen among the lot was preserved as the type-specimen, the rest being treated as co-types. It was from one of these latter that the operculum was extracted.



Text-fig. 19.—*a.* operculum of *Acrostoma iravadica* from Manwyne ; *b.* operculum of *Acrostoma baccata* f. *bituberculata* : × 6.

No examples of this species, either living or fossil, were found in the Northern Shan States. The species has probably a restricted distribution in Yunnan and parts of Upper Burma above Bhamo.

Acrostoma baccifera (Theobald).

1865. *Melania variabilis* var. *baccifera*, var. *vittata*, Theobald, *Journ. As. Soc. Bengal*, XXXIV, pp. 273, 274, pl. ix, figs. 4, 5.
1884. *Melania* (*Melanoides*) *subasperata*, var. *sublaevigata*, and var. *vittata*., Nevill, *op. cit.*, pp. 262-263.
1915. *Tiara* (*Melanoides*) *baccifera*, var. *sublaevigata*, and var. *vittata*, Preston, *op. cit.*, p. 28.

Theobald regarded this species as a variety of his " *Melania variabilis* " which is *A. baccata*. While it seems to be closely allied to *A. baccata* in some features, it differs in the shape of the mouth which is smaller and relatively rounded with the anterior end blunt and obtuse. The shell is comparatively slender and the whorls more convex than in *A. baccata*. The varieties *sublaevigata* and *vittata* are to be treated as mere forms of *A. baccifera* showing the extent of variability in the species. Nevill's specific name *subasperata* for this species is apparently based on the slight resemblance of the type-specimen to one of the forms of the Philippine species *A. asperata* (Lamarck), but the variations in the form of the mouth and in sculpture of the latter species (as shown in Brot's *Conch. Cab.*, pl. viii) indicate the probable remoteness of the Shan species from the Philippine one.

A. baccifera and its forms are represented in the Indian Museum collection by a single shell each, probably those collected by Fedden

in the Shan States. The operculum, the soft parts, and the exact locality from which they were collected are unknown.

The species was not found in the Northern Shan States by the Mollusc Survey party.

Genus **Melanoides** Olivier.

1920. *Melanoides*, Annandale, *Rec. Ind. Mus.*, XIX, p. 108.
1920. *Melanoides*, Annandale, *Ind. Journ. Med. Research*, VIII, p. 106.
1921. *Melanoides*, Annandale, *Rec. Ind. Mus.*, XXII, p. 558.

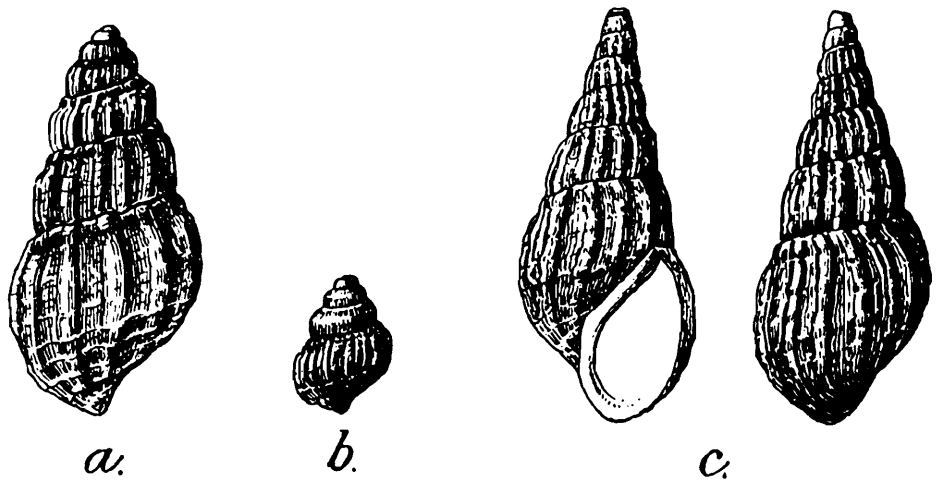
The diagnostic features of the genus have been well described by Annandale in the first reference cited above. But the species hitherto assigned to this genus and to other well known subgenera or groups of the so-called *Tiara* or *Melania* have been redistributed into certain well-defined genera having distinct conchological as well as anatomical features.

This genus is rather poorly represented in the Burmese region, at any rate, in comparison with *Acrostoma*. In the parts of the Northern Shan States visited only two species of *Melanoides* were found. One is the widely distributed and extremely variable species *Melanoides tuberculata* (Müller), and the other is an undescribed and probably rare species not hitherto recorded from Burma and perhaps closely related to one of the species described from the Malay Archipelago.

Melanoides tuberculatus (Müller).

1874. *Melania tuberculata*, Brot, *Conch. Cab.*, p. 247, pl. xxvi, figs. 11-11*g*.
1897. *Melania tuberculata*, Martens, *Weber's Zool. Ergebn. Niederl Ost-Indien*, IV, p. 56.
1918. *Melania tuberculata*, Annandale, *op. cit.*, pp. 114, and 155-157.
1919. *Melanoides tuberculata*, Annandale, *Rec. Ind. Mus.*, XVIII, p. 31.
1925. *Melanoides tuberculatus*, Annandale and Rao, *Rec. Ind. Mus.*, XXVII, p. 118.
1927. *Melanoides tuberculata*, Pilsbry and Bequaert, *Bull. Amer. Mus. Nat. Hist.*, LIII, p. 256, pl. xxi, figs. 1-7.

The species is common in the Northern Shan States at low altitudes, near the edge of rivers and streams, and a large number of living speci-



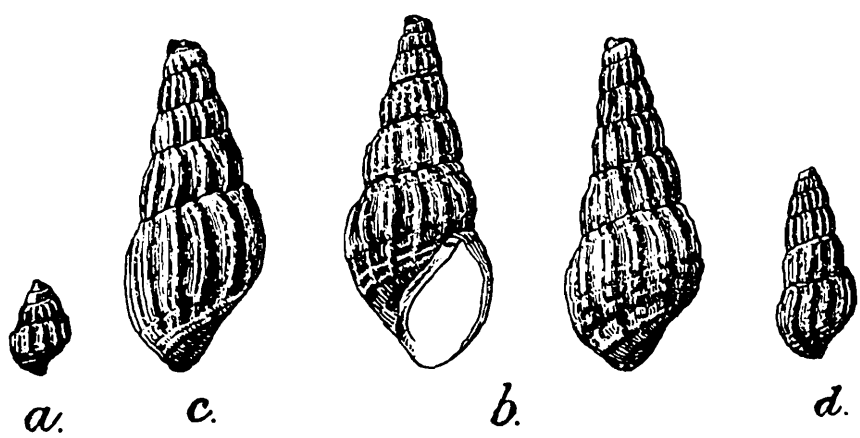
TEXT-FIG. 20.—*Melanoides feegradei*. Living shells from the type-series. *a*. young shell; *b*. embryo ; *c*. full-grown shell, *a*, *b* : × 6·6, *c* : × 2.

mens was obtained from various places in North Hsenwi, South Hsenwi, and Hsipaw States. Those from the Shweli valley are comparatively large in size and have the sculpture prominently developed.

The last two whorls are usually devoid of tubercles, their place being taken by well developed, flat, parallel, spiral ridges. The upper whorls have, however, the tubercles in regular vertical rows. In clean shells a number of vertical zig-zag brown bands may be seen on the last whorl. In fact the extremes of variation exhibited in the species occur in the collection from the Northern Shan States.

Melanoides feegradei,[1] sp. nov.

The shell is of moderate size, elongate-conical, and has 7-8 gradually increasing whorls of which the last is about twice as high as the penultimate whorl. The whorls of the spire are not at all convex while the bodywhorl is remarkably swollen. The suture is transverse, very narrow and slightly impressed. The sculpture consists of 13 or 14 equidistant, well-defined longitudinal hollow ridges which extend without interruption from suture to suture on the upper whorls, but on the bodywhorl they are crossed by 4-6, or exceptionally eight, comparatively thin and rather widely separated spiral ridges on the anterior part. The longitudinal sculpture between the ridges is rather obscure in the adult. The aperture is narrowly ovate, the apex being narrower than the base which is slightly rounded. The outer lip is broadly sinuate above, its lowest point being higher than, or at the same level as, the columella. The columellar fold is narrow and has a smooth shining appearance. It is very thin at its commencement but is rarely obsolete. In the interior of the mouth there are 4-5 comparatively broad, longitudinal grooves which correspond to the ridges on the bodywhorl and may be seen through when the shell is held against the light with the aperture facing the observer. The outer lip is thin and brittle. The last longitudinal ridge on the bodywhorl is a little distance away from the margin of the lip. The operculum is smaller than the aperture, thin, opaque, and narrowly ovate. The



Text-fig. 21.—*Melanoides feegradei.* Subfossil shell from the banks of the Namtu R., Hsenwi. *a.* embryo ; *b.* full-grown shell ; *c*, *d.* Young shells : (×2).

nucleus is minute and placed near the middle of the anterior broader end. On the undersurface there is a broad, lunate ridge which connects the

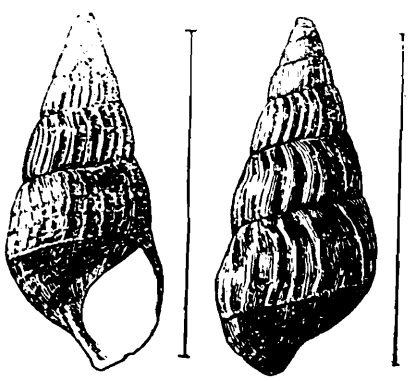
[1] The species is named after Dr. E. S. Feegrade, Special Malaria Officer, Burma, who took great interest in collecting shells from various parts of the Northern Shan States, and has been kind enough to submit them to me for examination.

base and the apex, and has its concave side facing the columella. The colour of the shell varies from yellowish to dark brown.

Measurements of shells in millimeters.

Locality.	Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.	REMARKS.
One of the Type-series from Hsenwi	20·0	8·5	8·5	4·5	Apex slightly eroded.
Sukmun ..	24·0	10·0	9·0	5·5	Spire incomplete
Bank of Namtu river, Hsenwi ..	24·0	11·5	10·5	6·5	,, (subfossil).
Old Lashio ..	30·0	15·0	12·5	8·0	,, (subfossil).

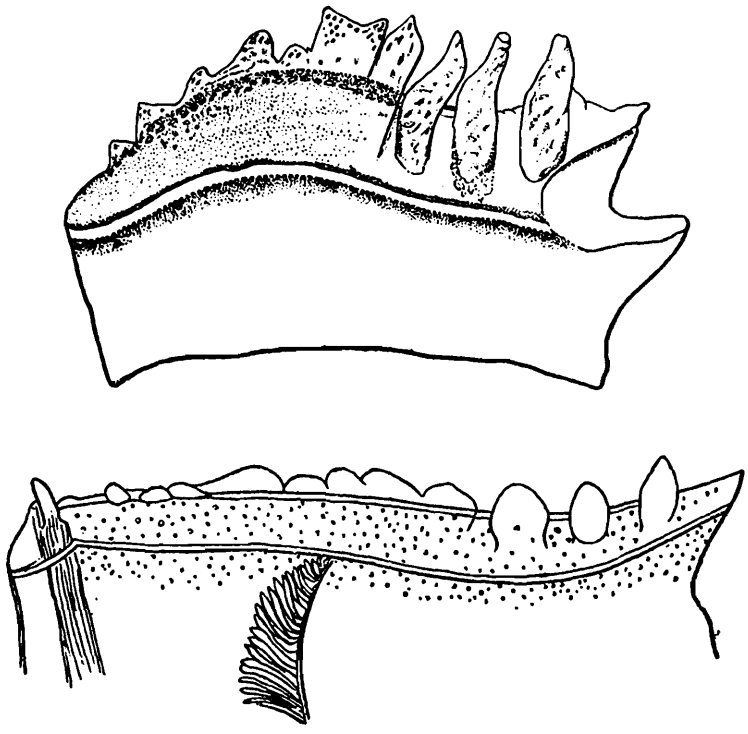
The mantle edge bears a few processes decreasing in size from left to right. The first three are large, finger-shaped, stout at base and slightly tapering towards the apex, and are separated one from the other. The remaining few are short, triangular and continuous. The gill-lamellae are triangular, broad-based, and bear a short transverse fold near the middle of the vertical side. The radular teeth are typical of the genus, but their resemblance to those of *Melanoides scabra* is remarkable. The central is short, and much broader than high. The basal margin is more or less transverse, and the upper broadly emarginate in the middle and bears five triangular cusps of which the median is the largest, and the outer is separated from the inner by a short gap. The lateral lies in a transverse position, the cusp-bearing part being much broader and shorter than the basal which is very thin at its commencement and broadens out slightly towards the outer end. It bears 4-5 cusps of which usually one, the second, is much larger than any of the others. The marginal stands upright, is longer than the lateral, narrow at the base and gradually broadening out above, and bears 7-8 sharp elongate cusps at the upper margin.



TEXT-FIG. 22.—*Melanoides feegradei.* Dead shell from Nahsai.

The species is viviparous and has about twelve embryos in various stages of development in the terminal part of the genital duct. The first two embryos near the external genital opening are usually full-grown. In the very young embryos the ground sculpture, which consists of numerous longitudinal lines, is well developed, and there are but minute traces of the vertical ridges especially on the upper whorls. In the growing embryo, however, the vertical ridges attain prominence at the expense of the ground sculpture which becomes more or less obsolete in the adult shell. The spiral ridges commence about the middle of the bodywhorl and become less and less conspicuous below. They are, however, more prominent in the embryo than in the adult. A well-defined brownish spiral band runs close to the suture in the older embryos. The operculum is thin and transparent in the full-grown embryo and has

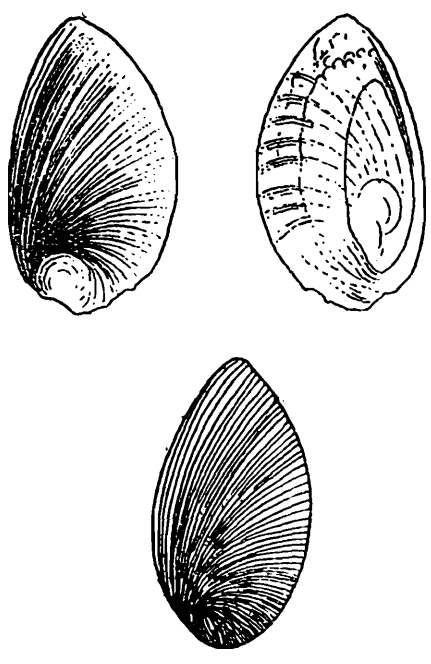
a conspicuous nucleus consisting of 2-3 whorls and lying more or less excentrically near the broader end.



Text-fig. 23.—Mantle edge of *Melanoides feegradei* above, and that of *Melanoides tube culatus* below.

Type-series.— M. $\frac{12778}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

The species was found living at the edge of the Namtu river, Hsenwi, in very small numbers. It was, however, abundant in a subfossil condition in sand on the banks of the Namtu river at Hsenwi, on the banks of streams near Sukmun and Nahsai on the Lashio-Namtu Road, and at Old Lashio. The apex of the spire is in many instances incomplete.



Text-fig. 24.—Operculum of *Melanoides feegradei* (× 6) above, and that of *M. tuberculatus* below.

The affinities of this species are obscure. It resembles in some respects a variety of *M. montrouzeri* Gass., and in others the Sumatran *M. stricticosta* Martens. There seems to be a large number of known species having vertical ridges but without any obvious natural mutual relationship. *M. cancellata* from China is quite distinct from this species. It seems probable that these species have had a polyphyletic origin in the East. One of the African species *M. anomala* from the Belgian Congo resembles in one of its phases the present species, but the latter has its upper whorls less convex, and is subject to very little variation in external features, particularly in the sculpture.

The very young shells of this species have a superficial resemblance to the

Schistosome carrier *Oncomelania hupensis*, but may be distinguished from the latter by the nature of the outer lip which is not thickened.

Genus **Paludomus** Swainson.

1915. *Paludomus*, Preston, *op. cit.*, p. 38.
1921. *Paludomus*, Annandale, *op. cit.*, p. 562.

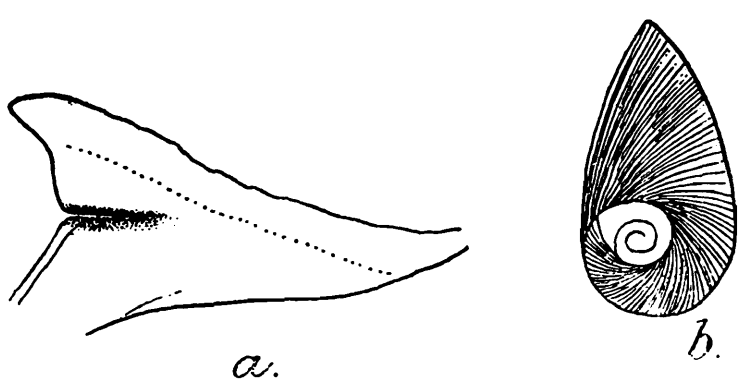
The Indian and Ceylonese species of this genus, of which a large number has been described, need a thorough revision. In the Burmese molluscan fauna this genus is well represented, but in point of richness of species South India and Ceylon come first, Assam comes second, and Burma last. It is noteworthy that like *Acrostoma* this genus has a limited distribution in the Indian Empire, and both genera have been recorded from almost the same areas.

In the form of the shell and operculum the genus is distinct. The mantle-edge bears a number of small processes, and in this respect the genus resembles *Melanoides* and differs from *Acrostoma*. The radular teeth do not differ materially from those of *Melanoides*.

Paludomus regulata Benson.

1856. *Paludomus regulata*, Benson, *Ann. Mag. Nat. Hist.*, Ser. 2, XVII, p. 496.
1877. *Paludomus andersoniana* var. *peguensis*, and *P. regulata*, Nevill, *Journ. As. Soc. Bengal*, XLVI, pp. 35-36.
1884. *Paludomus andersoniana*, Nevill, *op. cit.*, p. 290.
1910. *Paludomus andersoniana*, subsp. *peguensis* and *P. regulata*, Preston, *op. cit.*, pp. 41-42.

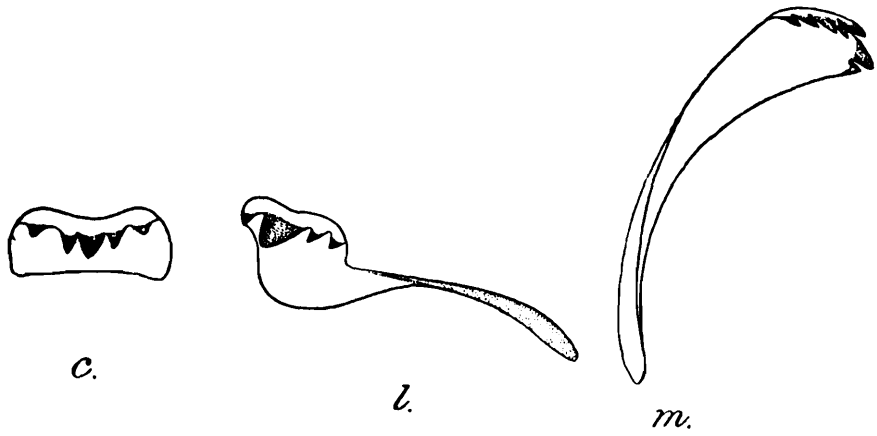
I have examined a large number of shells and opercula of *P. regulata*, *P. andersoniana* and its varieties from Burma preserved in the Indian Museum, and I am unable to find any constant differences between Benson's species and Nevill's. The points of difference in the operculum, on which Nevill laid emphasis, appear to be of no definite value in distinguishing the two species. There is no doubt considerable variation in the shape of the whorls, and in the colouration and sculpture of the shell. I think that Nevill's *P. andersoniana* should be treated as a synonym of Benson's *P. regulata*, or only as a form of *P. regulata*.



TEXT-FIG. 25.—*Melanoides feegradei*. *a.* gill-lamella, and *b.* operculum of advanced embryo.

Living as well as dead individuals of this species were obtained in small numbers in pools and streams, and on the banks of the Namtu river at Hsipaw. This seems to be the only record for the Northern

Shan States hitherto. The species appears, however, to be widely distributed in Upper and Lower Burma.



Text-fig. 26.—Radular teeth of *Melanoides feegradei*. *c.* central ; *l.* lateral ; *m.* marginal.

Family Limnaeidae.

Genus **Limnaea** Lamarck.

1925. *Limnaea*, Annandale and Rao, *Rec. Ind. Mus.*, XXVII, pp. 144-189, also pp. 103-107.

This genus is represented in the Northern Shan States chiefly by the groups *Pseudosuccinea* Baker and *Galba* Schrank. The occurrence of *Radix* Montfort is open to some doubt, while *Limnaea* (*s. s.*) has no representatives at all in this region.

The *Limnaea* fauna of the Northern Shan States appears to have no real affinity with that of the Inlé watershed or of the plains adjoining it, the only species common to both the areas being *L. luteola* and *L. andersoniana*. The former is well represented in India and Burma and the latter has a wide range in the hilly country extending from parts of Central Asia to Western China. *L. acuminata* seems to be extremely common in the Northern Shan States while it is very rare in the Southern Shan States.

The occurrence of *L. auricularia* in a subfossil condition makes it appear that the group *Radix*, to which it belongs, had probably a much wider range in Asia than it has at the present time, but the evidence based on the discovery of a single specimen seems to be rather inconclusive.

Limnaea auricularia (Linn).

1925. *Limnaea auricularia*, Annandale and Rao, *op. cit.*, p. 158.

A small shell of this species was found in a subfossil condition in sand on the banks of the Namtu river at Hsipaw. The spire is minute, less than half a millimeter high, and has two whorls. The bodywhorl is relatively very large. The anterior part of the outer lip and of the columella is somewhat incomplete. The columella is broad at its commencement above and narrows abruptly towards the anterior end.

The shell has the following dimensions in millimeters :

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
7·0	7·0	7·0	5·0

When examined under a lens the surface exhibits well-impressed longitudinal lines. The inside of the mouth is smooth and polished, but bears minute traces of the impressed lines on the outer surface.

The shell resembles in certain features some of the shells of this species from the Pleistocene beds of Great Britain.

Limnaea andersoniana Nevill.

1918. *Limnaea andersoniana*, Annandale, *Rec. Ind. Mus.* XIV, p. 106, pl. x, figs. 1-2.
1921. *Limnaea andersoniana*, Annandale and Prashad, *Rec. Ind. Mus.*, XXII, p. 574, pl. viii, figs. 1-6.
1925. *Limnaea andersoniana*, Annandale and Rao, *op. cit.*, p. 163.

The species occurs all over the Northern Shan States and also on the Chinese side of the Shweli river on the Sino-Burmese Frontier. The form *simulans* is of more common occurrence than the forma *typica*, a phenomenon which is, I believe, correlated with the type of environment in which they live. The whole country is traversed by a number of small streams which in the dry season appear to be suitable for the growth and propagation of this form. In this season the streams are shallow and have very little water in them, but have an abundance of soft mud covered with algal slime. This type of environment seems to be a favourable ground for the stream form to thrive in. The forma *typica* usually lives in ponds and tanks with phanerogamic vegetation, a type of environment which is not common on the Shan plateau.

Shells from the Northern Shan States are subject to considerable variation not only in form but also in texture. The soft parts do not exhibit any striking variation.

The form *brevios*, nov. described below appears to be endemic in this region.

Forma **typica** Nevill.

Several living specimens were obtained in Old Lashio, Kutkai, Namkham and Mankat mostly in muddy pools at the edge of streams. The bottom of the pools had in all cases either grass or aquatic vegetation of various kinds. A dead and bleached shell was picked up on the banks of a stream near Sukmun on the Lashio-Namtu road.

f. simulans Preston.

It is by far the commonest form in the sluggish streams of the Northern Shan States living specimens of which were found in various localities in the North and South Hsenwi States, at Namtu, and in Chinese territory near Selan.

f. **brevios,** nov.

It has a characteristic shell which differs in general facies from any of the other forms of the species. The spire is usually higher than broad at base and more than $\frac{1}{3}$ the height of the shell. There are five oblique moderately convex whorls which increase rapidly in size, and a conspicuous shell is formed outside the suture which is oblique and well

impressed. The outline of the spire is therefore interrupted. The bodywhorl is more oblique than the rest of the whorls. The mouth is relatively short, half as high as the shell, vertical, more or less oblong, rounded anteriorly, and dome-shaped posteriorly. The peristome is continuous ; the columella is broad and coarse, slightly depressed, and not markedly twisted at its commencement. The umbilicus is not visible when the shell is viewed from the dorsal side. The shell is thin but not brittle. The inside of the mouth is porcellaneous in appearance. The shell is of a yellowish brown colour.

The radular teeth are not very different from those of f. *simulans* but the central resembles that of f. *intermedia*.

Measurements in millimeters.

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.	
9·5	6·0	5·0	3·0	(long-spired).
9·0	6·2	5·5	3·0	(short-spired).

Type-series.—M. $\frac{12795}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Several living specimens were found in a sluggish channel on grass-clad hill-sides between Muse and Mongyu. The chief distinguishing feature of this form is in the abbreviated mouth with more or less straight sides and in the obliquity of the last whorl. There are shells with short spire and elongated mouth which approach the forma *typica*, but the character of the whorls serves to distinguish them from it.

Limnaea acuminata Lamarck.

1920. *Limnaea acuminata*, Annandale and Sewell, *Ind. Journ. Med. Research*, VIII, p. 110.
1925. *Limnaea acuminata*, Annandale and Rao, *op. cit.*, p. 177, also fig. iii on p. 156.

Excepting a single doubtful record from an uncertain locality in the Northern Shan States the species was altogether unknown from the Shan plateau. The hitherto known Northern limit of its range in Burma was Mandalay, and perhaps Bhamo ; but the species was, however, recorded from several places in Lower Burma. It has not only a wide distribution in the Northern Shan States but also an extensive range upto South-West China.

Forma **typica** Lamarck.

1921. *Limnaea acuminata*, Annandale and Prashad, *Rec. Ind. Mus.*, XXII, p. 568, fig. 12a, b.

Living specimens of this form were obtained in shallow sluggish streams full of weeds at Mongyai in South Hsenwi State and at Hsipaw in the Shan State which bears the same name. Dead shells were also picked up on the banks of the Namtu river at Hsenwi and Hsipaw.

f. **patula** Troschel.

1925. *Limnaea acuminata* f. *patula*, Annandale and Rao, *op. cit.*, p. 181.

This form is very common in the Northern Shan States in sluggish streams or in pords containing weeds such as *Elodea*, *Potamogeton* and *Vallisneria*. In a small weedy stream about 3 miles South-east of Kutkai which flows from a deep pond above it, specimens of this form were found in all stages of growth in such large numbers that the weeds were practically covered over by them. It was the month of December and probably the close of the breeding season.

f. **hians** Sowerby.

1915. *Limnaea (Gulnaria) hians*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 113.
1925. *Limnaea acuminata* f. *hians*, Annandale and Rao, *op. cit.*, p. 182.

A few specimens of this form were found in isolated ponds at Lashio and Hsenwi. They have no deposit of any kind on the shell and no deep tint. In sculpture and polish they approach shells of this form from India.

f. **rufescens** Gray.

1876. *Limnaea rufescens*, Hanley and Theobald, *Conch. Ind.*, p. 30, pl. lxix, figs. 1-4.
1925. *Limnaea acuminata* f. *rufescens*, Annandale and Rao, *op. cit.*, p. 181.

This form is apparently rare in the Northern Shan States. It has been found in very small numbers in pools and channels amongst fields on the North bank of the Shweli river near Namkham and Kawngmu.

Limnaea yunnanensis Nevill.

1923. *Limnaea yunnanensis*, Annandale, *Journ. As. Soc. Bengal*, (N. S.), XIX, p. 417, figs. 1-3.

Two small living specimens were taken in a pool on the North bank of the Shweli river near Namkham. They are smaller than the type-specimen but have the essential features of the species in the outer lip. A few specimens taken on the Chinese Frontier near Selan have a relatively rough sculpture and short spire, and their outer lip more arched. They seem to form a good link between the species and the f. *distensa* Annandale described from Yunnan. The species is apparently common in Yunnan, but has not established itself in the Northern Shan States.

Limnaea luteola f. **siamensis** Sowerby.

1878. *Limnaea luteolus* var., Nevill, *Hand List Moll. Ind. Mus.*, I, p. 233.
1925. *Limnaea luteola* f. *siamensis*, Annandale and Rao, *op. cit.*, p. 107, also p. 185, fig. iv, 5-6.

The distribution of this form in Burma is not fully known. It has hitherto been recorded from Lower Burma and the Southern Shan States.

Specimens from the Northern Shan States were obtained on the Chinese Frontier near Kawngmu, at Mongyin, and at Hsipaw. In the

last named locality individuals were found living in large numbers in a small muddy pool choked with weeds. They have a relatively rough sculpture and a fine deposit of mud on the shell.

Family Planorbidae.

This family is represented in the Northern Shan States by three species belonging to three different genera. *Indoplanorbis* has only one species widely distributed in India and Burma. In the other two genera, *e.g.*, *Gyraulus* and *Segmentina* a large number of species has been described, but the Indian and Burmese species are few and are easily recognised by characteristic conchological features.

Genus **Indoplanorbis** Annandale and Prashad.

1922. *Indoplanorbis*, Annandale, *Rec. Ind. Mus.*, XXIV, p. 360.

Indoplanorbis exustus (Deshayes).

1925. *Indoplanorbis exustus*, Annandale and Rao, *Rec. Ind. Mus.*, XXVII, p. 108.

This species is common all over the level tracts of the Northern Shan States in ponds and sluggish streams. The shells vary in colour and sculpture. Some have a dark deposit which gives them a rough appearance while others are smooth and yellowish to chestnut-brown in colour.

The species has a wide distribution in the Indian Empire, and further East from Siam to Sumatra.

Genus **Gyraulus** Agassiz.

1922. *Gyraulus*, Germain, *Rec. Ind. Mus.*, XXI, p. 98.

The specific limits of the forms assigned to this genus are not definite. The Indian species not only overlap one another in certain features, but also seem to be closely allied to some of the European species.

Gyraulus convexiusculus (Hutton).

1918. *Planorbis saigonensis*, Annandale, *Mem. As. Soc. Bengal*, VI, p. 304.
1919. *Gyraulus convexiusculus*, Annandale and Prashad, *Rec. Ind. Mus.*, XVIII, pp. 52-54.
1922. *Planorbis (Gyraulus) saigonensis*, Germain, *op. cit.*, p. 119.

The species is found all over the Northern Shan States not only in the river valleys but also in streams at higher altitudes. Individuals are variable in colour and in the angulation of the last whorl. The peripheral angle on the last whorl is moderately developed, but in some it is feeble as in those from Inailong in North Hsenwi, while in individuals from Mongyai in South Hsenwi it is prominently developed.

The species thrives in weedy ponds and streams, but in one instance it was found under stones in a hill-stream South of Namkham. It occurs in a subfossil condition in sand on the banks of the Namtu river at Hsenwi. At Mongyu near the Chinese Frontier an abnormal specimen with a continuous, somewhat thickened lip was taken along with a few smaller normal individuals. In some shells from Mongyai and Hsenwi the inside of the mouth is polished, cream or pearl white in colour, and

has often a slight ridge a little to the inside of the margin of the upper lip which gives it some resemblance to *G. labiatus* (Benson), but in size and in the number and character of the whorls they do not approach the latter species.

G. convexiusculus seems to be common on the Shan plateau both in the living and in the subfossil condition. It has a very wide geographical range in the Oriental region.

Gyraulus euphraticus (Mousson).

1919. *Gyraulus euphraticus*, Annandale and Prashad, *op. cit.*, pp. 54-56.

Several living specimens of this species were taken in a small pond in the Police Garden, Lashio. The shell-form is not quite typical, but the radular teeth agree very well with those figured by the authors in the work cited (fig. 8 A).

The species has been recorded from Seistan in Persia, and from several localities in Northern India. Its occurrence in Burma is noteworthy, and the species has probably a wide range extending further East into China.

Genus **Segmentina** Fleming.

1923. *Segmentina*, Germain, *Rec. Ind. Mus.*, XXI, p. 163.

This genus is represented by *S. calathus* (Benson) in the Northern Shan States. *S. caenosus* (Benson) which seems to be of common occurrence in the Southern Shan States was not found in the Northern States. The distinguishing feature of the latter species lies in the rapidly increasing whorls, and in the depressed form of the shell. Benson did not observe the internal laminae in the shell. Specimens from the Southern Shan States have feebly developed laminae.

Segmentina calathus (Benson).

1923. *Segmentina calatha*, Germain, *op. cit.*, p. 168.

Several living specimens were found in a weedy tank in Mongyai, South Hsenwi. The larger specimens have a bright amber or reddish colour, and the smaller ones a lighter shade of yellow or amber. There are longitudinal whitish bands on some of the older shells. The umbilicus and the internal laminae are rather prominent. A few shells were also taken in a subfossil condition in sand on the banks of the Namtu river at Hsenwi.

The species has been recorded from Seistan, Northern India, Ceylon, Burma and Sumatra.

Family ANCYLIDAE.

The species of this family are, on account of their small size, liable to be overlooked in the field or lost in large collections, and their extreme fragility renders their examination somewhat difficult. The Indian and Ceylonese species of this family belong to the genus *Ferrissia* Walker, and seem to be widely distributed. They have been hitherto recorded from Assam, Bengal, Bihar and Orissa, Burma, Bombay, Ceylon and Southern India.

Genus **Ferrissia** Walker.

1921. *Ancylus*, Annandale and Prashad, *Rec. Ind. Mus.*, XXII, p. 588.
1925. *Ferrissia*, Annandale and Rao, *Rec. Ind. Mus.*, XXVII, p. 112.

The species referred to by Annandale and Prashad in the reference cited belong to the present genus. They seem to be more or less closely allied to one another, and the only reliable characters on which the species seem to be based are to be found in the colour and form of the shell. From the Shan States only two species, namely *F verruca* and *F baconi* are known. The latter was found in a subfossil condition in the Southern Shan States, and the former in a living condition in hill streams of the Northern Shan States.

Ferrissia verruca (Benson).

1915. *Ancylus verruca*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 105.
1921. *Ancylus (Ferrissia) verruca*, Annandale and Prashad, *op. cit.*, p. 589.

Several living individuals were taken in hill streams at Kutkai and Namkham. In the former place they were found in large numbers on submerged aquatic plants at the edge of the Nam Teng river. At Namkham they were found concealed under stones in shallow, torrential streams flowing down the Loi-lun range of hills. The shells are subject to considerable variation in colour and sculpture. The larger ones are pale and have a coating of algae which obscures the minute sculpture ; the smaller shells are yellowish brown, transparent, and have well developed sculpture.

A small bleached subfossil shell was taken in sand at the edge of a stream near Mongyin.

The species seems to be widely distributed in India, Burma and Ceylon.

Family Succineidae.

The Burmese species of this family are little known, but the few hitherto recorded from Burma seem to have a wide distribution in that country as well as in India. They are represented by the genera *Succinea* Draparnaud and *Indosuccinea* Rao. Two species of the latter, namely *I. semiserica* and *I. plicata* have been recorded from parts of Lower Burma, but none hitherto from the Shan States or from any part of Upper Burma.

Succinea Draparnaud.

1924. *Succinea*, Rao, *Rec. Ind. Mus.*, XXVI, p. 377.

This genus is represented by six species in the Shan States, of which three, *viz.*, *S. indica* Pfeiffer, *S. limnaeiformis* Rao and *S. godivariana* Gude were recorded previously from the Southern Shan States.[1] The last named species was found only in a subfossil condition. In the course of the Mollusc Survey only three species of *Succinea* were found without any previous record from the Southern Shan States or any other part of Burma.

[1] Rao, *Rec. Ind. Mus.*, XXVI, pp. 380, 382, 405-406 (1924).

Succinea elegantior Annandale.

1921. *Succinea elegantior*, Amin-ud-Din, *Rec. Ind. Mus.*, XXII, pp. 593-598, figs. 20, 21 (1), 22-24.
1924. *Succinea elegantior*, Rao, *op. cit.*, p. 386, and fig. 1F.

A few living specimens of this species were found in a village in the Chinese Frontier province of Mengmao on the North bank of the Shweli river near Muse. They were crawling timidly on wet ground overhung by grass and other weeds close to a channel flowing out from the North bank of the Shweli river.

The shells are smaller and of a much lighter colour than those from Manipur. The jaw, radula and genitalia do not show any marked variation.

The following particulars are reproduced from the field-book: " The animal is of a pale colour with the sides and front of the anterior end and the neck speckled black, while its mantle is minutely spotted black. A dark stripe runs from each eye obliquely downwards over the neck."

The species was first described from the Manipur valley in Assam, and since its discovery in 1920 is now recorded for the second time. The range of the species probably extends from Assam to Western and Southern China through Upper Burma and the Northern Shan States.

Succinea rutilans Blanford.

1914. *Succinea rutilans*, Gude, *Faun. Brit. Ind. Moll.*, II, p. 448.
1924. *Succinea rutilans*, Rao, *op. cit.*, p. 404, fig. 4.

This appears to be the commonest *Succinea* in the Northern Shan States. Living specimens were found in large numbers in damp places near the edge of rivers and streams in level tracts at altitudes not exceeding 2,500 feet above sea-level. In the valley of the Shweli river a few specimens were taken at Namkham, Selan, and a village in the Chinese province Mengmao near Muse, but in Mongyai and Hsipaw in the Southern part of the Northern Shan States the species was relatively more abundant.

In size the shells are slightly larger than those hitherto recorded. The colour seems to vary from a light olive brown to a reddish or a yellowish amber colour. The proportion of the spire to the bodywhorl is subject to slight variation.

The following notes on the colour of the animal are reproduced from the field-book. " The anterior part has irregular black spots while the posterior has lighter radiating stripes. Each of the posterior pair of tentacles has a black stripe extending on the dorsal side from its tip down to the head and neck. In the front of the head there is a V-shaped mark the arms of which are flanked on the outside by a dark line from the base of the tentacles. The anterior pair of tentacles is short, stumpy and often tubercular in appearance. The underside of the foot is dirty yellow in colour, and the visceral hump black."

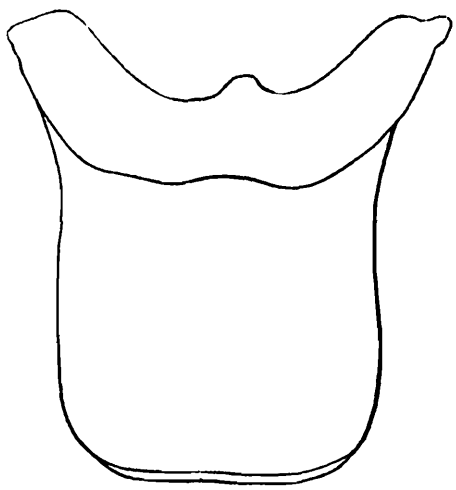
The jaw is apparently subject to some variability. In the Shan specimens there is a prominent median projection on the cutting margin which is absent in the individuals from Assam. The radular teeth also show slight variations in the central and the marginals. The genitalia agree in the main with those of the Manipur individuals figured by

Amin-ud-Din.[1] The male and female ducts are, however, quite distinct up to their external openings and not united as shown in his figure. The muscular nature of the terminal part of the genitalia often renders this portion opaque and obscures the distinctness of the ducts. The duct of the spermatheca opens more than half way down the female duct.

The species seems to have a wide distribution in Burma, especially in the valleys of hill-districts. Its occurrence in Assam, Singapore, Shan States and Yunnan is noteworthy. Upper Burma is probably its headquarters from which it has spread West into Assam, East into the Southern part of China, and South into the Malay Peninsula. The species has not been found further West of the Manipur valley in Assam, or in any other part of India.

Succinea daucina f. **burmanica,** nov.

The shell of this form is smaller in size than that of *S. daucina* or its form *hraswasikhara*, and in form is somewhat intermediate between the two. It differs from the former in its relatively short spire, less impressed suture, and in the more even arch of the outer lip, and from the latter in having a less swollen bodywhorl, and a relatively high penultimate whorl which is about as broad as high. The suture is oblique and moderately impressed. In sculpture and colour the shell does not differ from *S. daucina.*



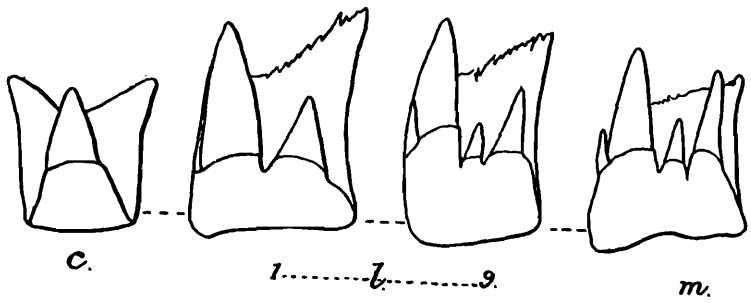
Text-fig. 27.—Jaw of *Succinea daucina* f. *burmanica.*

The soft parts somewhat closely resemble those of *S. rutilans.* The jaw is quadrate or rarely slightly longer than broad. The cutting piece has short arms which, however, project outwards and are more or less produced at their extremity. The cutting margin has a median conical projection.

The radular teeth also conform to the type found in *S. rutilans.* The central has traces of lateral basal denticulations. The laterals are more or less uniform and have sharp elongate conical cusps. The marginals have as a rule four cusps, the entocone being strongly developed.

[1] Amin-ud-Din, *Rec. Ind. Mus.*, XXII, p. 595, fig. 21, 2a and 2b (1921).

The first and third cusps are usually short. The upper margin of the basal plate is oblique and crenulated.



Text-fig. 28.—Radular teeth of *Succinea daucina* f. *burmanica*. *c.* central, *l.* laterals, *m.* marginal.

The genitalia agree in every detail with those of *S. rutilans*.

The largest shell in the collection has the following measurements in millimeters :

Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
7·5	5·0	4·5	3·5

Type-series.—M. $\frac{12813}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

This form was found in small numbers in a living state at Hsenwi and Old Lashio. In the latter place they were found crawling on dry twigs on the banks of a dried-up stream on the road to Hsenwi. The muddy bottom contained large numbers of *Limnaea andersoniana* f. *simulans* in a more or less torpid condition. At Hsenwi a few individuals were taken in roadside ponds and streams choked with weeds. A small shell in a subfossil state was picked up in sand on the banks of the Namtu river at Hsenwi.

From the known records of *Succinea daucina* its distribution seems to be rather restricted, but the close relationship which is apparent between this species and *S. rutilans* seems to suggest that the former may prove to be at least as widely distributed as the latter. Nevill's record of *S. daucina* from Madras is open to doubt. The Madras specimen is probably a form of *S. gravelyi* recorded from Adyar near Madras. *S. daucina* has been hitherto recorded from Calcutta and Port Canning in Lower Bengal.

LAMELLIBRANCHIA.

In the course of the Mollusc Survey a few species of bivalves were also collected. With the exception of one or two species they were not found in large numbers. In the collection from the Northern Shan States this class is represented by two families, *viz.*, the Unionidae and the Cyrenidae. Dr. Baini Prashad who has made an extensive study of the freshwater bivalves has been kind enough to name the entire collection, for which my sincere thanks are due to him.

Family Unionidae.

The members of this family are all inhabitants of freshwater areas and are commonly found in temperate and tropical regions of the world. In the Northern Shan States six species belonging to four genera were found.

Genus **Indonaia** Prashad.

1918. *Indonaia*, Prashad, *Rec. Ind. Mus.*, XV, pp. 146-148, fig. 2.

Indonaia bonneaudi (Eydoux).

1838. *Unio bonneaudi*, Eydoux, *Mag. de Zool.* V, pp. 10, 11, pl. 119, figs. 1, 1a.
1914. *Nodularia* (*Nodularia*) *bonneaudi*, Simpson, *Descr. Cat. Naiades*, p. 988.

Four individuals of this species were obtained in the living condition in wet sand on the North bank of the Shweli river near Selan within a few yards of the Chinese Frontier village, Tenglun. Their presence in the sand was marked by traces of their furrows.

The distribution of this species in Burma seems to be very wide. It has also been recorded from Manipur and Cachar in Assam.

Indonaia caerulea (Lea).

1792. *Unio caeruleus*, Lea, *Trans. Amer. Phil. Soc.*, IV, p. 95, pl. xiii, fig. 25.

A few specimens of this species were found in the living condition at Namkham, and in a village in Mengmao province near Muse. At the former place four specimens were taken in wet sand of the Shweli river near the North bank. They left long trails in the sand at the end of which they were found buried. At the latter place they were picked up in pools which were partially dried. Near Selan a few dead shells were taken at the edge of the river Shweli.

The species seems to have a wide distribution in North and Central India, and its range extends up to Assam. There has hitherto been no record of the species from Burma.

Genus **Lamellidens** Simpson.

1900. *Lamellidens*, Simpson, *Proc. U. S. Nat. Mus.*, XXII, p. 854.
1921. *Lamellidens*, Prashad, *Rec. Ind. Mus.*, XXII, p. 605.

Lamellidens lamellatus (Lea).

1830. *Unio lamellatus*, Lea, *Trans. Amer. Phil. Soc.*, VI, p. 19, pl. vi, fig. 16.

A single living specimen was taken at the bottom of a small stream near Muse. A few dead shells of this species were also picked up in thick clay of a creek close to the Southern bank of the Shweli river near Selan.

The species has been previously recorded from parts of Upper and Lower Burma, and from Bengal and Ceylon. It has not been found hitherto in the Shan States.

Genus **Trapezoideus** Simpson.

1900. *Trapezoideus*, Simpson, *op. cit.*, p. 858.
1921. *Trapezoideus*, Prashad, *op. cit.*, p. 609.

Trapezoideus foliaceus (Gould).

1843. *Unio foliacea,* Gould, *Proc. Boston Nat. Hist. Soc.,* I, p. 141.

The species was found living in streams at Mankat and Tangyan in the South Hsenwi State. A few dead shells were picked up on the banks of the Namtu river at Hsenwi and of a tributary to the Namyao near Old Lashio.

The occurrence of the species in Burma has been previously recorded from Bhamo in the North and Tavoy in the South, but from the Shan States it is presumably recorded for the first time.

Trapezoideus dallianus (Frierson).

1913. *Parreysia dalliana,* Frierson, *Nautilus,* XXVI, p. 142.
1922. *Trapezoideus dallianus,* Prashad, *Rec. Ind. Mus.,* XXIV, p. 110.

Two complete specimens in a subfossil state were found in sand on the banks of the Namtu river at Hsenwi.

Genus **Parreysia** Conrad.

1853. *Parreysia,* Conrad, *Proc. Acad. Nat. Sci. Philadelphia,* VI, p. 267.

Parreyssia bhamoensis (Theobald).

1873. *Unio bhamoensis,* Theobald, *Journ. As. Soc. Bengal,* XLII, p. 207, pl. xvii, fig. 1.
1922. *Parreyssia bhamoensis,* Prashad, *op. cit.,* p. 100.

Two fairly large right valves of this species were taken at the edge of the Namtu river at Namtu. The inner surface of each is beautifully nacreous, but the outer is much worn.

The species has been previously recorded from Bhamo in Upper Burma, and Pegu in Lower Burma. It is probably a rare species.

Family CYRENIDAE.

This family is represented in the Northern Shan States by four species belonging to the genera *Corbicula, Sphaerium,* and *Pisidium.*

Genus **Corbicula** Megerle von Mühlfeldt.

1811. *Corbicula,* Megerle von Mühlfeldt, *Mag. Gesell. Naturf. Berlin,* V, p. 56.

The synonymy of Indian species included in the genus is in a state of confusion, and the numerous species described from this region merge into one another imperceptibly. My colleague, Dr. Baini Prashad who has studied the question in detail, proposes to discuss the synonymy of Oriental species in a monograph which is in preparation.

Corbicula striatella Deshayes.

1854. *Corbicula striatella,* Deshayes, *Proc. Zool. Soc. London,* XXII, p. 344.

This is by far the commonest species of bivalve found in the Northern Shan States, particularly in the valleys of the Namtu and the Nam Pang rivers. Several living specimens were found at the bottom of muddy and sluggish streams free from vegetation in the neighbourhood of

Mongyai, Mankat, and Hsipaw. A few dead shells were obtained on the edge of streams at Kawngmu, Tangyan, and Old Lashio.

The species has a wide range in India and Burma.

Corbicula nöetlingi v. Martens.

1899. *Corbicula Nöetlingi*, v. Martens, *Arch. Naturg. Berlin*, LXV, p. 47, pl. iv, figs. 7-9.
1918. *Corbicula noetlingi*, Annandale, *Rec. Ind. Mus.*, XIV, p. 141, pl. xix, fig. 12.

The species was found in large numbers in a stream coming off the Shweli river on its Northern bank near a village in Mengmao province, close to Muse. A few specimens were taken in weedy road-side channels and pools at Hsenwi. Several dead shells were obtained on the banks of the Namtu river at Hsenwi and Hsipaw, and at the edge of a stream near Sukmun station on the Burma Corporation Railway.

The species is probably endemic in the Shan States, and has a wide range in this region. It was first described from the Northern Shan States.

Genus **Sphaerium** Scopoli.

1777. *Sphaerium*, Scopoli, *Introduction Nat. Hist.*, p. 397.

Sphaerium montanum Tapparone-Canefri.

1889. *Sphaerium montanum*, Tapparone-Canefri, *Ann. Mus. Civ. Stor. N t. Genova*, (2) VII, p. 356.

This species appears to be common at the bottom of muddy streams or pools in the Northern Shan States. Several specimens were taken at Selan, Mongyu (near the Chinese Frontier), Hosi, Kutkai, and Mongyai.

The range of the species is probably restricted to Burma.

Genus **Pisidium** Pfeiffer.

1821. *Pisidium*, Pfeiffer, *Naturges. deuts. Land und Süssw. Moll.*, I, p. 123, pl. i, fig. 19.
1925. *Pisidium*, Prashad, *Rec. Ind. Mus.*, XXVII, p. 407.

Pisidium clarckeanum G. & H. Nevill.

1871. *Pisidium clarkeanum*, G. & H. Nevill, *Journ. As. Soc. Bengal*, XL, p. 9, pl. i, figs. 4, 4*a-d*.
1921. *Pisidium clarkeanum*, Prashad, *Rec. Ind. Mus.*, XXII, p. 618.
1925. *Pisidium clarckeanum*, Prashad, *op. cit.*, pp. 408-412, pls. vii, viii.

The species was found in small numbers in mud at the edge of streams and pools at Mongyu, Kutkai, Hsenwi, Hsipaw and Mongyai. It is noteworthy that no specimens of this species were found in the Shweli valley on the Chinese Frontier.

The species appears to have a wide range extending from Bombay and the United Provinces to Assam and Burma.

General considerations.

The molluscs of the Northern Shan States are found in two different types of environment, namely areas of flowing water such as streams and

rivers, and areas of standing water such as pools and tanks. The smaller streams, and the pools and tanks contain aquatic vegetation amongst which several of the smaller species of molluscs live. A few species of Gastropods and many of the Lamellibranchs are found concealed in the mud at the bottom.

Hill-streams do not, as a rule, serve as favourable haunts for molluscs, but a few species seem to be well adapted for life in hill-streams subject to torrents in the rains and to partial desiccation in the dry weather. The representatives of this group in the Northern Shan States belong to the genera *Neritina, Paludomus*, and *Ferrissia.* The first is represented by an undetermined species found only in the subfossil state in the Namtu valley. *Paludomus regulata* has a single record at Hsipaw in the same valley. *Ferrissia verruca* was the only species which was found living in a hill-stream on the western lower slopes of the Loi-lun range of hills. It also occurs living in the uplands of Kutkai, and in a subfossil state in a sandy deposit on the banks of the Nam Sawn, a tributary to the Namtu river near Mongyin.

The fluviatile mollusc fauna of the river valleys and the uplands is by far the best represented, and most of the species collected belong to this type. But there is no uniformity in the distribution of species in various localities. There are certain species which are confined to one particular locality and not found elsewhere. In the valley of the Shweli for instance no species of *Taia* or *Acrostoma* were found. The valley of the Namtu, however, is rich in species which are more or less widely distributed in the Northern Shan States. Certain species are, however, peculiar to this valley. Again the Rissoid subfamilies Triculinae and Amnicolinae seem to be restricted to certain areas, chiefly the uplands. Our knowledge of the mollusc fauna of the Northern Shan States is still so imperfect that it is hardly safe to generalise or to attach any significance to available data.

The mollusc fauna of the Northern Shan States may now be considered under two different heads: (1) the subfossil, and (2) the living. In the course of my tour in the Northern Shan States I did not come across any lake or cave deposits. Superficial deposits consisting of sand and particles of calcareous matter are found on the banks of rivers in the valleys of the Shweli and the Namtu. Several species of molluscs were found in these deposits, but there were only a few which could be called " subfossil " in the strict sense of the word. The remaining species though found in these deposits had their living representatives in other parts of the Shan States or in Burma outside the limits of the Shan plateau.

The following list includes subfossil species, or forms and varieties of species of which no living individuals were seen or collected in any area, in or outside the Shan States :

Neritina sp.
Taia aspercallosa var. *brookesi.*
Hydrobioides namtua.
Tricula horae var. *major.*
Limnaea auricularia.
Acrostoma baccata f. *pyramidalis.*
" " f. *recta.*
" *baccifera.*
" *kubja.*
Trapezoideus dallianus.

With the exception of *Taia* and *Hydrobioides* all the other genera are represented by species both in India and Burma. Of the species listed above *T horae* var. *major*, *Trapezoideus dallianus* and the species of *Acrostoma* have not been found outside Burma. *Limnaea auricularia* is found in Kashmir and is palaearctic in distribution. Living species of *Neritina* have hitherto been recorded from various parts of India, Burma and Ceylon.

Though these species occurred only in a subfossil state in the region at the time that we surveyed, it is possible that they occur in the living state at other favourable seasons, and in other parts of the Northern Shan States.

The species found living in the Northern Shan States are not all peculiar to this area or even to Burma in general. Taking the Viviparids into consideration we find that there are some species which are common to Burma and to some parts of India. *Taia theobaldi* is apparently a species peculiar to the Shan plateau, and perhaps the dominant species of *Taia* found in the Northern Shan States. With the exception of the f. *globosa*, which occurs also in the Southern Shan States, all the other forms, varieties and races of *T theobaldi* seem to be characteristic of the Northern Shan States. *Taia aspercallosa* marks a fresh line of evolution in shell-sculpture and form in the genus, and is probably endemic in the Namtu valley. *Vivipara bengalensis* is represented by the Burmese race *doliaris*. The form *balteata* is Assamese, and its occurrence in Burma is recorded for the first time. *V dissimilis* is common to both India and Burma, but the Burmese forms are distinct. The species of *Cipangopaludina* are widely distributed in the Far East, but some are peculiar to China. In the mollusc fauna of India this genus is probably a fresh intruder, as but one species has hitherto been recorded in Assam alone. Of the Ampullarids *P. theobaldi* is a purely Burmese species, and perhaps also the var. *compacta* of *P. conica*.

The freshwater Rissoidae are all Burmese, and with the exception of *Bulimus pygmaea*, all species seem to be restricted to the Shan plateau. *Tricula gregoriana* is, however, a Chinese species. It was first recorded from Yunnan.

Among the Tiaridae *M. tuberculata* has a very wide distribution in the Oriental region, and *Paludomus regulata* is common in Upper and Lower Burma. All other species are peculiar to the Shan States.

In the family Limnaeidae *L. andersoniana* f. *brevios*, *L. luteola* f. *siamensis* are found only in Burma, the former restricted to the Northern Shan States. *L. yunnanensis* is a Chinese species. All the others have a wide distribution in the Indian Empire.

Among the Planorbidae and the Ancylidae there are no species peculiar to the Northern Shan States or even to Burma in general.

The Succineids recorded from Burma are not characteristic of that region. *S. daucina* and *S. rutilans* are found in India, Burma, and probably still further East. *S. elegantior* was first described from Manipur in Assam, and is now recorded from the Chinese Frontier.

There are a few species of bivalves which are purely Burmese, but the rest are common to India and Burma.

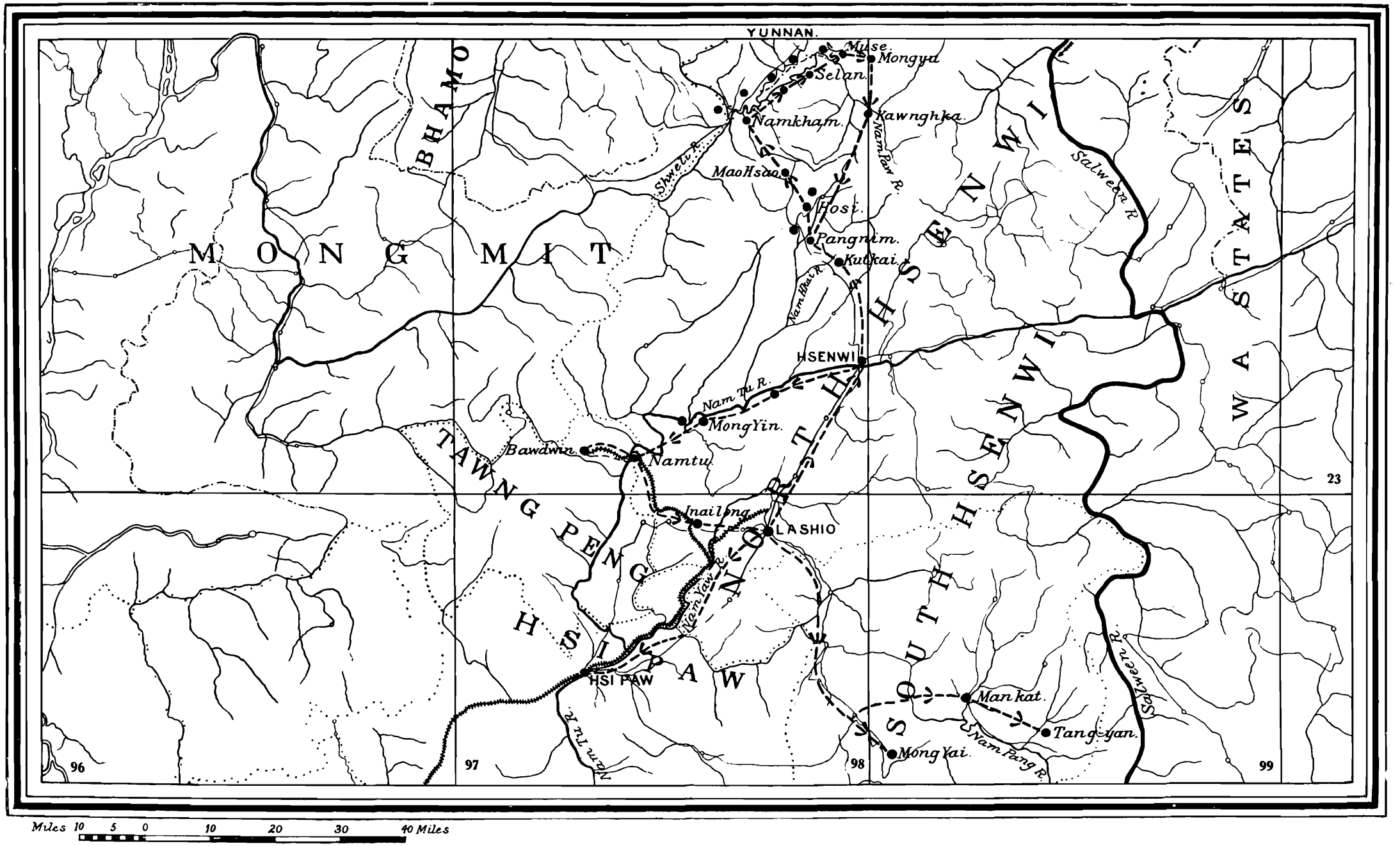
The Chinese element in the mollusc fauna is almost negligible. The characteristic Chinese species of the Delavayidae are not found in the living condition in the Northern Shan States. The Stenothyrinae, the Lithoglyphinae, and the Pomatiopsinae among the Rissoidae, the genus *Semisulcospira* among the Tiaridae, the group Viviparae Angulares and the characteristic Chinese genus *Margarya* among the Viviparidae have not been recorded hitherto from any part of the Shan plateau.

Reviewing the mollusc fauna of the Northern Shan States as a whole it is found that a considerable proportion of the species recorded is common to both India and Burma, and that the proportion of endemic species is very small.

Comparing the mollusc fauna of the Northern and Southern Shan States so far as it is known one finds certain striking differences, but taking into consideration the divergence in physical features of the two regions, and the fact that the majority of the species known from the latter are of lacustrine origin, the differences in the character of the fauna need not be unduly emphasised. But one fact stands out clearly, namely that the number of species found in the plains of the river valleys and in the lakes is much higher than that represented in the water courses of the hills and uplands.

EXPLANATION OF PLATE XII.

Map of the Northern Shan States. The thick broken line indicates the route taken by the Mollusc Survey party and the circular dark spots the places visited. The names of only the more important places are given.



Map of the Northern Shan States.

EXPLANATION OF PLATE XIII.

The vertical line next to or between the different views of the shells shows the actual height of the specimen.

Taia theobaldi f. *globosa*, nov.

FIG. 1.—Type-specimen from Mankat, S. Hsenwi State.

Taia theobaldi f. *niger*, nov.

„ 2.—One of the type-series from Mongyin, N. Hsenwi State.

Cipangopaludina lecythis f. *purpureus*, nov.

„ 3.—One of the type-series from rice-fields between Mongpa and Mongyin.

Cipangopaludina lecythis f. *crassispiralis*, nov.

„ 4.—One of the type-series from Mongyin, N. Hsenwi State.

Acrostoma kubja, sp. nov.

„ 5.—A broad shell from the type-series from Hsipaw.

„ 6.—An elongate narrow shell from the same lot as above.

„ 7.—Dorsal and ventral views of a shell with prominent sculpture.

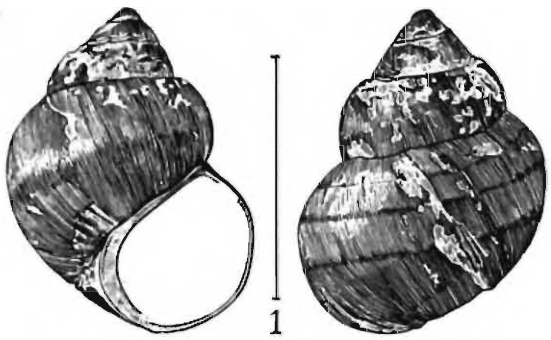
„ 8.—A very young shell from the type-series.

Succinea daucina f. *burmanica*, nov.

„ 9.—Type-specimen from Old Lashio.

Limnaea andersoniana f. *brevios*, nov.

„ 10, 11.—Two shells from the type-series from the hill-sides between Muse and Mongyu.



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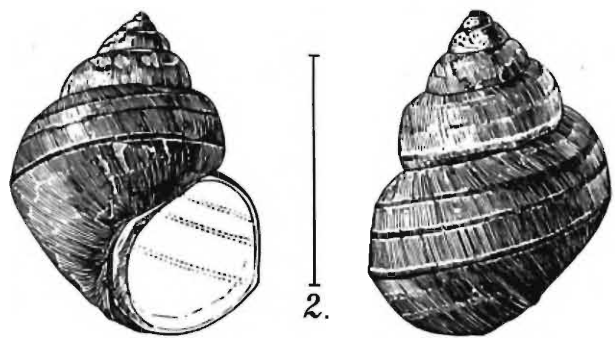

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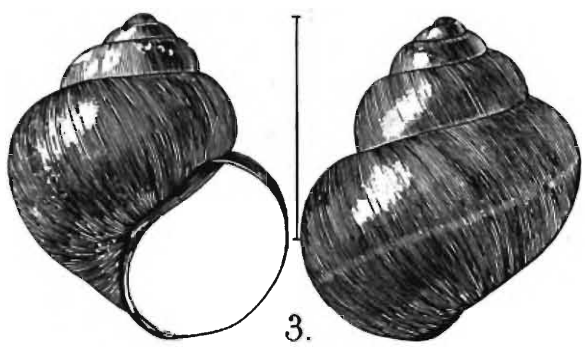

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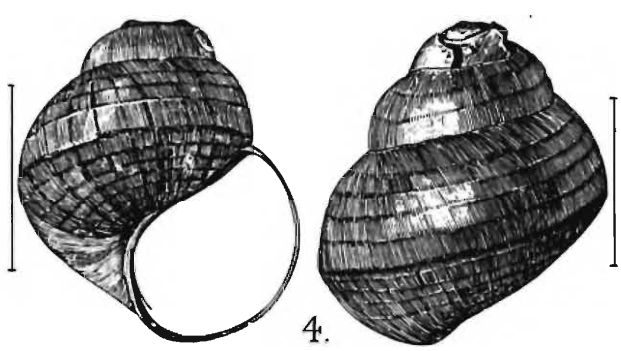

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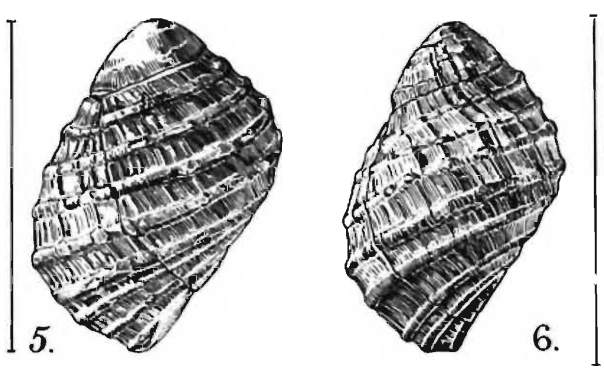

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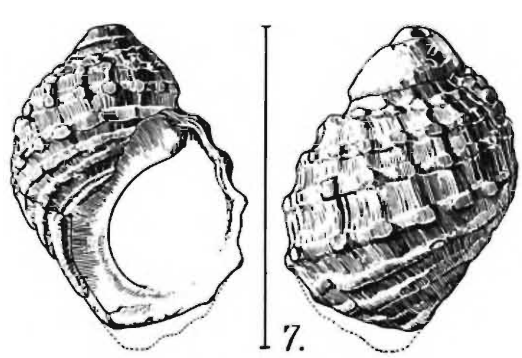

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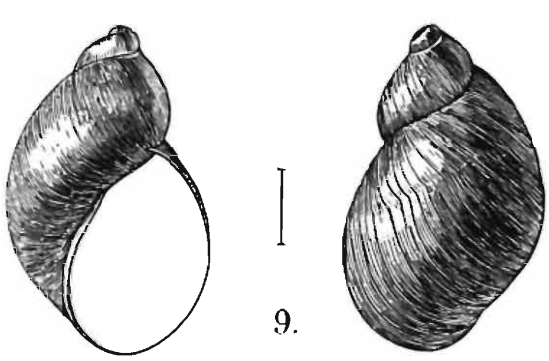
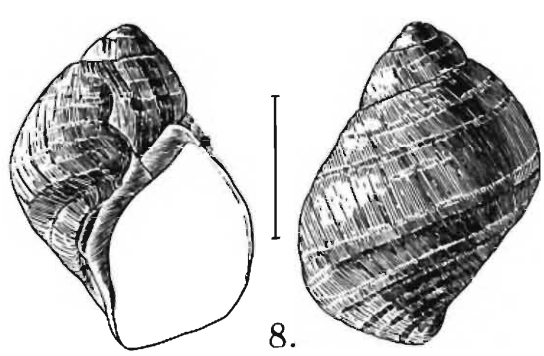


9.



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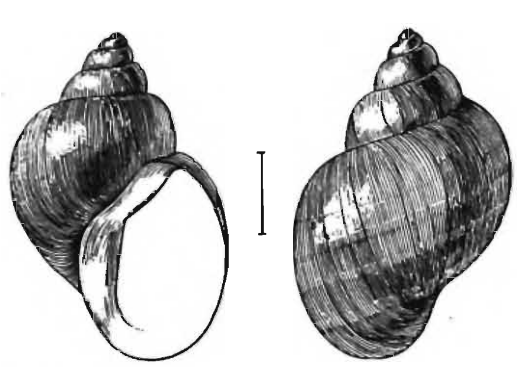

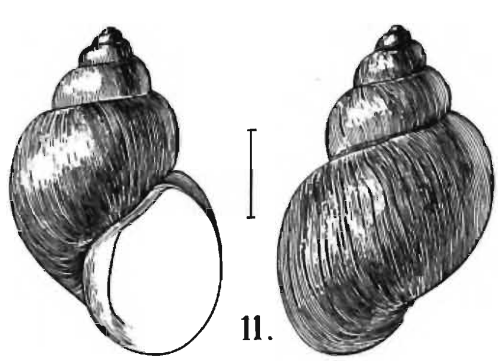

11.

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EXPLANATION OF PLATE XIV

The vertical line next to or between the different views of the shells shows the actual height of the specimen.

Taia theobaldi var. *leonardi*, nov.

FIG. 1.—From a pool 3 miles S. East of Kutkai, N. Hsenwi State.
„ 2.—A slightly younger shell from the same locality.

Taia theobaldi race *hsenwia*, nov.

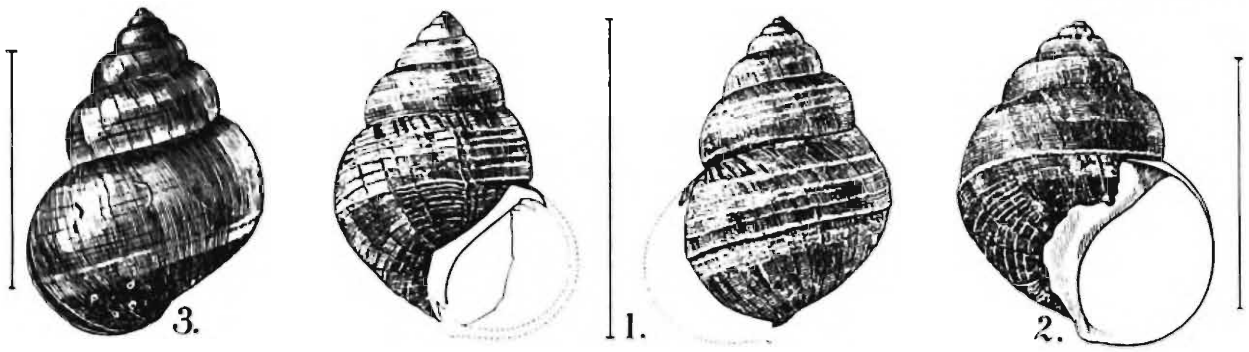
„ 3, 4.—Shells from a stream on the Kutkai-Hsenwi mule-track.
„ 5.—Dead shell from Sukmun, N. Hsenwi State.
„ 6.—Shell from a stream near Pangnim, N. Hsenwi State.
„ 7.—Shell from a stream near Mongyu, N. Hsenwi State.
„ 8.—One of the type-series from the Nam Teng R., Kutkai.

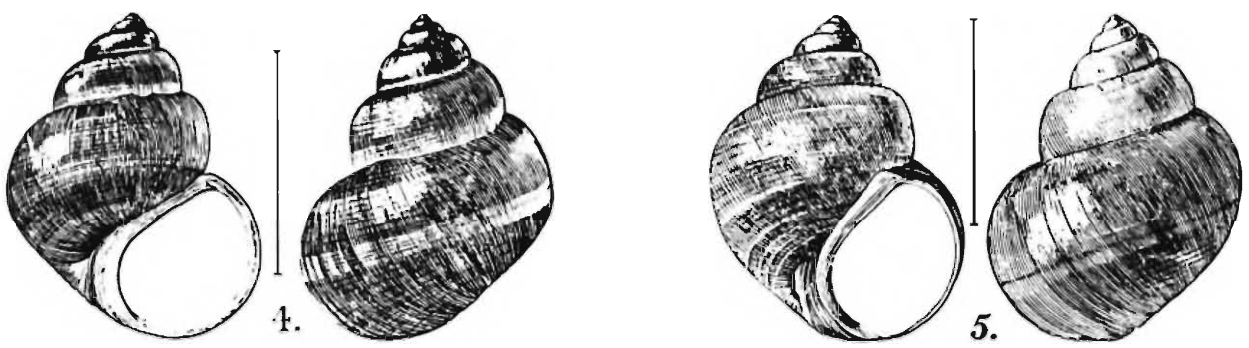
Taia aspercallosa, sp. nov.

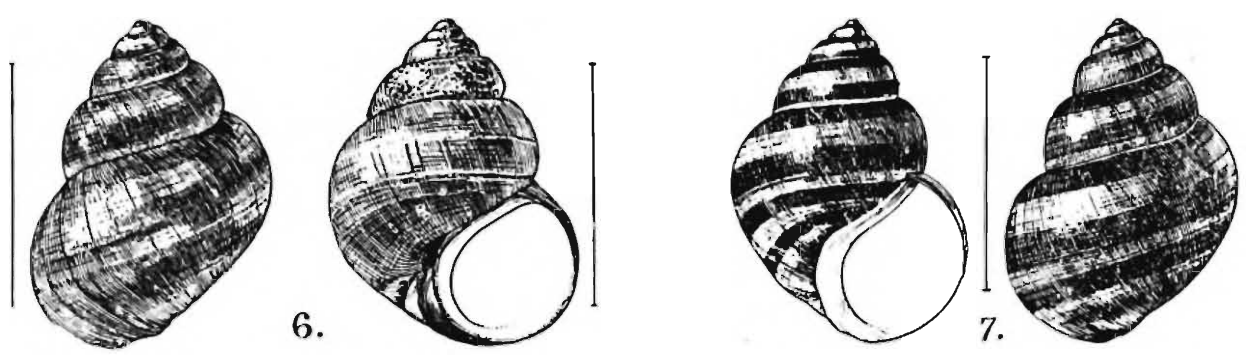
„ 9, 10.—Two shells from the type-series.

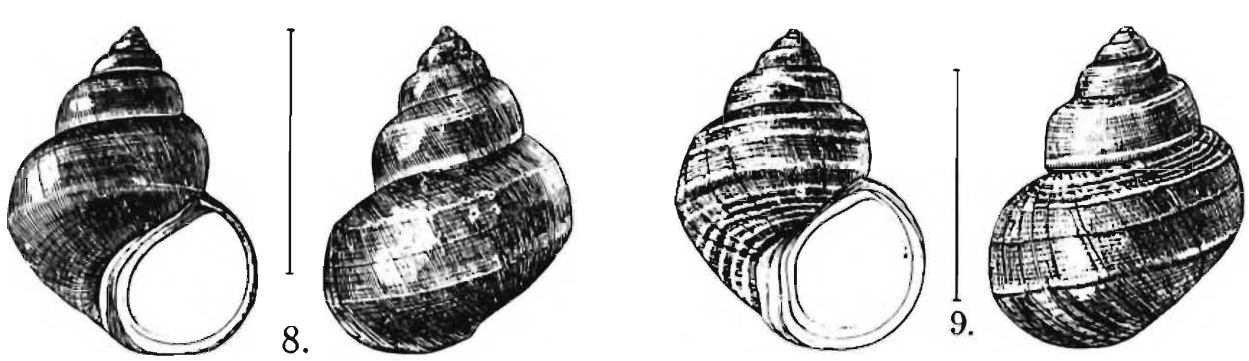
Taia aspercallosa var. *brookesi*, nov.

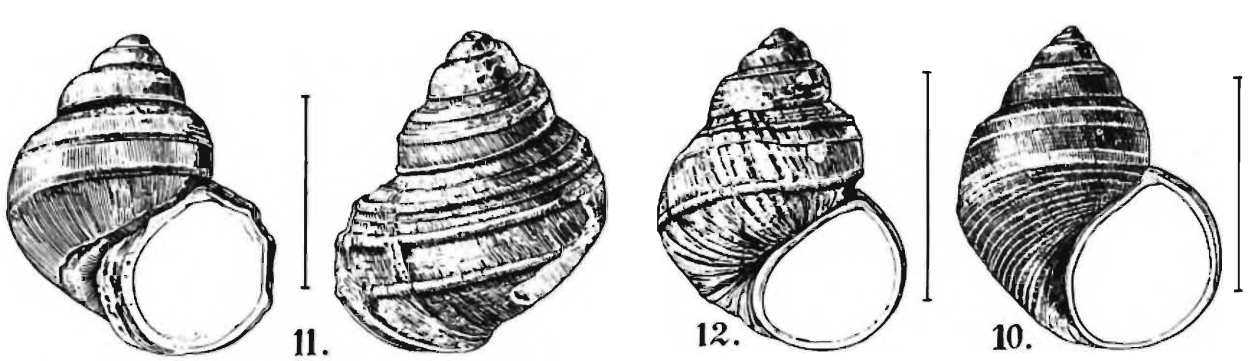
„ 11, 12.—Subfossil shells from the banks of the Namtu R., Hsenwi.











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