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THE FAUNA OF THE SALT RANGE, PUNJAB.

PREFATORY NOTE.

The following series of papers is based on the results of a visit paid to the Punjab Salt Range by myself in July, 1922 at the suggestion of Dr. N. Annandale, who was aware of some of the interesting forms that inhabit that isolated range. The time of the year chosen was not particularly favourable for collecting zoological specimens as it was then extremely hot and dry. However, the collection proved to be of great interest and as most of the material could be worked out by the members of the Zoological Survey of India at Calcutta, it has been thought advisable to publish the contributions from various authors together. Special attention was paid in the field to the collection of fish, Batrachia, Reptilia, land and freshwater Mollusca and aquatic Crustacea, but incidentally several species of insects were also collected. Of the insects, a representative collection was made of dragon-flies (Odonata), while the other groups are represented by a few individuals only. Some Hemiptera were collected in the garden attached to the dak bungalow at Choa Saidan Shah and three species of mosquitoes¹ from underneath furniture at the police rest house, Kallar Kahar.

I have to thank the Deputy Commissioner of the Jhelum District, the Sub-Divisional Officer and the Tehsildar of Pind Dadan Khan for the great help and useful assistance rendered to me in making arrangements for my touring. To Dr. Annandale I am greatly indebted for making valuable suggestions and for going through the manuscript.

Sunder Lal Hora.

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INTRODUCTION.

By S. L. HORA.

The position of the Salt Range is thus defined by Fleming² in his report on the geological structure and mineral wealth of the range.

“The hills, generally included under the designation of the Punjab Salt Range, occur in the northern part of the Sinde Saugor Doab, or district between the river Jhelum and Indus, crossing it from E. to W. between the parallels of 32° 22' and 33° N. Latitude and 71° 30' and 73° 30' Longitude.”

I visited only the part of the range lying in the Pind Dadan Khan Tehsil of the Jhelum District between Khewra and Nurpore, and Kallar Kahar in the Chakwal Tehsil.

During the month of July the hills through which I passed presented a dreary appearance and were almost entirely bare of vegetation. At

¹ I am indebted to Col. S. R. Christophers, C.I.E., I.M.S. for the identification of these mosquitoes. They are *Anopheles rhodesiensis* Theo., *A. stephensii* Liston and *A. funestus* var. *listoni* Liston.

² Fleming, *Journ, As, Soc, Bengal* XXII, p. 231 (1853).

all places, with the exception of Choa Saidan Shah, the scarcity of water was badly felt and in some villages the inhabitants had to go for miles to get drinking-water. They generally depend for their necessary supply on seasonal rain-fall, which they collect in mud tanks and which are frequented indiscriminately by men and cattle so long as the supply lasts. The hills are of solid rocks and present a ragged appearance throughout. "A striking feature of the Pind Dadan Khan hills is the series of plateaux they enclose; the two parallel ranges, from 2,000 to 3,700 feet in height, support between them at an elevation of from 2,000 to 3,000 feet a series of fairly level uplands, richly cultivated and carrying a dense population. The rocks which build up the range are throughout tilted at a very high angle; but there are few peaks which are either detached or conspicuous."¹

There are no metalled or unmetalled roads suitable for light-wheeled traffic anywhere in the portion of the range I visited, and camels formed the chief means of conveyance. The roads are usually strewn over with pebbles and small pieces of stone, which render them unsuitable for walking over long distances. The bad condition of the roads, the extremes of climate, the scarcity of drinking-water along the road side, and lastly the precipitous climbing are some of the difficulties which a collector has to encounter in these parts.

The heat never attains the extremes common in the plains of the Punjab, but even in the hills it was found to be extremely difficult to stay out in the field after 9 A.M. in the month of July. The nights were usually very pleasant. It is reported that in the winter a bitter north wind prevails and consequently the cold is severe, and sometimes light snowfall also occurs. The winter begins from the middle of October and lasts till the end of March. During the rainy season (July, August and September) the weather gets quite pleasant after a heavy fall of rain as the temperature immediately falls considerably.

The rainfall is uncertain and varies from year to year. On an average it amounts to about 20 inches in the parts I visited, but no definite statistics are available on this point.

On the whole the climatic conditions prevailing in these parts resemble those of a desert or a semi-desert region.

The geological structure of the Salt Range has been discussed in detail by several authors,² while in the Jhelum District Gazetteer (Lahore: 1907) Mr. (now Sir Henry) Hayden gives a short summary. "The greater part of the District," he says, "lies on the Sandstones and conglomerates of the Sewalik Series (upper tertiary), but towards the south, the southern scarp of the Salt Range affords sections of sedimentary beds ranging from cambrian upwards. The lowest bed is the salt marl and rock salt, which affords the material for extensive mining industry." The presence of salt rocks is of great importance in considering the aquatic fauna, as the water is rendered saline by their presence

¹ Punjab District Gazetteers. Jhelum District (Lahore: 1907).

² Fleming, *Journ. As. Soc. Bengal* XXII, pp. 229-279, 333-368, 444-462 (1853); Theobald, *ibid.*, XXIII, pp. 651-677 (1854); Oldham, *Manual Geol. Ind.* 2nd. edition, pp. 109, 118 (1893); Wynne, *Mem. Geol. Surv. Ind.* XIV, pp. 1-303 (1878); Middlemiss, *Rec. Geol. Surv. Ind.* XXIV, p. 19 (1891).

at several localities. The inhabitants of these parts distinguish two kinds of rocks, white and red. They say that so long as water flows over white rock it is fresh, but when it comes in contact with red rock it becomes saline. Water in all the streams becomes saline after flowing for a few miles and is thus rendered useless for irrigation purposes.

I visited several streams *viz.* Mitha-patan near Khewra, Katas nallah and Kas Gandhala near Choa Saidan Shah, Kas Pir-khara near Sardhi, and Nilawan below Nurpore among others. These after heavy rainfall acquire the characteristic impetuosity of mountain torrents. The streams referred to above flow over huge rocks and the water in them is usually low and clear except after heavy rain, when it becomes red on account of the silt that is washed down into it from the neighbouring hills. Each stream flows through a beautiful gorge. The scenery of some of these gorges and especially that of the Nilawan gorge is extremely picturesque and imposing. All the streams from this region discharge themselves into the Jhelum river.

It has already been remarked that after flowing for some distance the water of these streams becomes saline. This change is usually brought about within a short distance, and its effect on the fauna is remarkable. I made some observations on this point at Mitha-patan. It was found that animals such as fish, frogs and crabs could live comfortably in slightly saline water and that with the increase in salinity the fauna became disproportionately poorer. In distinctly salt water young of fish, dragon-fly larvae and a few beetles were captured. When the water became absolute brine, no animal was found to live in it. For the sake of an experiment I transferred a few living fish from fresh water into distinctly salt water. They were observed to live in it for at least one hour quite actively. I regret that owing to bad weather I was not able to carry these experiments to a successful issue.

There are several lakes in this range, but most of these are situated in the Khushab Tehsil of the Shahpur District. I visited one at Kallar Kahar. "Its extent varies much in different seasons, but may be stated as about a mile long by half a mile broad, its greatest length being from east to west. It receives the drainage from the various hills around, and also a small stream of fresh water which enters it at its West end near the village of Kuhar. Its depth nowhere exceeds three or four feet, and its margin is formed of black fetid mud, outside which is a thick saline incrustation produced by the evaporation of its water."¹ In May, 1921 the lake is said to have dried up completely, and when I visited it in the third week of July this year, it was almost drying up. When I passed through Kahar for the second time a week later, the lake was almost full and presented a beautiful view from the neighbouring hills. No animals were found to live in it.

Very little attention has so far been paid to the fauna of the Salt Range and all that has hitherto been known from this part is chiefly due to the efforts of earlier geologists who besides attending to their duties made valuable collections of animals. Mr. W. Theobald was the first to make zoological collections in this isolated range, in the cold

¹ Fleming, *Journ. As. Soc. Bengal*, XXII, p. 235 (1853).

weather of 1851-52, when he was attached to the Survey party under Dr. Andrew Fleming. Unfortunately specimens from Theobald's collection, most of which are now preserved in the collection of the Indian Museum, bear no precise locality and are labelled merely as being from Salt Range. But from Fleming's report ¹ it appears that his assistants went all over the range and remained for a considerable time at Pind Dadan Khan. Theobald's collection was rich in reptiles and molluscs and contained a few species of birds also. Dr. W. Waagen, to whom we are indebted for the earliest record of fishes, visited the range in 1870-71. He appears to have collected fishes only at several places in the range, all to the east of the Indus.

In the following series of papers as many as sixty-three species of animals are either recorded or described as new. They are distributed among five groups of animals. The geographical distribution of these species is given in a tabular form below :—

No. of species.	Class of animal.	New.	Endemic	N. India or India.	Oriental.	Afghan-Baluch-Persian desert.	Palae-arctic.
22	Reptiles ...	—	2	6	5	9	—
4	Batrachia ...	—	—	3	—	—	1
14	Fish ...	2	4	10	—	—	—
21	Mollusca ...	2	4	9	6	2	—
2	Aquatic Crustacea	—	—	2	—	—	—

It is not surprising to find that 30 out of a total of 63 species are widely distributed in N. India or throughout India generally, while another 11 are still more widely distributed in the Oriental Region. The most interesting feature is the presence of an Afghan-Baluch-Persian element as well as of many endemic species ; the former element is found both among aquatic and among terrestrial forms. Remembering that the climatic conditions in the Salt Range are similar to those that prevail in the Afghan-Baluch-Persian desert, it is easy to account for the invasion of the desert fauna into a territory that otherwise belongs geographically to the Indo-Gangetic plain.

¹ Fleming, *Journ. As. Soc. Bengal*, XXII, p. 235 (1853).

REPTILIA AND BATRACHIA OF THE SALT RANGE, PUNJAB.

By SUNDER LAL HORA, D.Sc., Assistant Superintendent, and B. CHOPRA, M.Sc., Research Assistant, Zoological Survey of India.

As long ago as 1851-52 a fairly large collection of reptiles was made in the Punjab Salt Range by William Theobald of the Geological Survey of India. The specimens were sent to Calcutta in two lots. The earlier consignment was despatched from Pind Dadan Khan¹ and was described by Blyth in the *Proceedings of the Asiatic Society of Bengal* for 1853. It comprised seven species of lizards and one of snake. The second lot, which contained specimens from several other localities besides the Salt Range, was also described by Blyth² in the same journal in the following year. It was richer than the first and included specimens of several interesting forms. Unfortunately we do not know any particulars of the exact localities in which Theobald made his collections. Most of the specimens sent by Theobald are still preserved in the collection of the Zoological Survey of India, including the types of Blyth's new species. In the following table Blyth's identifications are shown, together with the modern names of the species and their distribution. We have also added the names of the species collected by one of us and not obtained by Theobald. Those recently collected are distinguished by a star (*). The only addition to our knowledge of the herpetology of the Range since 1854 is Dr. Annandale's³ description of a new species of lizard (*Gymnodactylus montium-salsorum*) based on specimens from Theobald's collection.

Blyth's identification.	Modern name,	Further distribution.
Lizards.		
<i>Gymnodactylus geckoides</i>	<i>Gymnodactylus montium-salsorum</i> Annand.	Endemic.
<i>Stenodactylus scaber</i> ...	<i>Gymnodactylus scaber</i> * (Rüppel)	Egypt, Abyssinia through south-western Asia to Baluchistan and Sind.
	<i>Gymnodactylus kachhensis</i> * Stoliczka	Cutch, Sind.
<i>Hemidactylus coctaei</i> ...	<i>Hemidactylus flaviviridis</i> * Rüppel	Abyssinia, Arabia, Persia, Baluchistan, India, Burma and Malay Peninsula.
	<i>Hemidactylus brookii</i> * Gray	Southern Europe, N. W. Africa, South Asia, Malay Archipelago and Australia.

¹ Blyth, *Journ. As. Soc. Bengal* XXII, p. 410 (1853).

² Blyth, *Journ. As. Soc. Bengal* XXIII, p. 737 (1854).

³ Annandale, *Rec. Ind. Mus.* IX, p. 313, pl. xvii, fig. 2 (1913).

Blyth's identification.	Modern name.	Further distribution.
Lizards—contd.		
<i>Hemidactylus leschenaultii</i> ?	<i>Hemidactylus flaviviridis</i> ¹ Rüppel.*	India, Ceylon and Malay Peninsula (<i>H. leschenaultii</i>).
<i>Cryptodactylus macularius</i>	<i>Eublepharis macularius</i> * (Blyth)	Euphrates, Persia, Baluchistan and N. W. India.
	<i>Calotes versicolor</i> (Daud.)*	Afghanistan to China.
<i>Charasia dorsalis</i>	<i>Charasia dorsalis</i> (Gray)	Southern India.
<i>Laudakia</i> (?) <i>melanura</i>	<i>Agama melanura</i> * (Blyth)	W. Baluchistan, Sind and N. W. India.
<i>Agama agilis</i> (<i>Trapelus flavimaculatus</i> (Rüpp.))	<i>Agama isolepis</i> Blg. ...	Egypt, Persia, Baluchistan, Sind and Punjab.
<i>Uromastix hardwickii</i> ...	<i>Uromastix hardwickii</i> * Gray	W. Baluchistan and N. W. India.
<i>Monitor dracaena</i> ...	<i>Varanus bengalensis</i> (Daud.)	India and Ceylon.
	<i>Varanus flavescens</i> * (Gray)	N. India, Burma and Malay Peninsula.
<i>Acanthodactylus vulgaris</i>	<i>Acanthodactylus cantoris</i> Günth.	S. E. Persia, Baluchistan, Sind and N. W. India.
<i>Cabrita leschenaultii</i> ...	<i>Cabrita leschenaultii</i> D. & B,	Peninsular India, Ceylon and S. E. Berar.
	<i>Ophiops jerdonii</i> * Blyth	N. W. Baluchistan, Sind and India.
	<i>Mabuia dissimilis</i> * (Hallow)	Sind to Bengal.
<i>Eurolepis taeniolatus</i> ...	<i>Eumeces taeniolatus</i> (Blyth)	Endemic.
Snakes.		
<i>Tortrix eryx</i> (<i>Eryx indica</i> Gray)	<i>Eryx johnii</i> (Russell)	Sind, Cutch, Punjab and sandy tracts of Central and Southern India.
	<i>Oligodon arnensis</i> * (Shaw)	India and Ceylon.
	<i>Zaocys mucosus</i> * (Linn.) ...	Afghanistan to Malay Peninsula and Java.
<i>Vipera echis</i> Ind. var. ...	<i>Echis carinata</i> (Schneider)	N. Africa, S. W. Asia and India.

Considering the old and the recent collections together, we find that at least 18 species of lizards and 4 of snakes are known from the

¹ The only specimen in our collection from northern India referred to *H. leschenaultii* proved on examination to belong to *H. flaviviridis*. The former species is essentially a south Indian form and, therefore, Blyth's record of it from the Salt Range is doubtful. Unfortunately we have not been able to trace the Salt Range specimen identified by Blyth as *H. leschenaultii* in the collection of the Indian Museum

Salt Range. Of the 18 species of lizards 2 are evidently endemic, 4 are known to be widely distributed in the Oriental region and 5 in India, while the remaining 7 have hitherto been known from the desert tracts of south-east Persia, Baluchistan and Sind. The climate being dry and hot for a considerable part of the year, and consequently the conditions of life being very unfavourable for many terrestrial animals, it is not surprising to find a preponderance of the desert or semi-desert forms in the reptilian fauna of the Salt Range.

Of the four species of snakes, 2 are desert forms, while of the remaining two, one is widely distributed in India and the other in the Oriental Region.

Nothing has so far been known of the Batrachian fauna of the Salt Range. In the recent collection the following four species are represented :—

Rana cyanophlyctis Schneider.

Rana tigrina Daud.

Bufo viridis Laur.

Bufo stomaticus Lütken.

One species of *Rana* and one of *Bufo* are represented by a single tadpole each. *Bufo viridis* is chiefly a palaearctic form, while the other three are quite common throughout India.

We have received great help from Dr. N. Annandale in preparing this paper and are greatly indebted to him for it.

We propose to discuss in the following notes only those forms which have recently been collected in the Pind Dadan Khan Tehsil of the Jhelum District.

REPTILIA

Family GECKONIDAE

***Gymnodactylus scaber* (Rüppel).**

1890. *Gymnodactylus scaber*, Boulenger, *Faun. Brit. Ind. Reptiles*, p. 62.

1913. *Gymnodactylus scaber*, Annandale, *Rec. Ind. Mus.* IX, p. 315.

A female specimen, 44 mm. in length without the tail, was obtained from the kitchen walls attached to the civil rest house at Sardhi. It agrees fairly closely with the specimens of the species from Bushire, Malakand, Afghanistan and Sind in the collection of the Indian Museum. The colour is somewhat different. The back in the middle is infuscated with gray and so are also the distal portions of the limbs.

Gymnodactylus scaber has hitherto been found in Egypt, Abyssinia, Baluchistan and Sind, but its occurrence in the Salt Range, Punjab extends its range considerably eastwards.

***Gymnodactylus kachhensis* Stoliczka.**

1890. *Gymnodactylus kachhensis*, Boulenger, *op. cit.*, p. 63.

1913. *Gymnodactylus kachhensis*, Annandale (in part), *op. cit.*, p. 315.

Two specimens of this species were taken on the walls of the civil rest house at Nurpore. They agree with the type-specimen in our collection.

We have examined all the specimens referred to this species in the collection of the Indian Museum and find that those from Quetta and N.W. Baluchistan¹ differ from the others in several important points. They represent Strauch's *G. fedtschenkoi* from Turkestan, with Nikolski's² figure of which they agree in every particular. *G. fedtschenkoi* is thus reinstated as a member of the Indian fauna, though Boulenger³ was wrong in attributing specimens from the Punjab Salt Range to this species.

The four closely allied species of this group of *Gymnodactylus*, now included in the fauna of the Indian Empire, may be distinguished by the following key :—

- A. About 20 longitudinal rows of scales across mid-belly.
 - I. Tubercles between eye and ear-opening prominent and distinctly keeled; both femoral and preanal pores in male *G. montium-salsorum*.
 - II. Tubercles between eye and ear-opening small and rounded or indistinctly keeled; only preanal pores present in male *G. scaber*.
- B. At least 30 longitudinal series of scales across mid-belly.
 - I. Sub-caudal plates large, longer than wide; three pairs of chin shields; about 40 longitudinal rows of scales across mid-belly (preanal pores in male) *G. fedtschenkoi*.
 - II. Sub-caudal plates absent, under surface of tail covered with normal scales; two pairs of chin shields well marked; about 30 longitudinal rows of scales across mid-belly (preanal pores in male) *G. kachhensis*.

Hemidactylus brookii Gray.

1890. *Hemidactylus gleadowii*, Boulenger, *Faun. Brit. Ind. Reptiles*, p. 86, fig. 27.
 1898. *Hemidactylus brookii*, Boulenger, *Ann. Mag. Nat. Hist.* (7) I, p. 123.

Four specimens of this common Indian species were taken from a village in the vicinity of Choa Saidan Shah.

Hemidactylus flaviviridis Rüppel.

1890. *Hemidactylus coctaei*, Boulenger, *Faun. Brit. Ind. Reptiles*, p. 92.
 1912. *Hemidactylus flaviviridis*, Boulenger, *Faun. Malay Penin. Reptiles*, p. 44.

In the collection from the Punjab Salt Range, this species is represented by three specimens. They were taken from the walls of the dak bungalow at Khewra. The species occurs all over the Indian Empire.

It has been noticed by Boulenger (*op.cit.*) that the upper surface of the tail is provided with "4 or 6 longitudinal series of conical tubercles," but from an examination of a large series of specimens of *H. flaviviridis* in the collection of the Indian Museum from widely different localities

¹ These specimens were recorded by Annandale as *Gymnodactylus* sp. (*prox. kachhensis*) in *Mem. As. Soc. Bengal* I, p. 197 (1907).

² Nikolski, *Herpet. Turanica*, pl. iv, fig. 1 (1899) in Fedtschenko's *Reise in Turkestan*.

³ Boulenger, *Faun. Brit. Ind. Reptiles*, p. 61 (1890); see Annandale, *Rec. Ind. Mus.* IX, p. 313, pl. xvii; fig. 1 (1913).

we find that this character is not constant. The tubercles may be present or absent and specimens of both types are present in fairly large numbers in our collection. Those with a smooth tail are numerically better represented. We have not, however, been able to find any other well-marked character correlated with this difference in the tail. Of the three specimens from the Salt Range, only one has a tail, which is smooth.

Dr. Annandale informs us that this species has frequently been confused with *H. leschenaultii* which he believes to be confined, so far as India is concerned, to the central and southern part of the Peninsula. Blyth's specimen from the Salt Range is no longer available, but we find one from Sind identified as *H. leschenaultii* which actually belongs to *H. flaviviridis*.

Family EUBLEPHARIDAE.

Eublepharis macularius (Blyth).

1890. *Eublepharis macularius*, Boulenger, *Faun. Brit. Ind. Reptiles*, p. 108, fig. 33.

A young specimen of this species was procured at night in a field close to the civil rest house at Nurpore.

The type-specimen from the Salt Range is in quite good condition except that it has lost its natural colouration. It is a young female and is about 12 cm. in length including the tail, which is partly reproduced.

As the specimens of the two Indian species of *Eublepharis* have been confused in our collection, we give below the localities whence those of the two Indian species are represented.

E. hardwickii.

4121	...	Khurda, Orissa.	...	J. Wood-Mason.
6219	...	Gangam, Madras Presidency	...	V. Ball.
6220	...	Sunderbuns, Calcutta.	...	W. Swinhoe.
6221-22	...	Chaibassa, Chota Nagpur	...	Capt. Haughton.
18460	...	Central Provinces, India	...	Zool. Gardens, Calcutta.

E. macularius.

6224 (Type)	...	Salt Range, Punjab	...	W. Theobald.
5884, 5889	...	Sind	...	Karachi Mus. Ex.
5957-58	...	Karachi	...	" " "
5968	...	"	...	" " "
14329	...	Afghanistan	...	C. R. M. Green.
5840	...	Rajanpur, Trans Indus	...	E. Sanders.
5969	...	Shahpur, Punjab.	...	E. C. Corbyn.
19343	...	Nurpore, Salt Range, Punjab	...	S. L. Hora.
11703	...	Quetta, Baluchistan	...	Col. St. John.
18533	...	Rawalpindi, N. Punjab	...	R. Hodgart.
6223	...	Amritsar, Punjab	...	Purchased.
13682	...	Cherat	...	Sir H. Collet.
13967	...	Chitral	...	F. J. Daly.
		Malakand	...	H. McMahon.

Family AGAMIDAE.

Calotes versicolor (Daud.).

1890. *Calotes versicolor*, Boulenger, *Faun. Brit. Ind. Reptiles*, p. 135, fig. 42.

Calotes versicolor is commonly found on bushes and bare rocks in the Salt Range. It is very much dreaded as a poisonous lizard and very few people cared to collect these animals for money.

Three specimens of this species are present in the recent collection. One was shot at Sardhi, while the other two were purchased at Nurpore.

Dr. Annandale informs us that our specimens represent the race *gigas* (*Mem. As. Soc. Bengal* I, p. 189, 1905). This race is a semi-desert form and is not found in the Indo-Gangetic plain, Assam or Burma.

Agama melanura (Blyth).

1885. *Agama melanura*, Boulenger, *Cat. Brit. Mus. Lizards* I, p. 363.

1885. *Agama lirata*, *id.*, *ibid.*, p. 364.

1890. *Agama melanura*, *id.*, *Faun. Brit. Ind. Reptiles*, p. 150.

1890. *Agama lirata*, *id.*, *ibid.*, p. 150.

The types of both the species, *Agama melanura* (Blyth) and *A. lirata* (Blanford) are preserved in the collection of the Indian Museum. From an examination of these specimens, and also of others which have been from time to time referred to these species and are now preserved in our collection, we find that *A. lirata* is identical with *A. melanura*. The only difference noted by Boulenger in these two species is the size and arrangement of the scales on the dorsal surface. But even in this respect we find the specimens identical.

We give below a list of specimens of this species in the collection of the Indian Museum. The type is labelled as having come from Simla but we think that this is really a mistake. It is in all probability from the Salt Range, Punjab.

6703 (Type)	...	?Simla	...	...	W. Theobald.
3410	...	W. Baluchistan	...	...	W. T. Blanford. (Type of <i>A. lirata</i>).
4814-19	...	Sind	...	...	C. H. T. Robinson.
15099-15101	}	Sind	...	...	A. W. Murray.?
15103-15106					
15108-15109					
19344	...	Nurpore, Punjab Salt Range			S. L. Hora.

Uromastix hardwickii Gray.

1890. *Uromastix hardwickii*, Boulenger, *Faun. Brit. Ind. Reptiles*, p. 157, fig. 45.

From the number of specimens present in the collection, it appears that the species is very common in the Salt Range. The shepherd boys are known to play with this lizard when out in the field. They catch it in a curious way. When they see a lizard of this species in the open, they close the nearest hole by placing their foot on it. Then they alarm the lizard by throwing bits of stones and it invariably runs to the hole and finding it closed, dances about the foot and is easily captured.

Several specimens, all young, were obtained in the neighbourhood of Choa Saidan Shah.

Uromastix hardwickii is a desert form and is found in the semi-desert tracts of Baluchistan and N. W. India.

Family VARANIDAE.

Varanus flavescens (Gray).

1890. *Varanus flavescens*, Boulenger, *Faun. Brit. Ind. Reptiles*, p. 164.

This is a common North Indian species and is represented in the Salt Range collection by two specimens. Both of them were purchased at Nurpore.

Family LACERTIDAE.

Ophiops jerdonii Blyth.

1921. *Ophiops jerdonii*, Boulenger, *Monograph Lacertidae* II, p. 201.

This is one of the commonest species of lizard found in the Salt Range and is represented in the collection by a large series of specimens. It was seen everywhere along the paths and on the slightest provocation by individuals either hid themselves under stones or amongst thick bushes.

Ophiops jerdonii is found in Baluchistan (Quetta), Cutch, Sind, North-western, central and Peninsular India.

Family SCINCIDAE.

Mabuia dissimilis (Hallow).

1890. *Mabuia dissimilis*, Boulenger, *Faun. Brit. Ind. Reptiles*, p. 185.

In the collection from the Punjab Salt Range there are four specimens of *Mabuia dissimilis*. These were obtained from villages in the neighbourhood of Choa Saidan Shah. The species is quite common in the plains of India.

Family COLUBRIDAE.

Oligodon arnensis (Shaw).

1890. *Simotes arnensis*, Boulenger, *Faun. Brit. Ind. Reptiles*, p. 314.

1919. *Oligodon arnensis*, Wall, *Snakes of Ceylon*, p. 231.

A single specimen of the common Indian snake *Oligodon arnensis* was captured at night on the walks in the garden attached to the dak bungalow at Choa Saidan Shah. The species is found in India and Ceylon.

Zaocys mucosus (Linn.).

1890. *Zamenis mucosus*, Boulenger, *Faun. Brit. Ind. Reptiles*, p. 324.

1919. *Zaocys mucosus*, Wall, *Snakes of Ceylon*, p. 172.

This species is represented by a single specimen taken in the garden attached to the Kallar Kahar police rest house. It is about four and

half feet in length. *Zaocys mucosus* is very widely distributed. It is found in Afghanistan, throughout India, Ceylon, Burma, S. China, Siam, Malay Peninsula and Java.

BATRACHIA.

Family RANIDAE.

***Rana cyanophlyctis* Schneider.**

1920. *Rana cyanophlyctis*, Boulenger, *Rec. Ind. Mus.* XX, p. 12.

Rana cyanophlyctis is the commonest frog found in the Salt Range and is represented by a large number of specimens including adults, half-grown frogs and tadpoles. The species was also found in slightly saline water.

Its range extends from Arabia to India, Ceylon and the northern part of the Malay Peninsula.

***Rana tigrina* Daud.**

1918. *Rana tigrina* (larva), Annandale and Rao, *Rec. Ind. Mus.* XV, p. 34.

A single tadpole of *Rana tigrina* was obtained in a small stream below Watli in the neighbourhood of Choa Saidan Shah. It is a very widely distributed Indian species and its range is known to extend as far east as Burma and Yunnan.

Family BUFONIDAE.

***Bufo viridis* Laur.**

1890. *Bufo viridis*, Boulenger, *Faun. Brit. Ind. Rep. Batrachia*, p. 594.

1918. *Bufo viridis*, Annandale and Rao, *Rec. Ind. Mus.* XV, p. 40.

Several adult specimens of this species were collected near the Khewra dak bungalow, where they were usually seen hopping about towards the evening. A tadpole was also collected in a stream (Sandreh) about a mile from Khewra.

Bufo viridis is chiefly a Palaearctic species but is known to be very common in the Kashmir Valley and in many districts north and west of the Punjab.

***Bufo stomaticus* Lütken.**

1918. *Bufo stomaticus* (larva), Annandale and Rao, *Rec. Ind. Mus.* XV, p. 39.

There is a single tadpole from a small stream below Watli in the neighbourhood of Choa Saidan Shah, which Dr. Annandale thinks belongs to *Bufo stomaticus*.

This species is found all over the Indo-Gangetic plain, in the western and eastern Himalayas and occasionally in those parts of Bengal and Bihar that lie south of the Ganges Valley.

FISH OF THE SALT RANGE, PUNJAB.

By SUNDER LAL HORA, D.Sc., Assistant Superintendent, Zoological
Survey of India.

(Plate VIII.)

Theobald, who made a valuable collection of molluscs and reptiles in the Salt Range in 1851-52, appears to have paid no attention to its fish-fauna. The earliest record of fishes from this district is found in part VI of Day's¹ Monograph of Indian Cyprinidae, wherein he described a new species of *Barbus* from "Chua Saidar Shah" and recorded "*Discognathus lamta*" from "Nilwan ravine" and "*Scaphiodon irregularis*" from "Marri." In a footnote on page 325 he made references to six other species and observed that "besides the fishes alluded to in this paper, the collection contained the following from Marri in the Punjab: *Macrones Lamarrii*, Val., *Labeo ricnorhynchus*, McClell., *Barbus tor*, H. B. Likewise *Barilius piscatorius*, McClell., from a fresh water stream near Wallus. Also one small specimen of *Cirrhina gohama*, H. B., and several young of *Nemacheilus corica*, H. B." The collection referred to above was made by Dr. W. Waagen of the Geological Survey of India. The only addition to our knowledge of the ichthyology of the range since Day's monograph is the description of a new species of *Garra*² based on a specimen from Waagen's collection. Dr. Waagen collected fish from widely separated places in the Salt Range, while the recent collection on which these notes are based was made in the Pind Dadan Khan Tehsil of the Jhelum District. I give below a list of the species which have so far been recorded from the Punjab Salt Range with their distribution.

* <i>Macrones secnghala</i> (Sykes)	...	The Indus, Salt Range of the Punjab, Jumna, Ganges as low as Delhi, also the Deccan, Kistna river and Assam.
<i>Garra montis-salsi</i> Hora.	...	Endemic.
<i>Scaphiodon readingi</i> , sp. nov.	...	"
* <i>Labeo ricnorhynchus</i> (McClell.) ³	...	Assam, along the Himalayas to Afghanistan
<i>Labeo sindensis</i> (Day)	...	Sind, Punjab and at Poona.
<i>Crossochilus latia</i> (H.B.) Day	...	India and Burma.
<i>Barbus tor</i> (H.B.) Day	...	"
<i>Barbus terio</i> (H.B.)	...	Orissa, Bengal to Punjab.
<i>Barbus punjabensis</i> Day	...	Sind, Lahore and Jubbulpore.
* <i>Barbus waageni</i> Day.	...	Endemic.
<i>Barilius vagra</i> (H.B.)	...	Sind Hills, along the Himalayas to Assam.
* <i>Nemachilus corica</i> (H.B.)	...	Punjab, N.E. Bengal and Assam.
<i>Nemachilus punjabensis</i> , sp. nov.	...	Endemic.
<i>Ophiocephalus gachua</i> (H.B.)	...	India and Burma.

The species whose name is preceded by an asterix (*) are not represented in my recent collection from the Salt Range.

¹ Day, *Journ. Asiat. Soc. Bengal* XII, pp. 318-327 (1872).

² Hora, *Rec. Ind. Mus.* XXII, p. 651 (1921).

³ Day does not make any reference to this species either in the *Fishes of India* or in the *Fauna of British India*, but he included it in his Monograph of the Indian Cyprinidae (*Journ. Asiat. Soc. Bengal* XI, p. 123, 1871).

As many as four out of a total of fourteen species now known to inhabit the Salt Range are endemic, while the rest are fairly widely distributed either in India or in India and Burma.

Only those forms are discussed in the following notes which have recently been collected in the Pind Dadan Khan Tehsil of the Jhelum District.

The types of the new species are preserved in the collection of the Zoological Survey of India.

***Garra montis-salsi* Hora.**

1921. *Garra monti-salsi*, Hora, *Rec. Ind. Mus.* XXII, p. 651.

In building up the synoptic table of the genus *Garra* in 1921 (*loc. cit.*) I had only the type of the species before me. On finding more material from the Khewra gorge in the unnamed collection, I hurriedly added a note modifying the description of the proboscis on the snout. In my recent collection from the Salt Range there are several specimens of this species. In some of them the proboscis is represented by a small knob-like projection between and slightly in front of the nostrils. The transverse cleft across the anterior region of the snout is also less conspicuous and so are the lateral tubercular areas. In this species the gill-openings extend for a considerable distance on the under surface and are separated from each other by a distance equal to the postorbital part of the head or slightly less than that. Another character that appears to be constant is that the lower lobe of the caudal is coloured grey while the upper is white. A black mark is present behind the upper corner of the gill-opening and a number of black wavy lines are present on the sides of the tail along the middle of longitudinal rows of scales. The maxillary barbel is longer than the diameter of the eye.

When revising the Indian species of the genus *Garra* it was pointed out by me (*loc. cit.*, p. 638) that the proboscis on the snout, which had been regarded as a secondary sexual character of the male, is common to both sexes in all the species in which it occurs except in *G. lamta*, of which I have had no opportunity of examining a large series of fully grown specimens. An examination of the Salt Range specimens has revealed to me the existence of secondary characters of a different nature in certain members of this genus. They exist in the form of regular rows of tubercles on the dorsal aspect of the paired fins of male specimens. On the dorsal surface of the pectoral in *G. monti-salsi* the tubercles are present on the anterior eight rays; they begin in a single row proximally but soon after they form more rows and in the case of the first four rays are continued along the divisions of the ray and extend to the margin of the fin. In the case of the other four rays they are arranged to form a single row, which ends at a considerable distance from the margin of the fin. Tubercles are also present on the postero-lateral part of the head and at the sides of the body anteriorly, but here they are not regularly arranged. In the case of the ventral fin tubercles are present on the outermost ray only in one or irregularly arranged two rows. In the males of *Garra stenorhynchus* similar characters are met with, but the rows of tubercles are not so numerous

on the pectoral, hardly exceeding one row on each ray, and are totally absent on the ventral. Each tubercle is in the form of a sharp, pointed, spine-like outgrowth resting on a broad, subcircular cushion-like base.

Similar structures in exactly the same position have already been described and figured in the males of certain species of the genus *Nemachilus*,¹ but the arrangement of tubercles in the two genera is quite different.

Garra montis-salsi is very common in mountain torrents in the Pind Dadan Khan Tehsil of the Jhelum District. Specimens were collected by me at Khewra and Choa Saidan Shah.

***Scaphiodon readingi*,² sp. nov.**

(Plate VIII.)

? 1872. *Scaphiodon irregularis*, Day (in part), *Journ. As. Soc. Bengal* XLI, p. 324.

This is a stout-looking fish with both the profiles evenly arched. The dorsal profile rises gradually from the tip of the snout to the commencement of the dorsal fin, beyond which it slopes down to the base of the caudal. The head is short and conical with the tip bluntly pointed; its length is contained 5 to 5.4 times in the total length including caudal. The eyes are prominent and are placed at the sides of the head in such a way that their upper margin is slightly below the dorsal profile of the head; they are situated almost in the anterior half of the head and their diameter is contained from 4 to 5 times in the length of the head. The eye is proportionately larger in the young specimens. The snout is shorter than the interorbital width and is about 1.6 times the diameter of the eye. There is a fissure across the snout above the upper lip and there are two lateral lobes one on each side above the angle of the mouth. The nostrils are situated in the posterior half of the distance between the tip of the snout and the anterior margin of the orbit. There is a pair of well-defined maxillary barbels; they are as long as the diameter of the eye. In some specimens minute rostral barbels occur and it is not uncommon to find these structures only on one side of the fish. The upper lip is well-developed and overhangs the mouth, which is situated on the under surface slightly behind the tip of the snout; it is continuous at the angle of the mouth with the lower lip, which is widely interrupted in the middle. In some specimens the middle portion of the lower jaw is covered with a thick skin, while in others a yellowish horny covering is distinctly visible between the lateral lobes of the lower lip. In all specimens the edge of the lower jaw is sharp and cutting and the mandible is covered by a horny covering. There is a series of minute pores along the pre-opercular border.

The dorsal fin contains three spines and ten branched rays, the last of the series being divided to the base. The last spine is osseous, weak and serrated along its posterior border for about half of its length. The commencement of the dorsal is equidistant between the tip of the snout and the base of the caudal fin; its longest ray is equal to the length

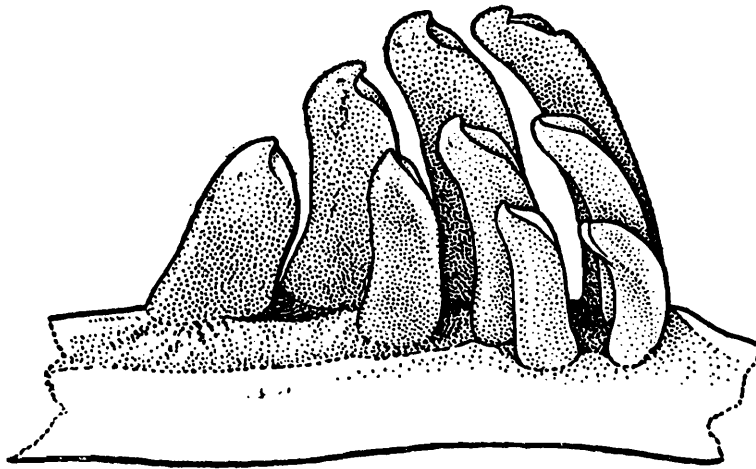
¹ Hora, *Rec. Ind. Mus.* XXIV, p. 81, figs. 4 and 5 (1921).

² With special permission I have named this fish after His Excellency the Right Honourable Rufus Daniel Isaac, Earl of Reading, P.C., G.C.B., G.M.S.I., G.M.I.E., G.C.V.O., Governor-General and Viceroy of India.

of its base, which is almost as long as the head without the snout. The shortest ray in the dorsal fin is slightly less than the postorbital part of the head. The ventrals commence almost below the origin of the first divided ray of the dorsal fin; it is separated from the anal by half of its own length. The pectorals are as long as the head behind the anterior margin of the nostrils; it is separated from the ventrals by a considerable distance. The anal fin contains seven branched rays and its second branched ray is considerably longer than the longest ray in the dorsal fin. The caudal is longer than the head and is deeply forked; the upper lobe is better developed and is slightly longer than the lower.

The lepidosis is quite normal except on the under surface, where the scales are greatly reduced in front of the ventrals and almost indistinguishable on the chest. There are 36 to 40 scales along the lateral line and 7 to $7\frac{1}{2}$ longitudinal series above it and 4 to $4\frac{1}{2}$ below it to the base of the ventral fin. There is a scaly appendage both on the inner and outer margin of the base of the ventral fin. The scales on the sides of the anus and the anal fin are different in outline and seem to form a sheath on either side. The extreme dorsal surface in front of the dorsal fin is probably naked as no scales are visible under an ordinary power of the microscope.

In certain specimens the snout and fins are covered with regular rows of tubercles, which I believe are of parasitic origin as was shown by Dr. Baini Prashad¹ in the case of *Scaphiodon macmahoni*. They are regularly arranged along the rays of the fins, especially that of the anal and on the sides of the snout. These encysted bodies are sometimes present on the sides of the body also.



Text-fig. 1.—Teeth-bearing portion of pharyngeal bone of *Scaphiodon readingi*, sp. nov.: $\times 12$.

The pharyngeal bones are stout and each bears nine teeth, which are arranged in three rows. Their arrangement may be represented by the following formula:—4.3.2/2.3.4. Each tooth is flat and possesses a sickle-shaped crown, which bears a sharp point.

The colour in spirit is dark olive above and on the sides, fading into white below the lateral line and on the under surface. The margins of the scales in the upper three-fourths of the body are provided with

¹ Prashad, *Rec. Ind. Mus.* XVIII, p. 160 (1920).

numerous fine black dots. The membrane between the rays of the dorsal fin is also provided with fine black dots. Some of the rays of the caudal fin are infuscated with grey while both the upper and the lower margins are distinctly black.

Locality.—Salt Range, Punjab. From the arrangement and number of scales given by Day for the specimens of *Scaphiodon* collected by Dr. W. Waagen at Mari on the eastern side of the Indus, it seems quite probable that they represented this form. It was quite common in pools in the course of mountain torrents all over the portion of the range I visited. Good series were taken in the Khewra gorge, in Kas Ghandhala below Choa Saidan Shah and in gardens below Sardhi.

In 1872 Day¹ referred four specimens collected by Dr. W. Waagen at Mari to *Scaphiodon irregularis* and remarked that “they have L.1.38, L. tr. $7\frac{1}{2}/9$, whilst the rows of scales above the lateral line are not so distinctly irregular.” In his later and more comprehensive works² he states that *S. irregularis* is only found in “Sind Hills to 3500 feet elevation.” But in the same place he extends the range of *S. watsoni* to the Salt Range of the Punjab. Judging from Day’s statements there appears to be great confusion regarding the occurrence of either *S. irregularis* or *S. watsoni* in the Punjab Salt Range and unfortunately I have not been able to trace specimens from Dr. Waagen’s collection which could clear this point. In my collection from a portion of the Salt Range that lies in the Pind Dadan Khan Tehsil of the Jhelum District there are numerous specimens of *Scaphiodon*, which do not belong to either of the two species referred to above and in my opinion represent a form hitherto undescribed. Each of the two species from the Sind Hills (*S. irregularis* and *S. watsoni*) is represented by a single specimen in our collection. These specimens were purchased from Day and are, in all probability, either the types of the species or from the type-series. The differences between these two forms and the new species are tabulated below.

<i>S. irregularis</i> Day.	<i>S. watsoni</i> Day.	<i>S. readingi</i> , sp. nov.
Greatest depth of body $\frac{1}{6}$ of total length.	Greatest depth of body $\frac{2}{5}$ of total length.	Greatest depth of body $\frac{5}{12}$ to $\frac{2}{3}$ of total length.
Snout 1.3 diameter of eye.	Snout 1.5 diameter of eye.	Snout 1.5 diameter of eye.
Interorbital space almost flat.	Interorbital space slightly convex.	Interorbital space slightly convex.
Third dorsal spine as long as head without the portion in front of nostrils, feeble, serrated and equals $\frac{3}{4}$ depth of body.	Third dorsal spine as long as head without snout, strong, serrated and equals $\frac{2}{3}$ depth of body.	Third dorsal spine as long as head without snout, weak, serrated and equals $\frac{2}{3}$ depth of body.
Pectoral almost as long as head.	Pectoral considerably shorter than head.	Pectoral considerably shorter than head.
Lower lobe of caudal longer.	Lobes of caudal almost equal.	Upper lobe of caudal longer.
36 scales along lateral line.	33 scales along lateral line.	36-40 scales along lateral line
9 longitudinal rows of scales between base of dorsal and lateral line.	6 longitudinal series of scales between base of dorsal and lateral line.	7-7 $\frac{1}{2}$ longitudinal series of scales between base of dorsal and lateral line.
Arrangement of scales above lateral line irregular.	Arrangement of scales above lateral line regular.	Arrangement of scales above lateral line regular.
No marks on the body.	“Various and very irregular black spots on the body.”	No definite marks on the body.

¹ Day, *Journ. As. Soc. Bengal* XLI, p. 325 (1872).

² Day, *Fish. India* II, p. 551 (1878); *Faun. Brit. Ind. Fish* I, P. 284 (1889).

Scaphiodon readingi is distinguished from *S. macmahoni*¹ by the possession of a proportionately longer head, shorter pectorals and a stouter caudal peduncle; from *S. baluchiorum*² by the same characteristics except that of the head and longer barbels; from *S. daukesi*³ by the size and the position of the mouth and the smaller head.

In the description of the new species, I have alluded to different types of scales that occur in definite regions, but I think it worth while to discuss them in detail here as they appear to throw some light on the origin of the Schizothoracinae. The lateral scales and those on the under surface agree in form and structure with those of *Scaphiodon macmahoni* described and figured by Annandale and myself⁴. They are slightly broader than long. But a scale from the sides of the anus is quite different. It is more than twice as long as broad with the nucleus close to the proximal end. The lateral scales of Schizothoracinae are very similar in form and structure to the reduced scales found on the chest region of certain species of *Scaphiodon*, while the anal scales of the same subfamily (see Annandale and Hora *loc. cit.*) are like those of *Scaphiodon* from the same region. Moreover, there is a tendency among certain members of the genus *Scaphiodon* to possess small scales or to lose their scaly garment altogether. The irregular arrangement of scales and their small size on the dorso-lateral surface of *S. irregularis* and their absence in front of the dorsal fin in *S. readingi* are, therefore, facts not without significance in respect to the origin of the Schizothoracinae.

Measurements in millimetres.

Total length without caudal.	...	107.5	101.0	84.8	73.5	71.5	48.6	46.5	46.0	33.2
Length of caudal	...	25.0	26.0	22.5	21.0	21.4	15.0	15.1	16.1	11.5
Length of head	...	26.1	23.5	21.4	18.8	19.0	13.8	13.1	12.7	10.2
Height of body	...	31.2	27.8	22.6	20.5	21.2	12.5	11.1	13.0	8.0
Length of snout	...	8.8	8.0	6.5	6.0	6.4	4.1	4.4	5.0	3.1
Diameter of eye	...	5.3	5.1	4.8	4.5	4.6	3.7	3.8	3.4	2.6
Interorbital width	...	9.4	9.1	7.9	7.4	7.5	4.9	4.6	4.4	3.2
Longest ray of dorsal	...	18.4	17.5	18.0	12.7	14.9	8.2	9.4	9.0	6.5
Longest ray of anal	...	19.7	17.9	16.0	15.0	15.2	8.6	9.6	10.2	5.1
Length of pectoral	...	22.1	21.3	19.0	14.8	16.0	11.4	12.2	12.0	9.1
Length of ventral	...	18.2	19.0	17.0	12.6	14.1	10.8	11.4	11.0	8.8
Least height of caudal peduncle.		10.7	10.1	9.0	8.0	8.1	5.5	4.9	5.4	3.4
Length of caudal peduncle.		17.5	15.8	14.9	12.1	10.6	7.2	6.2	6.3	4.6

***Labeo sindensis* (Day).**

1872. *Cirrhitina sindensis*, Day, *Journ. As. Soc. Bengal* XLI, p. 319.

1878. *Labeo sindensis*, Day, *Fish. India* II, p. 544, pl. cxxxii, fig. 2.

This species is represented in the collection by a single specimen, which was taken in Kas Gandhala below Choa Saidan Shah. It agrees fairly closely with a specimen of *Labeo sindensis* from Sind in the collection of the Indian Museum. A specimen from Mari on the east of the Indus is also present in our collection.

¹ Regan, *Journ. As. Soc. Bengal* II, p. 8 (1906).

² Jenkins, *Rec. Ind. Mus.* V, p. 124 (1910).

³ Zugmayer, *Ann. Mag. Nat. Hist.* (8) X, p. 596 (1912).

⁴ Annandale and Hora, *Rec. Ind. Mus.* XVIII, p. 157 (1920).

Labeo sindensis according to Day (*op. cit.* 1878) is found in "Sind, the Punjab (at Lahore and Hardwar), also the Deccan at Poona."

***Crossochilus latia* (Ham. Buch.) Day.**

1878. *Cirrhina latia*, Day, *Fish. India* II, p. 548, pl. cxxx, fig. 4.

I refer provisionally a large number of specimen to the form recognised by Day as *Cirrhina latia*. On an examination of specimens referred to this species in the collection of the Indian Museum, I believe that several forms capable of specific separation have been grouped together under this name. It is, however, beyond the scope of the present paper to enter into details regarding *C. latia*.

This "species" is quite common all over India and is found in Burma also.

***Barbus tor* (Ham. Buch.) Day.**

1878. *Barbus tor*, Day, *Fish. India* II, p. 564, pl. cxliii, fig. 3.

It has already been pointed out by Dr. N. Annandale¹ that there is great confusion in the group of species of the genus *Barbus* familiar to Indian sportsmen as Mahseer. I have several specimens in my collection taken in Kas Gandhala below Choa Saidan Shah, which I refer to *B. tor* (*s. l.*). They possess a long and pointed head and in this respect resemble the form *mosal* of Hamilton Buchanan.

Barbus tor, to use the name in its accepted sense, is found throughout India and Burma.

***Barbus terio* (Ham. Buch.).**

1878. *Barbus terio*, Day, *Fish. India* II, p. 580.

There are four damaged specimens from Kas Gandhala below Choa Saidan Shah which I hesitatingly refer to *Barbus terio*. They agree with *B. terio* in several important characters but differ in details.

This species is commonly found in the Indo-Gangetic plain.

***Barbus punjabensis* Day.**

1878. *Barbus punjabensis*, Day, *Fish. India* II, p. 580, pl. cxiv, fig. 2.

Several specimens of this species were taken in a big pond near Chalisa railway station, which is at some distance from the base of the Salt Range.

Barbus punjabensis is found in Sind, the Punjab and at Jubbulpore.

***Barilius vagra* (Ham. Buch.).**

1878. *Barilius vagra*, Day, *Fish. India* II, p. 589, pl. cxlviii, fig. 3.

This species is represented by several young and half grown specimens taken in a small stream near Dheri Jaba. The edge of the caudal fin in all specimens is conspicuously stained with grey.

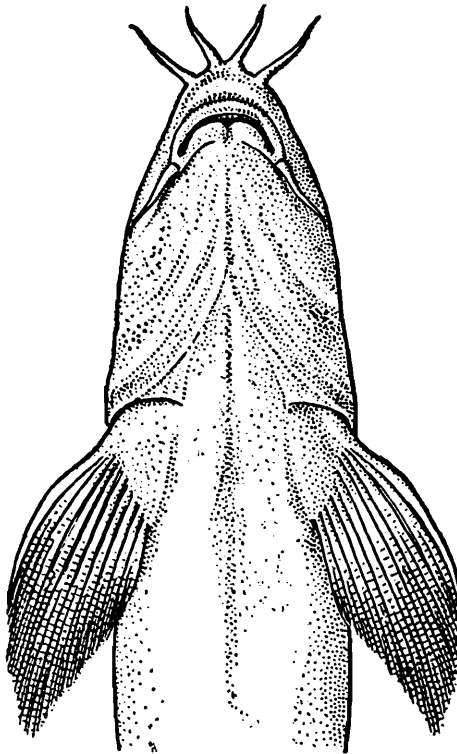
¹ Annandale, *Rec. Ind. Mus.* XVI, p. 134 (1919).

Barilius vagra is found in the Sind Hills, the Punjab, along the Himalayas and Assam.

***Nemachilus punjabensis*, sp. nov.**

D. 2/7. A. 1/5.

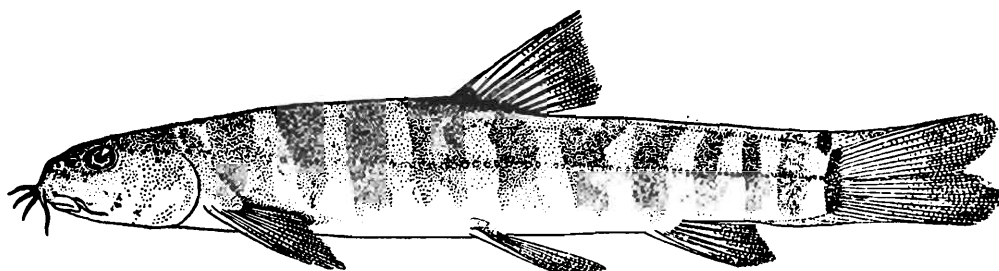
In this loach the dorsal and the ventral profiles run almost parallel to each other, the former is but slightly arched and the latter is straight and horizontal throughout. The head is sub-triangular and depressed, its lower surface is greatly flattened; its length is contained from 5·2 times (in the young) to 6·1 times in the total length including caudal. The depth of the body is about two-thirds the length of the head. The caudal fin is longer than the head. The eyes are not visible from below and for a greater part lie in the anterior half of the head. There are six barbels, the inner maxillary are almost as long as the diameter of the eye while the others are much longer. The mouth is bordered by well-developed lips, which are continuous at the angles; the lower lip is provided with a free labial fold which is widely interrupted and the lip itself is divided in the middle. The lateral line is complete and the body is devoid of scales.



TEXT-FIG. 2.—Under surface of head and chest of *Nemachilus punjabensis*, sp. nov. : $\times 5$.

The commencement of the dorsal is almost equidistant from the tip of the snout and the base of the caudal or somewhat nearer to the base of the caudal than to the tip of the snout; its longest ray is considerably greater than the depth of the body below it. The free upper margin of the dorsal is truncate. The pectoral is longer than the head and is separated from the ventral by a distance equal to half of its own length.

The ventrals miss the anus by a short distance. The caudal is divided in its last third.



TEXT-FIG. 3.—Lateral view of *Nemachilus punjabensis*, sp. nov. : $\times 2\frac{2}{3}$.

There are from eleven to thirteen dark zones encircling the body but not meeting on the abdomen. In front of the dorsal they run obliquely. These are separated from each other by much narrower but more conspicuous zones of ground colour which in spirit-specimens is slightly yellow. There is a dark band across the base of the caudal and a black spot at the base of the first two rays of the dorsal fin. Both the dorsal and the caudal are faintly marked with greyish bands across the middle of their lengths. The upper surface of the head is grey while the cheeks and the under surface are yellow. The under surface of the body is pale olivaceous.

Nemachilus punjabensis is readily distinguished by its long and narrow form, by the long pectorals and the characteristic colouration. The depth of the body is about one-ninth of the total length.

Measurements in millimetres.

Total length including caudal	...	44.0	47.0	44.6	39.5	31.2
Length of caudal	...	8.3	8.5	8.0	7.0	6.6
Length of head	...	7.6	7.9	7.2	6.9	6.0
Depth of body	...	5.0	5.2	5.0	4.8	4.5
Length of snout	...	3.0	2.6	2.8	2.8	2.2
Length of caudal peduncle	...	6.0	6.2	6.0	5.6	3.0
Least height of caudal peduncle	...	3.4	4.8	4.2	3.4	2.8
Longest ray of dorsal	...	6.3	5.8	6.0	6.0	5.0
Length of pectoral	...	8.0	8.0	8.0	7.8	5.6
Length of ventral	...	6.8	7.3	6.5	6.0	4.8

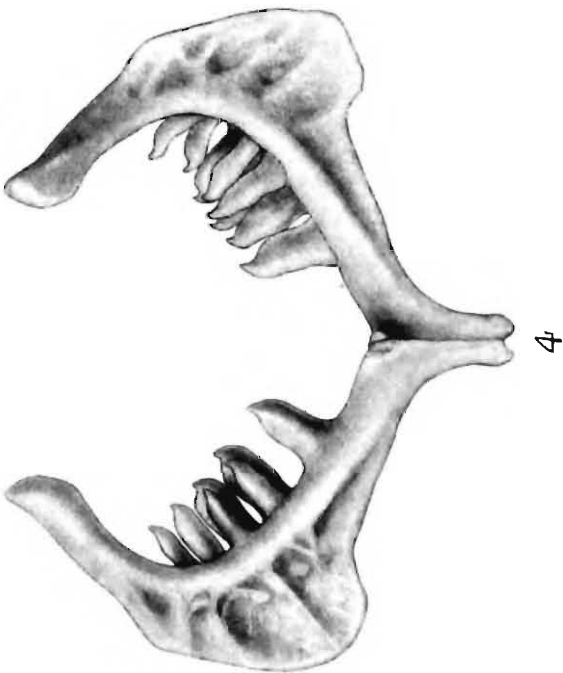
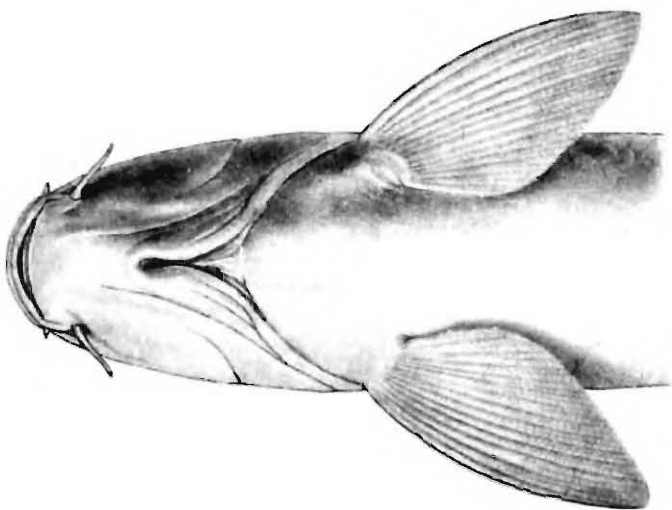
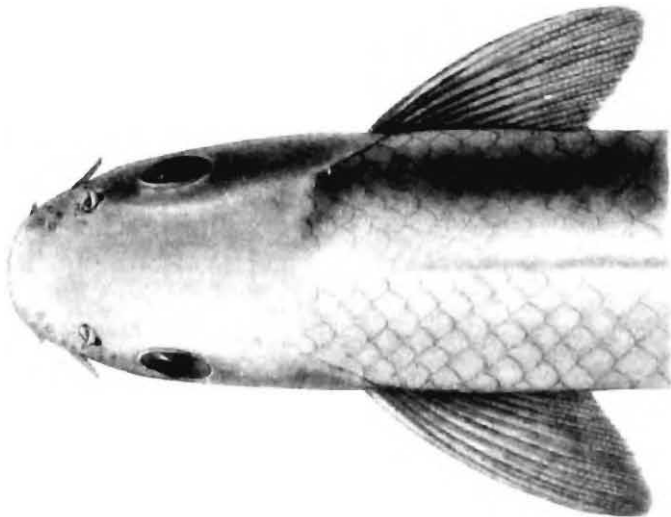
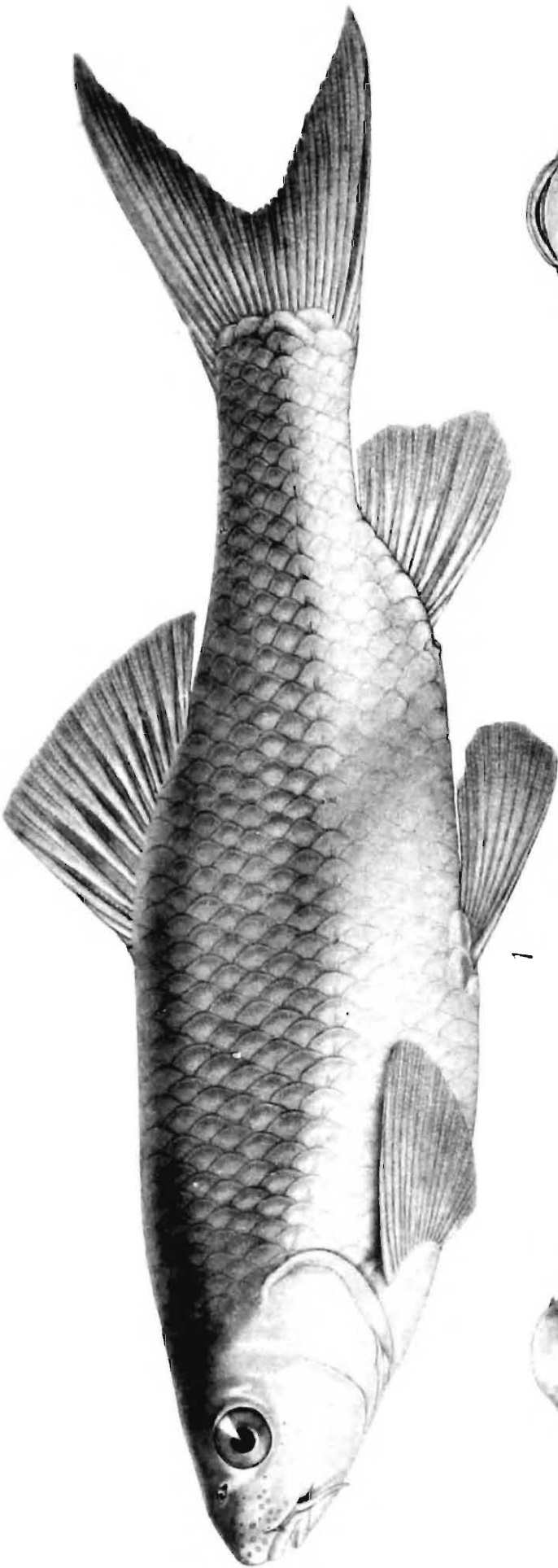
***Ophiocephalus gachua* (Ham. Buch.)**

1878. *Ophiocephalus gachua*, Day, *Fish. India* II, p. 367

Two young specimens of this species were taken in Kas Gandhala below Choa Saidan Shah. *Ophiocephalus gachua* is widely distributed in India and Burma.

EXPLANATION OF PLATE VIII.

- Fig. 1.—Lateral view of *Scaphiodon readingi*, sp. nov. : $\times 1\frac{1}{2}$.
,, 2.—Upper surface of head and anterior part of body of same : $\times 1\frac{1}{2}$.
,, 3.—Under surface of head and chest of same : $\times 1\frac{1}{2}$.
,, 4.—Pharyngeal bones of same seen from above : $\times 5$.



THE MOLLUSCS OF THE SALT RANGE, PUNJAB.

By N. ANNANDALE, D.Sc., C.I.E., F.A.S.B., Director, and H. SRINIVASA RAO, M.A., Research Assistant, Zoological Survey of India.

(Plate IX).

A considerable collection of molluscs was made in the Salt Range by Theobald as long ago as 1851-52. Some of the species he obtained were described by Benson at different times, while all the Gastropods were recorded by Nevill in his *Hand List of Mollusca in the Indian Museum* (1878 and 1885). Dr. Sunder Lal Hora, whose introduction to the papers in this series may be consulted for particulars as to the physical conditions prevalent in the Salt Range, has brought back an interesting collection, particularly rich in aquatic forms. It should be noted that all his specimens are from that part of the range which lies east of the Indus. Unfortunately we have no particulars as to the precise localities in which Theobald collected his shells.

Considering the two collections together, we find specimens of 20 species of Gastropoda, 9 terrestrial (including a *Succinea* of unknown habits), and 11 aquatic. Of the 19 species of which anything precise is known, six have a wide distribution in the Oriental region, and seven in N. India. Four species are apparently endemic in the Salt Range, while two were known hitherto only from the Baluchistan desert, Southern Persia and Iraq¹. We may thus say that about 32 per cent of the Gastropods are Oriental in a wide sense and another 37 per cent Indian, while at least 21 per cent are endemic, and that there is some evidence of an element belonging to the Afghan fauna. The Afghan forms are aquatic as well as one of the endemic species, three of the latter being terrestrial.

Conditions of life in the Salt Range are very unfavourable for terrestrial and still more so for aquatic molluscs. The climate is dry and extremely hot for a considerable part of the year and much of the water is saline. Such a climate is not always inimical to the existence of a rich, or at any rate an abundant fauna of land snails, but the fact that the soil is impregnated with mineral salts is a most deterrent condition. For aquatic forms these factors, especially the last, are still more unfavourable. It is not surprising, therefore, that 69 per cent. of the species are widely distributed in India or still further afield, for broad geographical range in a species in itself implies a physiological constitution readily adaptable to diverse conditions of life. That there should be a large endemic element in the Gastropod fauna might also be expected from the isolation of the Salt Range. It is interesting, however, to find that the Afghan fauna is represented. No species of this fauna has been

¹ One of these (*L. persica*) has since been found in the Western Himalayas, at Peshawar and also (exceptionally) in the Deccan.

found hitherto east of the Indus. The occurrence of *Limnaea persica* and *Melanoides flavidus* is doubtless to be accounted for by similarity of conditions to be found in the Afghan-Baluch-Persian desert on the one hand and in the Salt Range on the other. This has enabled the fauna, or at any rate certain of its representatives, to spread into a territory which belongs geographically to the Indo-Gangetic plain.

The Pelecypoda collected by Dr. Hora belong to two widely distributed Indian species and have no particular geographical interest.

LIST OF THE LAND AND FRESH-WATER MOLLUSCS OF THE PUNJAB SALT RANGE.

GASTROPODA.

Terrestrial Species.

- Fam. Helicidae.
Eulota pentapotamiensis, sp. nov. Endemic.
- Fam. Testacellidae.
Ennea bicolor (Hutton). Peregrine.
- Fam. Bulimindae.
Buliminus salsicola (Benson). Endemic.
B. dextrosinister, sp. nov. Do.
Pupoides coenopictus (Hutton). Drier parts of India.
Pupoides lardeus (Pfeiffer). Not recorded. Possibly endemic.
- Fam. Achatinidae.
Opeas gracile (Hutton). Peregrine.
Zootecus insularis (Ehrenberg). Do.
- Fam. Succineidae.
Succinea crassinuclea (Pfeiffer). N. India.

Aquatic Species.

- Fam. Hydrobiidae.
Amnicola (Alocinma) pulchella (Stoliczka). N. India ; Assam.
- Fam. Melaniidae.
Melanoides tuberculatus (Müller). Africa to New Guinea.
Melanoides flavidus (Nevill). Iraq ; S. Baluchistan.
- Fam. Limnaeidae.
Limnaea acuminata Lamarck. India ; Burma.
Limnaea luteola Lamarck. India ; Burma ; Mauritius (?introduced).
Limnaea persica Issel. S. Persia ; S. Baluchistan ; N. India ; Deccan.

PELECYPODA.

- Fam. Cyrenidae.
Corbicula striatella Deshayes. India.
- Fam. Unionidae.
Indonaia caeruleus (Lea). India.

TERRESTRIAL SPECIES.

***Eulota pentepotamiensis*, sp. nov.**

1878. *Nanina* (*Bensonia*) *jacquemonti* Martens (in part), Nevill, *Hand List Moll. Ind. Mus.* I, p. 49.

The shell is depressedly conoidal, almost flat below and with a very broad short spire, moderately thick, translucent white when fresh, often with a narrow brown stripe running round above the suture and the periphery of the body-whorl. The spire is flatter in some shells than in others, but is never acuminate. There are five and a half whorls, which increase gradually and evenly in size. The body-whorl is subcylindrical and without trace of a keel. The suture is linear and impressed. The mouth is lunate and almost horizontal as the last whorl descends very little, but there is some variation in this respect. The umbilicus is deeply perforate but always small. It varies considerably in size and in some shells is nearly closed. The edge of the lip is sharp and not at all reflected, and there are only slight indications, mainly on the upper part, of a thickening inside it. The columella is but slightly reflected over the umbilicus. The upper surface of the shell has an oily lustre, while the lower is highly polished. The sculpture consists of strong vertical striae, somewhat variable in development on the upper surface of the last four whorls, and of very much finer striae running in the same direction on those of the apex. On the lower surface the striae are also well developed except towards the mouth. A very minute spiral striation can be observed with a strong lens, especially on the upper surface.

Measurements of shells (in mm.).

	Type	1	2	3	4	5	6	
Major diameter	...	18.2	18.8	19.1	18.5	18.1	18.4	18.0
Minor diameter	...	16.5	16.8	16.8	16.0	15.8	16.0	15.6
Height	...	8.2	8.4	8.0	7.6	7.2	8.0	8.4
Greatest width of aperture		8.0	8.6	8.9	8.5	8.2	8.4	8.2
Height of aperture	...	6.5	7.1	7.1	6.9	6.6	6.8	6.8

This shell was confused by Nevill with that of *Bensonia jacquemonti*, to which it bears a certain quite superficial resemblance. It may easily be distinguished, however, by its size, texture and colour, and by differences in the shape of the mouth and the size of the umbilicus, which is always much smaller. The true relationships, in spite of geographical difficulties, seem to be with forms like *Eulota planispira*. The shell is, however, distinguished by its much more flattened form and very small umbilicus from that of *Eulota planispira*.

Type-specimen.—No. M $\frac{12126}{2}$ *Zoological Survey of India* (*Ind. Mus.*).

We have examined a large series of shells, including those collected in the Salt Range by Theobald and assigned by Nevill to *Bensonia jacquemonti*. Dr. Sunder Lal Hora obtained numerous empty shells on the hill-sides at Katas and two (smaller than the others) on the banks of the Katas Nallah, in July, 1922.

Ennea bicolor (Hutton).

1908. *Ennea bicolor*, Blanford & Godwin-Austen, *Faun. Brit. Ind. Moll.* I, p. 19, fig. 12.

1921. *Ennea bicolor*, Annandale & Prashad, *Rec. Ind. Mus.* XIX, p. 189.

A single specimen was obtained by Theobald in the Salt Range.

Buliminus (Petraeomastus) salsicola (Benson).

1914. *Ena (Subzebrinus) salsicola*, Gude, *Faun. Brit. Ind., Moll.* II, p. 248.

The series collected by Theobald in the Salt Range and described by Benson is still intact in the Indian Museum.¹ We have selected two shells (M $\frac{2128}{2}$) as lectotypes and figure them here. As there is some individual variation, it is impossible to regard any one shell as typical. Dr. Hora did not rediscover the species.

Buliminus (Subzebrinus) dextrosinister, sp. nov.

1878. *Buliminus (Petraeus) eremita* (?) Hutton, Nevill, *Hand List Moll. Ind. Mus.* I, p. 134.

Specimens thus recorded by Nevill and collected by Theobald in the Salt Range agree precisely with some of those of a large series recently obtained by Dr. Sunder Lal Hora in the same range, but the latter show much greater individual variability and include many sinistral shells. Dextral specimens resemble those of the true *B. eremita* from Afghanistan and adjacent districts in many particulars but are quite distinct from those of *B. salsicola* and are as worthy of specific distinction as those of such forms as *B. indicus*. The new species can best be described in comparison with *B. eremita*.

Apart from the fact that the shell in some localities is indifferently either dextral or sinistral and that at certain spots sinistral shells are more abundant than dextral, the most noteworthy differences are the following :—

- (1) In *B. dextrosinister* the base of the body-whorl is much less compressed than in *B. eremita* and consequently the umbilicus is less conspicuous and the mouth less expanded in appearance.
- (2) The shell is more elongate and has a more tapering spire than that of *B. eremita*.
- (3) The body-whorl tapers slightly towards the base, giving the shell a somewhat spindle-shaped form.
- (4) Both lips of the mouth are vertical and almost straight, running parallel to one another in such a way that the aperture forms an ellipse truncated obliquely at the posterior inner margin.
- (5) The body-whorl is less inflated than in *B. eremita* and the outer lip projects less beyond its outer outline.

In fresh shells the colour is opaque white conspicuously streaked or spotted with transparent brown.

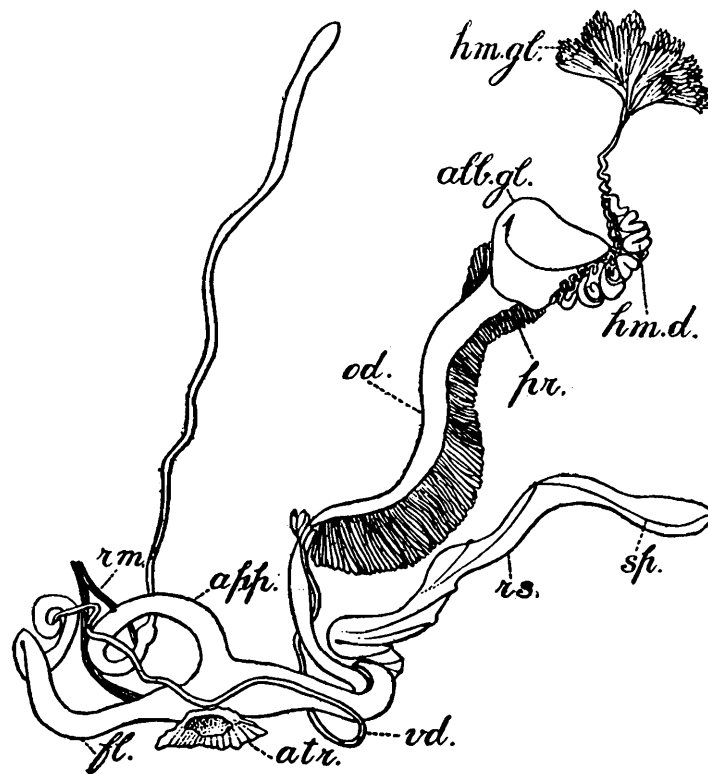
In sinistral shells the body-whorl has a somewhat distorted appearance and the outer lip projects further and is more curved than in dextral shells. Such shells are also a little larger than dextral specimens.

¹ The author of vol. II on the molluscs in the official "*Fauna of British India*," appears to be unaware of the fact that many of Benson's types are in the Indian Museum.

Shells in our large series exhibit considerable variation in outline, but the characters given above seem to be constant.

External characters of the animal.—The foot is narrow and pointed and a pair of tentacles are present in addition to the eye-stalks. The specimens that we examined were too much contracted to provide detailed information as to external features in other respects.

The genitalia agree in general structure with those of the Chinese species described by Wiegmann¹ except in one important feature, namely, the complete absence of a diverticulum on the copulatory pouch. The male and female ducts open into a common atrium situated, in a dextral shell, on the right side of the body a little behind the eye-stalks. The hermaphrodite gland, as in certain species figured by Wiegmann, Jacobi² and Beck,³ is racemose or rather finely lobulate. Its duct is much convoluted, especially towards the lower extremity. The albumen gland is large and elongate, sometimes folded on itself but straight in some individuals. The oviduct is broad and simple in structure. The copulatory pouch, which arises not very far from its base, is comparatively short and blunt at its extremity. There is no trace of the diverticulum.



TEXT FIG. 1.—Genitalia of *Buliminus dextrosinister*, sp. nov. (dextral shell) *alb. gl.* albumen gland; *atr.* genital atrium; *app.* appendage; *hm. gl.* hermaphrodite gland; *hm. d.* hermaphrodite duct; *fl.* flagellum; *od.* oviduct; *pr.* prostate; *rm.* retractor muscle of flagellum; *rs.* receptaculum seminis; *sp.* spermatophore pressed against the walls of the receptaculum seminis; *vd.* vas deferens.

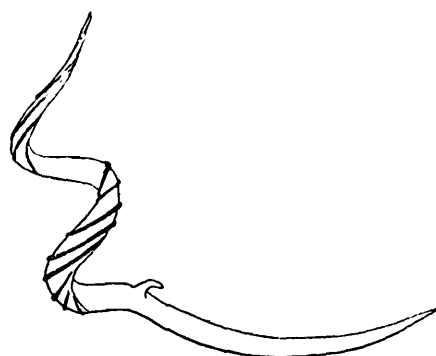
In one of the specimens examined the pouch contained two spermatophores. These were vermiform bodies sharply pointed at both ends

¹ Wiegmann, *Ann. Mus. Acad. Imp. Sci. St. Petersburg* VI, pp. 220-290, pl. x-xi (1901).

² Jacobi, *Journ. Coll. Sci. Tokyo* XII, pp. 76-82, pl. vi, figs. 113-115 (1898-1900).

³ Beck, *Jena. Zeitschr. Jena* XLVIII, pp. 187-225, p. viii-x (1912).

with a hooked process on one side near the middle and bearing a closely-wound chitinous spiral keel on one half. One extremity, that without keel, was bent in a regular wide arc for almost half of the length of the whole structure, while the other was twisted in an open spiral of three whorls.



TEXT FIG. 2.—Spermatophore of *Buliminus dextrosinister*, sp. nov.

The male part of the genitalia differs less than the female from that of previously described species of *Buliminus*. The penis-sheath is elongate and almost filiform but slightly dilated at the tip. The flagellum and the vas deferens are normal. The prostate is an elongate, band-shaped gland lying in close contact with the oviduct.

Alimentary System.—The jaw resembles that of *Buliminus (Subzebrinus) beresowskii* but is not so stout or deep.

The radula has the approximate formula 14. 10. 1. 10. 14. The teeth differ from those of *Buliminus reinianus* in that the main cusp is relatively larger, especially on the marginals, but are of the same type.

The alimentary canal is long and coiled. The oesophagus has thickened walls and its lumen is raised into folds. The stomach and intestine are wide and thin-walled.

In sinistral shells the soft parts are reversed in direction and position.

Type-series :—Dextral No. M $\frac{12125}{2}$, Sinistral No. M $\frac{12124}{2}$.

Measurements of shells (in mm.).

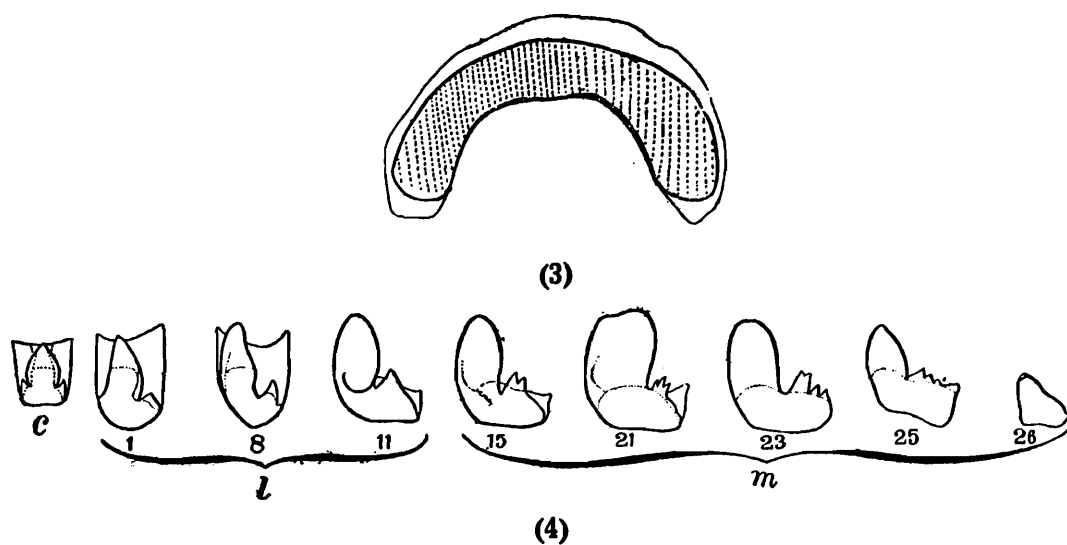
	Sinistral.			Dextral.		
	1	2	3	1	2	3
Height ...	21.3	21.0	20.5	18.8	17.0	17.8
Greatest breadth ...	6.5	7.0	7.0	6.0	6.2	6.5
Height of aperture	6.8	7.5	7.1	6.1	6.1	6.0
Breadth of aperture	4.8	5.3	5.2	4.9	4.3	4.1
Number of whorls ...	8½	9	8½	8½	8½	8½

Theobald's specimens are labelled "Salt Range." Those collected by Dr. Hora are from Kallar Kahar, Sardhi, Katas and Chalisa, all places in the same range and in the Jhelum district of the Punjab. Many of the specimens from Kallar Kahar were taken alive. They were attached in large numbers to tree-trunks in an apparently comatose condition, but we can see no trace of an epiphragm.

We have already suggested that local differences occur in the proportionate number of dextral and sinistral shells. The following are the facts on which we rely :—

In Theobald's series, the precise find-spot of which is unknown, the 22 specimens are all dextral. Combining this series with those obtained by Dr. Hora we have examined 154 shells. Of these 97 are sinistral and 57 dextral. In the total number, therefore, about 63 per cent are sinistral. If, however, we take the members of the series from different localities separately we find very different results. Of 48 shells from Sardhi 46 are sinistral and only 2 dextral, giving a percentage of nearly 94 per cent sinistral, while of 12 shells from Katas only 2 are sinistral, giving a percentage of only a little over 16 per cent. In a series of 70 shells from Kallar Kahar 49 are sinistral and 21 dextral, giving a percentage of about 70 per cent sinistral. Two shells from Chalisa station in the plains at the base of the range are both dextral. These shells are "dead" and may have been brought down from the hills in a flood.

We have to thank Professor P. C. Mahalanobis of the Calcutta Presidency College for the note on the mathematical significance of these figures printed immediately after this paper. His investigation seems to prove that the difference in the proportionate numbers of dextral and sinistral shells in different localities is not merely apparent.



TEXT FIG. 3.—Jaw of *Buliminus dextrosinister*, sp. nov.

TEXT FIG. 4.—Radular teeth of *Buliminus dextrosinister*, sp. nov.
c. Central ; l. laterals ; m. marginals.

***Pupoides coenopictus* (Hutton).**

1914. *Pupoides coenopictus*, Gude, *op. cit.* p. 259.

Two "dead" shells were obtained by Dr. Hora at Chalisa station. Others from Theobald's Salt Range collection are in the Museum.

***Pupoides lardeus* (Pfeiffer).**

1855. *Bulimus lardeus*, Pfeiffer, *Mart. Chem. Conch. Cab., Achatina* I, p. 151, pl. xxxix, figs. 14-16.

1876. *Bulimus coenopictus*, Hanley and Theobald *nec* Hutton, *Conch. Ind.*, pl. xxiii, fig. 9.

1914. *Pupoides lardeus*, Gude, *op. cit.*, p. 261.

There has been confusion about this species. Gude (*op. cit.*) cites Hanley and Theobald's figure in the synonymy of *P. coenopictus*, but

these authors state that they consider the types of *P. lardeus* to belong to *P. coenopictus* and their figure agrees with Pfeiffer's figure of the former species rather than with specimens of the true *coenopictus* from Quetta, from Hutton's collection and probably identified by him. We take it, therefore, that Hanley and Theobald did not figure the true *coenopictus*.

A single fresh specimen was obtained by Dr. Hora on the banks of the Katas nallah. The specimens from the Salt Range recorded by Nevill in his "Hand List" as *Pupa (Leuchochila)* sp. probably belonged to this species, but we have been unable to find them.

No precise locality seems to have been assigned to *P. lardeus* hitherto. It may be endemic in the Salt Range.

Opeas gracile (Hutton).

1914. *Opeas gracile*, Gude, *op. cit.*, p. 355.

A single empty shell was obtained by Dr. Hora at Chalisa station in the plains at the base of the Salt Range.

Zootecus insularis (Ehrenberg).

1906. *Zootecus insularis*, Pilsbry in Tryon's *Man. Conch.* (2) XVIII, p. 106. pl. xxvi, fig. 21.

1914. *Zootecus insularis*, Gude, *op. cit.*, p. 367.

Shells from the Salt Range are all white and opaque, but none seem to be quite fresh. They exhibit an extraordinary individual variability apparently not correlated in any way with locality. This is clearly shown by the series of measurements given below and in our figures. They were taken on fully formed specimens from two localities, namely, Sardhi on the hills, and Chalisa station in the plains at their base, both in the Salt Range, Punjab.

Dr. Hora also obtained specimens at Katas nallah.

SARDHI.			CHALISA.		
Height of shell in mm.	Greatest diameter of shell in mm.	Number of whorls.	Height of shell in mm.	Greatest diameter of shell in mm.	Number of whorls.
14.5	4.8	9½	15.0	5.0	9½
14.0	5.0	9	14.1	5.1	9
14.0	4.9	8½	13.5	5.0	8½
12.6	4.3	8½	13.0	4.8	9
12.0	4.0	9	12.3	4.3	8½
11.1	4.2	8½	11.4	5.0	7½
11.0	4.5	8½	11.2	4.9	8
10.0	4.3	8	10.7	4.4	8½
10.0	4.2	8½	10.5	4.6	7½
9.8	4.0	8	10.3	4.8	7½
9.7	4.3	8	10.2	4.5	8½
9.5	4.4	8	9.4	4.9	7
8.9	4.0	7½	9.4	4.0	8
8.8	4.2	7½	8.5	3.8	7½
8.8	4.0	7½	8.1	4.0	8

In one specimen the epiphragm remained complete. It had the form of a thin calcareous plate occupying the extreme outer part of the

mouth and somewhat convex externally. Towards the upper extremity there was an elongate transverse hole. Further into the shell there were at least two similar plates separated by short intervals, both with similar holes. The soft parts had completely disappeared but we extracted an embryonic shell. Possibly the hole had been made by some enemy which had devoured the snail.

***Succinea crassinuclea*, Pfeiffer.**

1878. *Succinea crassinuscula*, Nevill, *op. cit.*, p. 212.

1914. *Succinea crassinuclea*, Gude, *op. cit.*, p. 453.

The specimens recorded by Nevill from the Salt Range under the name *Succinea crassiuscula* are still in the collection.

The species occurs at Simla as well as in the localities recorded in the works cited above.

AQUATIC SPECIES.

GASTROPODA.

***Amnicola (Alocinma) pulchella* (Stoliczka).**

1836. *Paludina pulchella*, Benson, *Journ. Asiat. Soc. Bengal* V, p. 746.

1876. *Bythinia pulchella*, Hanley & Theobald, *op. cit.*, p. 18, pl. xxxviii, figs. 5, 6.

1922. ?*Digonistoma pulchella*, Baini Prashad, *Rec. Ind. Mus.* XXIV, p. 17.

This species is a true *Alocinma*, but the structure of the operculum is very liable to be obscured by erosion or the deposit of extraneous matter. The specimens from Manipur recorded under this specific name by Annandale¹ belong to the genus *Digonistoma* as stated, but not to Stoliczka's species.

Theobald obtained shells in the Salt Range and Dr. Hora collected a large series of living specimens in a small stream at Watli as well as empty shells from Katas Nallah and Chalisa. The shells are large and well formed.

***Melanoides flavidus* (Nevill), Annandale and Prashad.**

1919. *Melanoides pyramis* var. *flavida*, Annandale & Prashad, *Rec. Ind. Mus.* XVIII, pp. 29, 30, 34, figs. 3b, 4d, pl. iii, fig. 6, pl. iv, fig. 6.

The shape of the mouth of the shell in this form is so distinct that we prefer to regard it as a separate species. The columella is considerably longer and less arched than in the forms we leave in *M. pyramis* and its callus is thicker and more porcellaneous. The base of the body-whorl recedes much more abruptly on the ventral surface and the outer lip projects far beyond the level of the columella. The form *luteomarginatus* has the same characters and must be regarded as a variety of *flavidus*.

Many of the shells collected by Dr. Hora in the Salt Range are quite typical. Others are larger than any hitherto measured and of an almost uniform dull olivaceous colour. Unicolorous specimens of smaller size also occur together with typical shells. The largest in the collection is 38 mm. long by 13 mm. in maximum transverse diameter. Its apex is slightly eroded.

¹*Rec. Ind. Mus.*, XXII, p. 541, (1921).

Dr. Hora obtained living specimens in the Katas Nallah, in a small stream at Shivganga and at Choa Saidan Shah.

The species has been known hitherto only from the desert region of southern Baluchistan, from S. Seistan and from Iraq.

***Limnaea acuminata* Lamarck.**

1921. *Limnaea acuminata*, Annandale & Prashad, *Rec. Ind. Mus.* XXII, pp. 568, 569, fig. 12.

Shells from the Salt Range are mostly typical, showing considerable variation in shape, but not quite to the same extent as the series from the United Provinces figured in the paper cited. None are of very large size and some are distinctly dwarfed, but none exhibit any marked abnormality in form or structure.

Specimens taken among algae and weeds growing on a rocky bottom in the Katas Nallah have moderately thin shells of a pale luteous colour and not exceeding 26 mm. in length and 15 mm. in maximum transverse diameter. Those from Shivganga are similar. Shells from the banks of a stream at Choa Saidan Shah are slightly thicker and broader in proportion, while those from another stream at Dheri Jaba are very small, thin and rather narrow, not longer than 15 mm. or broader than 6.5 mm. Dr. Hora noted that a mineral deposit of the nature of tufa was being formed on the bottom of this stream.

***Limnaea luteola* Lamarck.**

1921. *Limnaea luteola*, Annandale and Prashad, *op. cit.*, p. 566.

Distinct as are extreme forms of this species from those of *L. acuminata*, many shells appear to be intermediate, and we have not been able to find any constant difference in the radula or the soft parts. Indeed these structures seem to be almost as liable to variation as the shell.

Dr. Hora obtained a good series of specimens from a stream near Kallar Kahar.

***Limnaea persica* Issel.**

1919. *Limnaea persica*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 41, pl. v, figs. 3-6.

Hitherto recorded only from Southern Persia and the Baluch desert, this species appears to have a wide range in the Himalayas and beyond. We find numerous specimens in the collection from Peshawar, from Bhim Tal and Naini Tal (4,500-7,000 feet) in Kumaon and also from Secunderabad in the Deccan. Specimens from Kumaon and from Secunderabad have been confused with *L. acuminata*, with shells of which they were mixed.

Dr. Hora obtained two living shells from a stream near Dheri Jaba and a few dead shells on the banks of the Katas Nallah.

***Indoplanorbis exustus* (Deshayes).**

1921. *Planorbis exustus*, Germain, *Rec. Ind. Mus.* XXI, pp. 26, etc., figs. 1-16.

1923. *Indoplanorbis exustus*, Rao, *Rec. Ind. Mus.* XXV, pp. 199-219, many text-figs.

Specimens from the Salt Range are of moderate size and rather pale colour, but not otherwise remarkable,

Dr. Hora found the species living in a pond near Watli and in a stream near Kallar Kahar. He also obtained empty shells at many localities in the range.

***Gyraulus convexiusculus* (Hutton).**

***Gyraulus euphraticus* Mousson.**

1919. *Gyraulus convexiusculus* and *Gyraulus euphraticus*, Annandale & Prashad, *op. cit.*, pp. 52, 40, 53, 55, figs. 5c, 5f, (not 5d), 7, 8a, 8b.

These two species occur together in the Salt Range as in so many other localities. Several "dead" shells of each were found on the banks of the Katas Nallah.

***Gyraulus saltensis* Germain.**

1922. *Gyraulus saltensis*, Germain, *op. cit.*, p. 127.

We assign to this species with some doubt several empty shells found with those of the preceding two species on the banks of the Katas Nallah. The type has not yet been returned to Calcutta and no figure has been published.

***Gyraulus labiatus* (Benson).**

1915. *Planorbis* (*Gyraulus*) *labiatus*, Preston, *Faun. Brit. Ind., Fresh W. Moll.* p. 119, fig. 5.

Dr. Hora collected a large series of living specimens in the Katas Nallah. They exhibit considerable variation in the degree to which the last whorl is deflected, but otherwise agree with Preston's figures of the type-specimen.

To judge from specimens recently examined by us, *G. labiatus* is widely distributed in northern and central India.

PELECYPODA.

We are obliged to Dr. Baini Prashad for the following note on the bivalves collected by Dr. Hora in the Salt Range :—

- " 1. The Unionidae from Choa Saidan Shah, Salt Range and Katas Nallah (Sta. 4) are all dead shells of the very widely distributed *Indonaia caeruleus* (Lea). There is no complete shell but only stray valves of different specimens.
2. The Cyrenidae from Katas Nallah (Sta. 4) and Jhelum district, are all either young or highly worn shells of the common species *Corbicula striatella* Desh., which is also a very widely distributed species.

EXPLANATION OF PLATE IX.

Eulota pentepotamiensis, sp. nov.

Figs. 1, 1*a*, 1*b*.—Type-specimen, $\times 2$.

Figs. 2, 2*a*.—Shell with elevated spire and narrow umbilicus, $\times 2$.

Figs. 3, 3*a*.—Shell with relatively depressed spire and broad umbilicus, $\times 2$.

Buliminus salsicola (Benson).

Figs. 4, 4*a*, 5, 5*a*.—Lectotypes, $\times 2$.

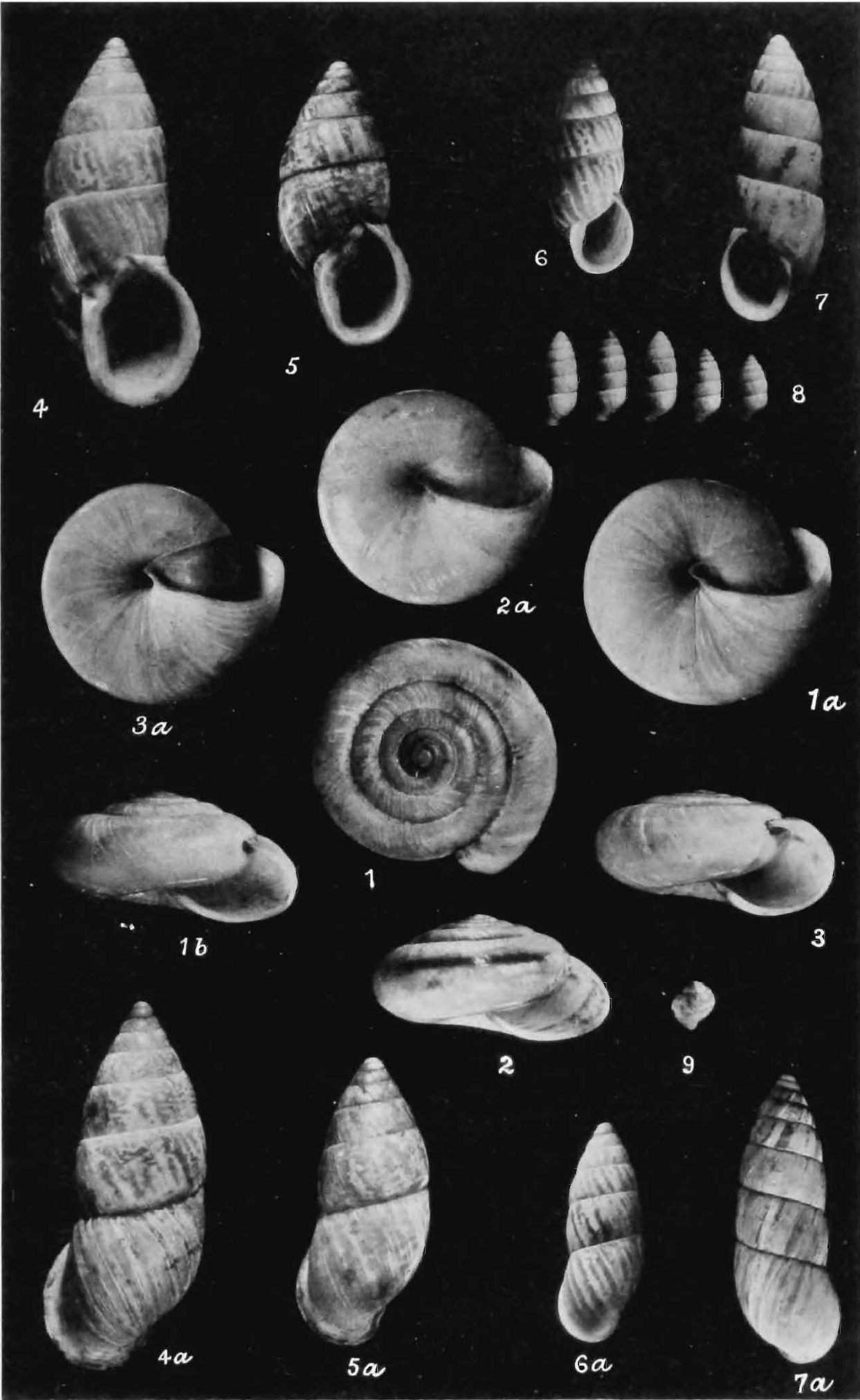
Buliminus dextrosinister, sp. nov.

FIGS. 6, 6*a*.—Dextral shell, $\times 2$.
Figs. 7, 7*a*.—Sinistral shell, $\times 2$. } Type-specimens.

Zootecus insularis (Ehrenberg).

Fig. 8.—Adult shells from the Salt Range, illustrating variability (nat. size).

Fig. 9.—Embryo, $\times 4$.



Salt Range Shells.

ZINCO COLLOTYPE CO., EDINBURGH

STATISTICAL NOTE ON THE SIGNIFICANT CHARACTER OF LOCAL VARIATION IN PROPORTION OF DEXTRAL AND SINISTRAL SHELLS IN SAMPLES OF THE SNAIL *BULIMI- NUS DEXTROSINISTER* FROM THE SALT RANGE, PUNJAB.

By P. C. MAHALANOBIS, *B.Sc., M.A. (Cantab.), Professor of Physics,
Presidency College, Calcutta.*

Dr. Annandale, Director, Zoological Survey of India, sent me the following data for a statistical report on a collection of shells of the snail *Buliminus dextrosinister* from the Salt Range.

Locality.	DEXTRAL.		SINISTRAL.		TOTAL
	No.	Percentage.	No.	Percentage.	
1. Chalisa 	2	100	...	...	2
2. Katas 	10	83.3	2	16.7	12
3. Kallar Kahar ...	21	33.3	49	66.7	70
4. Sardhi 	2	4.2	46	95.8	48
TOTAL ...	35	37.7	97	62.3	132

Two distinct questions arise.

- Do dextral and sinistral shells occur in nature in equal proportions or do they occur in different proportions ?
- If in different proportion, is this proportion the same for all localities, or is there local variation in the proportion ?

Let us assume that the shells occur in equal proportions in nature. Then the "theoretical proportion" of each is $\frac{1}{2}$. For example in the total sample, the "theoretical proportion" would be 66 of each. The "observed proportion" is 35 dextral and 97 sinistral.

Of course we cannot expect to get 66 dextral shells in *each* sample of 132. The "observed proportions" will vary on account of fluctuations of sampling. The question is whether difference between the "observed" and the "theoretical" proportion is merely due to such fluctuations of sampling or whether it is indicative of a real difference in the proportions in which dextral and sinistral shells occur in nature.

To put it in a slightly different way : A sample of 35 dextral and 97 sinistral shells may sometimes occur on account of fluctuations of sampling. But how often ? In other words, the precise mathematical question is : What is the exact probability of such occurrence ?

The solution is well-known and may be stated quite generally.

If the "theoretical proportion" of dextral and sinistral shells is p and q respectively ($p + q = 1$) then the probability of occurrence of a sample of s dextral and r sinistral ($s + r = m$) in a sample of m is given by

$$C_s = \frac{\binom{m}{s}}{\binom{m}{s} \binom{m}{r}} \cdot (p)^s (q)^r$$

By direct arithmetical calculation I obtain the following table.

TABLE II.—Probability of occurrence of "observed" samples for $p=q=\frac{1}{2}$.

Locality.			Number of dextral shells.	Probability.	odds against
1. Chalisa	...	...	2	0.25	4 to 1
2. Katas	...	...	10 or more.	0.01 92 86 —4	51 to 1
3. Kallar Kahar	...	...	21 or less	5.46 × 10 —12	18 28 to 1
4. Sardhi	...	...	2 or less	4.16 21 × 10	24.10 ¹⁰ to 1
TOTAL			35 or less	3.15 27 × 10 —8	32.10 ⁶ to 1

In the case of *Chalisa* the evidence is quite inconclusive. *Katas* also is doubtful; odds of 51 to 1 are not sufficiently high to justify us in asserting that the proportion of dextral shells is really greater than $\frac{1}{2}$. On the other hand the odds are very considerable in the case of *Kallar Kahar* and practically overwhelming in the case of the *Sardhi* and the *Total*. Thus on the whole we may reasonably argue that dextral shells occur in substantially lower proportion in nature.

I may now pass on to the second question, namely, is there any local variation in the proportion? The problem may be stated quite generally as follows.

In a first sample of n shells, p are found to be dextral and q sinistral ($p + q = n$), what is the chance of occurrence of s dextral and r sinistral shells in another sample of m ($m = r + s$)?

The solution is given by Bayes' theorem and the result can be easily calculated with the help of formulae given by M. Greenwood¹ and Karl Pearson.²

$$C_s = \frac{\binom{n+1}{p} \binom{m}{s}}{\binom{n+1}{p} \binom{m}{s} \binom{m+n+1}{p+s}} \cdot \frac{\binom{p+s}{s} \binom{q+r}{r}}{\binom{p+s}{s} \binom{q+r}{r}}$$

Greenwood³ says "Let the chance of a_2 or more successes in n_2 (s or more successes in m_1 in our notation) after a_1 successes in n_1 (i.e. p successes in n) be p_2 and the chance of a_1 or less successes in n_1 trials (p or less in n) after a_2 successes in n_2 (s success in m) be p_2 . Then, since either n_1 or n_2 might have been drawn first, a measure of the probability of the observed result will be $\frac{1}{2} (p_1 + p_2)$."

¹ *Biometrika*, IX, pp. 69-90.

² *Phil. Mag.* 1907, p. 365 also *Biometrika*, XIII, 1920, pp. 1-16, and *Tables for Statisticians and Biometricians*, pp. lxx-lxxiii.

³ *Ibid.* p. 81.

I am not quite sure about the validity of Greenwood's argument, at least, in its application to the present problem. It seems desirable to give full weight to the most favourable probability for agreement before differentiation is definitely asserted. On this principle the more numerous sample should invariably be taken as the first sample. Doing this we shall find the most favourable probability that the samples are in agreement. If this most favourable probability itself is found to be too small then we shall be justified in asserting differentiation. In other words we should choose the case most unfavourable for our conclusion, thus erring on the safe side.

I have also used the "four-fold X^2 method" of Pearson¹ as a check. In the present notation.

$$X^2 = \frac{(pr - qs)^2 (m+n)}{n. m. (p+s)(q+r)}$$

and may be easily calculated. The probability of occurrence, P, is then found from Tables XII and XVII (pp. 26, 31) of Tables for Biometricians and Statisticians. Q gives the probability on Bayes' theorem.

Chalisa : Katas

Q = .6286	...	...	...	6 to 10 in favour of agreement.
P = .312	...	...	...	1 to 3 in favour of agreement.

There is no evidence of differentiation. The probability is that both represent the same content in nature.

Chalisa : Kallar Kahar

Q = .0927	...	...	...	94 to 10 against agreement.
P = .2271	...	...	...	44 to 10 against.

Differentiation is not improbable but the evidence is not conclusive.

Chalisa : Sardhi

Q = .0047	...	...	...	...	212 to 1 against.
P = 2.55×10^{-5}	...	...	...	...	40,000 to 1 against.

Differentiation is probable; but the smallness of the number (2 only) in the case of Chalisa renders the conclusion somewhat doubtful.

Katas : Kallar Kahar

Q = .00065	..	...	...	...	1528 to 1 against.
P = .00630	...	...	..	...	157 to 1 against.

It seems fairly certain that Katas has got a higher proportion of dextral shells than Kallar Kahar.

Kallar Kahar and Sardhi

Q = .000177	...	...	...	...	5662 to 1 against.
P = .007083	...	...	...	...	140 to 1 against

These also seem to be quite significantly differentiated.

¹ Draper's *Company Research Memoirs, Biometric Series VIII*. "On a Novel Method of regarding the Association of two varieties classed solely in Alternate Categories."

Katas : Sardhi

$Q=5.5 \cdot 10^{-6}$... 180,800 to 1 against.

$P=1.6 \cdot 10^{-9}$... 10^8 to 1 against.

The probability is now overwhelming that the samples are different.

Summing up we may say : Chalisa is uncertain ; Katas shows distinctly higher proportion of dextral shells than either Kallar Kahar or Sardhi, while Kallar Kahar itself shows significant excess over Sardhi.

The following table will give some idea about the reliability of the observed proportion in each case :—

TABLE III.—Percentage frequency of dextral shells in samples of the same size *m*.

1. Chalisa <i>m</i> =2	3. Kallar Kahar <i>m</i> =70	4. Sardhi <i>m</i> =48	Total <i>m</i> =132
0 10.00	10 0.679	0 13.350	22 0.9137
1 30.00	11 1.087	1 19.143	23 1.2244
2 60.00	12 1.634		24 1.5927
	13 2.316	2 19.349	25 2.0137
	14 3.113		26 2.4781
	15 3.985	3 16.124	27 2.9713
2. Katas <i>m</i> =12	16 4.874	4 11.960	28 3.4571
	17 5.711	5 8.186	29 3.9682
	18 6.430	6 5.273	30 4.4278
2 0.084	19 6.970	7 3.236	31 4.8319
3 0.302	20 7.287	8 1.962	32 5.1606
4 0.866		9 1.084	33 5.3979
5 2.079	21 7.360	10 0.597	34 5.5332
6 4.312			35 5.5616
7 7.854	22 7.193		
8 12.622	23 6.809		36 5.4843
9 17.764	24 6.251		37 5.3085
	25 5.569		38 5.0457
10 21.317	26 4.819		39 4.7119
	27 4.054		40 4.3244
11 20.348	28 3.316		41 3.9019
12 12.435	29 2.638		42 3.4626
	30 2.043		43 3.0230
	31 1.540		44 2.5971
	32 1.131		45 2.1962
	33 0.808		46 1.8285
			47 1.4992
			48 1.2107
			49 0.9632

Taking 1% (one per cent of the samples) as a limiting value, we find the range to be 0 to 2 (*i.e.* 0% to 100%) dextral shells in the case of Chalisa, 5 to 12 (*i.e.* 42% to 100%) in the case of Katas, 11 to 32 (16% to 46%) in the case of Kallar Kahar, 0 to 9 (0% to 19%) in the case of Sardhi and 23 to 48 (17% to 29%) in the case of the total sample.

Finally we may compare each sample with the three others taken together.

		Dextral.	Sinistral.	Total.
1. Others	...	33	97	130
Chalisa	...	2	0	2
		35	97	132

$P=.0678$. The evidence is inconclusive.

2. *Katas and others*

Others	...	25	95	120
Katas	...	10	2	12

$P=2.38 \times 10^{-5}$ Katas seems to be really differentiated from the rest.

3. *Kallar Kahar and others*

Kallar Kahar	...	21	49	70
Others	...	14	48	62

$P=.1863$ Kallar Kahar agrees well with the rest of the sample and may be considered fairly typical.

4. *Sardhi and others*

Sardhi	...	2	46	48
Others	...	33	51	84

$P=2.38 \times 10^{-5}$ Sardhi also is different from the rest.

Conclusion.—We may on the whole conclude that dextral shells occur in less frequency in nature, the proportion probably being roughly from a fifth to a third; that Kallar Kahar is a fairly typical sample, while Katas and Sardhi seem to be somewhat differentiated from the rest.

NOTES ON CRUSTACEA DECAPODA IN THE INDIAN MUSEUM.

XVI. ON TWO INTERESTING CRABS FROM THE MOUTH OF THE RIVER HUGHLI.

By STANLEY KEMP, *Sc.D.*, *Superintendent, Zoological Survey of India.*

Plate X.

In bygone years the Indian Museum was indebted to the members of the Bengal Pilot Service for numerous and often very valuable collections of zoological material obtained at the Sandheads off the mouth of the River Hughli. Numbers of specimens are registered as presented by the Commissioners of H. M. Pilot Brigs and foremost among those whose names are recorded as donors are A. J. Milner, W. M. Daly and J. Barnet.

Nowadays the Pilot Brigs are replaced by modern steamships, one of which, the S.S. 'Fraser,' has recently been provided with a beam-trawl for such marine investigation as the exigencies of the service may permit. The results already obtained are of great interest and tend to show that our knowledge of the fauna which lives at the mouth of the Gangetic Delta at depths of about 20 fathoms is still very deficient.

Recent acquisitions among Decapod Crustacea include an example of the rare Penaeid *Atypopenaeus compressipes* (Henderson) and specimens of the two interesting crabs which are referred to below.

Family PORTUNIDAE.

Lissocarcinus arkati,¹ sp. nov.

(Plate X, fig. 1.)

The carapace is subcircular, with straight posterior margin, and is about one-fifth broader than long. The antero-lateral margins are evenly rounded but not strongly arched; the postero-lateral margins are straight, not concave as in *L. polybicides*, and meet the semi-circular excavations in which the basal segments of the last pair of legs are accommodated in a blunt and obtuse angle. The posterior border is slightly concave in the middle, acutely angled on either side at the base of the last pair of legs, and is very broad, not far short of two-thirds the greatest breadth of the carapace.

The carapace is distinctly convex in both longitudinal and transverse directions, with a pair of rather faint grooves marking the lateral boundaries of the cardiac region. The greater part of the upper surface is closely covered with a series of transverse ridges, each bearing a short fringe of forwardly directed setae. In the anterior half of the carapace

¹ An officer of the Bengal Pilot Service is known in the vernacular as an *ārkāṭi sāhib*. It is a tradition in the service that the name is derived from Arcot (*Arkāt*) in S. India and dates from the time when Madras was the seat of Government under the East India Company and pilots for all ports in the Bay of Bengal were in the service of the Nawab of Arcot. Forbes, in his Hindustani Dictionary, considers this derivation probable.

these ridges are long and often continuous across the carapace from side to side; in the posterior half, though equally conspicuous, they tend to become broken up into short lengths. On the extreme posterior parts the ridges are altogether wanting; in the middle line they are absent in the posterior quarter of the carapace, but on either side they extend backwards almost to the base of the last pair of legs. From 22 to 25 ridges may be counted in the mid-dorsal line of the carapace and from 28 to 32 on the margin behind the anterior orbital angle. In freshly preserved specimens the ridges and their setae are coloured deep red on a pinkish ground and the posterior smooth portions exhibit short streaks of dull red pigment which simulate ridges. The pterygostomian regions are conspicuously rugose, with numerous scattered setae.

The fronto-orbital border is nearly three-quarters the greatest breadth of the carapace and exceeds the breadth of the posterior border. The front projects very little and in the middle line is only a trifle in advance of the inner orbital angles (in this respect differing widely from *L. polybioides*); its breadth, excluding the inner orbital angles, is rather less than one-third the greatest breadth of the carapace. The margin is feebly notched in the middle line and on either side is straight or a little concave; the inner orbital angles are prominent with rounded tips and are separated from the front by a deep and rather wide notch. The orbits are large, with a notch in the upper border opposite the middle of the cornea and another in a similar position in the lower border.

The antero-lateral margins are thin and crest-like and are cut by four narrow incisions into five broad lobes (including the outer orbital angle) with acute or subrectangular anterior angles. The middle lobe is the broadest, and the foremost, which usually has a concave edge, is the shortest. The distance between the outer orbital angle and the hindmost tooth is scarcely half the breadth of the posterior margin.

The basal segment of the antenna is produced into the orbital hiatus and completely fills it to the exclusion of the flagellum, the produced portion of the segment being conspicuously carinate. The antennules are large and fold obliquely.

The outer maxillipeds do not differ materially from those of *L. polybioides*.

The chelipeds are equal, or nearly so, and are a little longer and much stouter than the walking legs. The upper surfaces of the palm, carpus and distal half of the merus are closely covered with ridges fringed with setae, similar to those on the carapace. On the merus the ridges are mostly transverse in direction, some long and some short. The inner edge of the segment bears from 4 to 6 short teeth which increase in size distally and are succeeded at the anterior end by a large broadly-rounded lobe; the posterior edge is roughened, with some tufts of whitish setae, and the inferior edge is almost smooth. On the upper side of the carpus there is a long continuous ridge extending from the tip of the large blade-like inner tooth to the outer aspect of the mero-carpal articulation; the remaining ridges, which are mostly short, are oblique in direction. Towards the outer limit of the upper surface the ridges on the carpus tend to form low blunt teeth and on its outer aspect the

segment is rather densely clad with white hairs, among which two sharp forwardly-directed teeth may be detected close to the propodal articulation. The upper border of the palm is rounded and covered with ridges which are mostly oblique and short. As in the carpus the ridges merge into blunt teeth and tubercles on the outer side, with tufts of setae interspersed; not infrequently the tubercles form a distinct longitudinal row opposite the finger-cleft. In the lower third of its outer surface the palm is almost smooth but the inferior edge is sharply defined and roughened, with a few short teeth or tubercles near the base of the fixed finger. The ridges on the dorsal surface of the palm pass over on to the inner face, which is otherwise rough, with one or two rows of smooth tubercles running towards the base of the fixed finger. The fingers have from 5 to 7 large rounded teeth on their inner edges and the tips overlap when the claw is closed. Both fingers bear sharp ridges separated by deep V-shaped depressions filled with setae. On the fixed finger there are two ridges on each side, the lowermost extending backwards on to the palm. On the dactylus there are 6 ridges; of these four are visible on the inner side, the two centre ones coalescing at about the middle of the finger-length.

The first, second and third walking legs are slender, subequal in length and rather shorter than the chelipeds. The merus is smooth and hairless; the carpus and propodus are bicarinate above with two lines of setae. The propodus of the first leg is fully 2.5 times as long as wide and, in all three pairs, the lower border is perfectly straight and ends in a small tooth. The dactylus is slender and lanceolate, with yellow corneous tips, two lines of setae and five longitudinal carinae, two of the latter being on the upper face.

The last pair of legs is subdorsal in position. The merus is scarcely one and a half times as long as wide, with a fringe of setae along its anterior edge. The two last segments are conspicuously lamellar, with fringes on their posterior edges, the dactylus being about twice as long as broad.

The above description is based on three large females, 16.4 to 20 mm. in length, two of which are ovigerous. The only male examined is extremely small, 6.6 mm. in length, and is possibly immature. In most respects the male agrees very closely with the female; but the transverse ridges are confined to the anterior half of the carapace and, though the chelipeds have almost identical sculpture, they are without the tufts of setae which are conspicuous in females. As in males of other species of the genus the 3rd to 5th abdominal tergites are fused. The last two pieces together form an almost equilateral triangle and the sixth segment is about two-thirds as long as its basal breadth.

The specimens yield the following measurements (in mm.):—

Sex	...	...	...	♀ ovig.	♀ ovig.	♀	♂
Length	...	...	...	20.0	18.9	16.4	6.6
Breadth	...	...	...	23.4	23.4	19.7	7.3
Fronto-orbital breadth	...	...	...	16.9	16.1	13.8	5.9
Breadth of front ¹	...	...	...	7.6	7.4	6.4	2.7
Breadth of posterior margin	...	...	...	14.8	14.7	12.8	4.3

¹ Excluding inner orbital angles.

The specimens were all trawled by the S.S. 'Fraser' at the Sandheads, at the mouth of the River Hughli, in about 20 fathoms of water. Two of the females are regarded as types and are registered in the collection of the Zoological Survey of India under number C 693/1.

The only other species of *Lissocarcinus* which possesses numerous transverse ridges on the carapace is the little known *L. boholensis* Semper,¹ from Bohol in the Philippine Islands. The very brief original description of this species, as Miss Rathbun has pointed out (*loc. cit., infra*), is erroneous in stating that the carapace is longer than broad. According to Semper's account the species differs from that described above in the produced front, in the chelipeds, which are described merely as rough on the outer and upper sides, and in having the transverse ridges of the carapace (in a specimen 14 mm. in length) restricted to the anterior half. The only subsequent record of *L. boholensis* that I have been able to find is that by Miss Rathbun,² who has described an extremely small specimen, 3.7 mm. in length, from the vicinity of Koh Kut in the Gulf of Siam. From the account of this specimen *L. arkati* differs widely. The shape of the carapace is said to resemble that of *L. polybioides*, the postero-lateral margins are concave, the posterior border is only half the breadth of the carapace, the fronto-orbital breadth is very little less than the extreme width, the front is strongly projecting, the surface of the chelipeds is "finely roughened" and the posterior margin of the propodus of the first three walking legs is apparently without a tooth at the distal end. In all these respects the specimen differs from the small male of *L. arkati* referred to above.

Miss Rathbun notes that her specimen was found in Salpae and other species of the genus are known to be symbiotic. It is probable therefore that *L. arkati* has some peculiar habit of life, but as regards this point no information is at present available.

Family XANTHIDAE.

Liagore rubromaculata de Haan.

(Plate X, fig. 2.)

1898. *Liagore rubromaculata*, Alcock, *Journ. Asiat. Soc. Bengal*, LXVII, p. 93

A large male of this species, only once previously found in the Bay of Bengal, has recently been obtained by the S.S. 'Fraser' at the Sandheads, off the mouth of the River Hughli, in water about 20 fathoms in depth. The carapace is 25 mm. in length and 36 mm. in breadth.

The species was first found on the Japanese coast and was redescribed by Alcock from a single specimen obtained at the mouth of the Irrawaddy delta in 20 fathoms and from eight specimens from Hongkong. It has since been recorded by Miss Rathbun³ from Kii, Japan, and by Parisi⁴ from China. Four additional specimens have also been obtained by the R.I.M.S. 'Investigator' at the upper end of the Persian Gulf, 29° 59' N., 50° 3' E., in 20 fathoms.

¹ Semper, in Nauck, *Zeitsch. wiss. Zool.* XXXIV, pp. 60, 67 (1880).

² Rathbun, *Kong. Danske Vidensk. Selsk. Skrifter*, 7 Række, *naturvid. og math.*, V, p. 363 (1910).

³ Rathbun, *Proc. U. S. Nat. Mus.* XXVI, p. 24 (1902).

⁴ Parisi, *Atti Soc. Ital. Sci. Nat.* LV, p. 178 (1916).

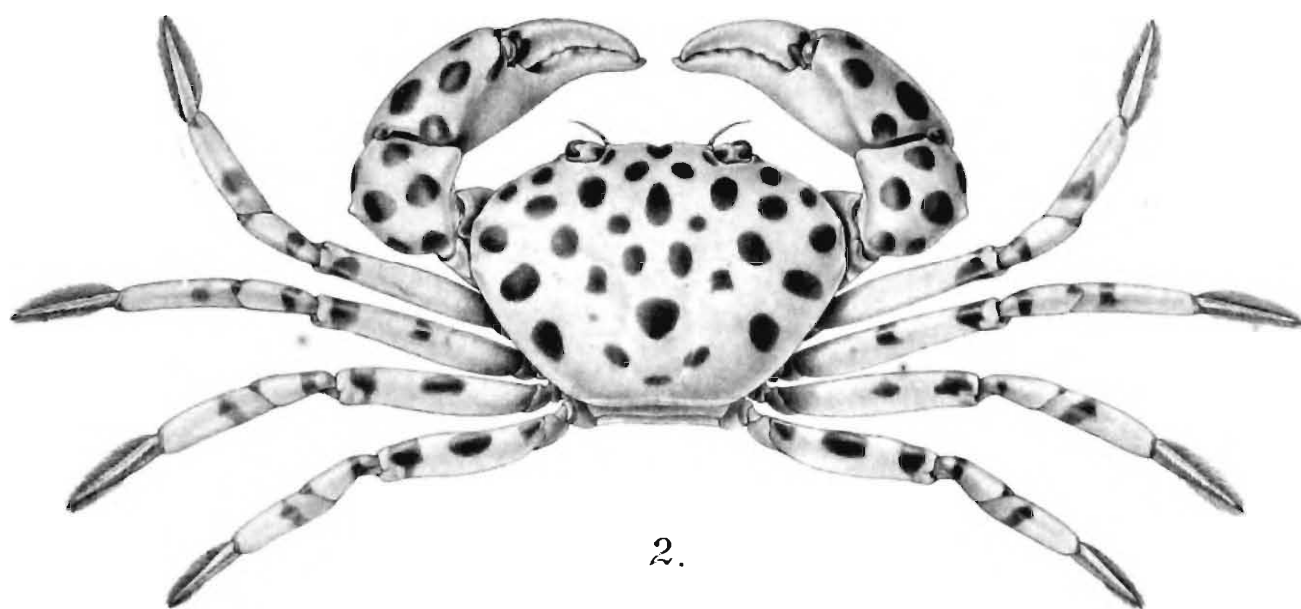
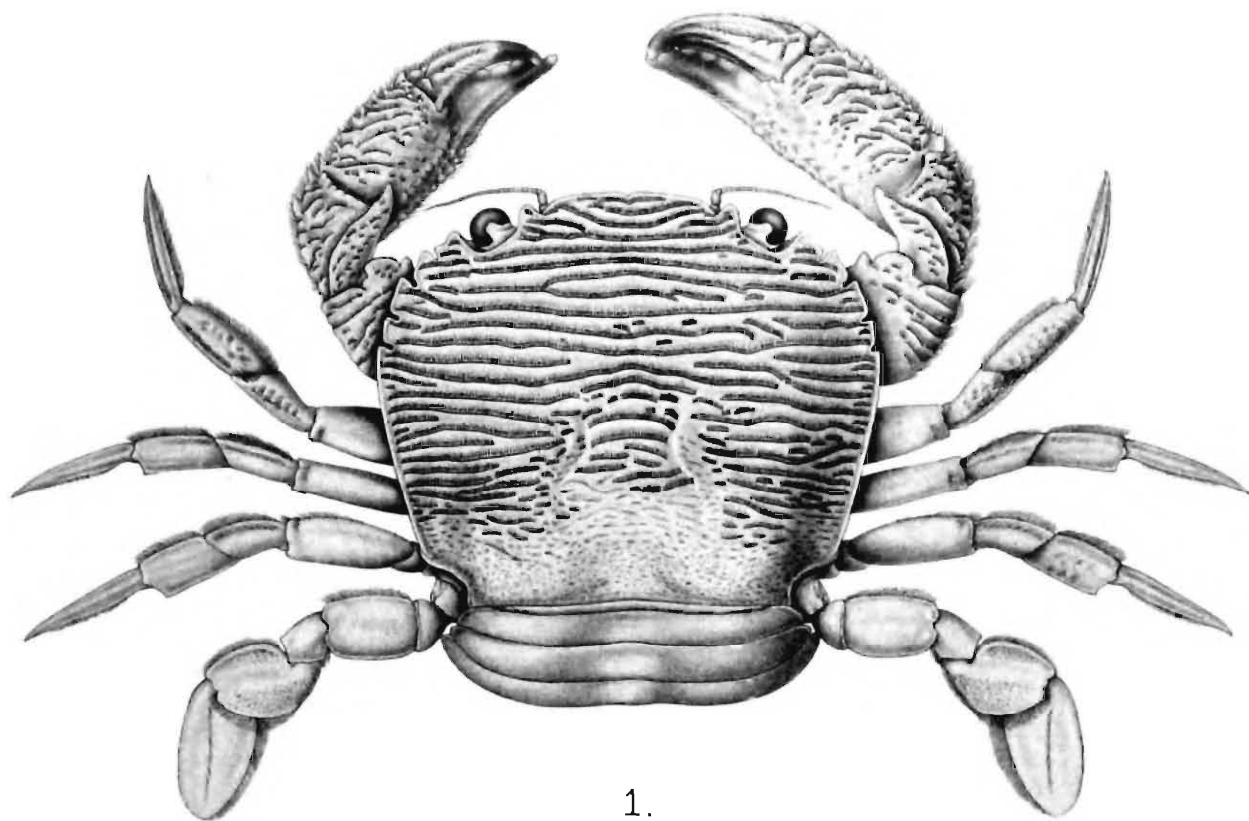
On comparison with the examples from Hongkong the only noteworthy difference is that in Indian specimens and in those from the Persian Gulf the antero-lateral margins are obscurely divided into four blunt lobes. In those from Hongkong no trace of this is apparent and de Haan in his original description ¹ says of the carapace "latera integerrima."

All the specimens are completely bleached with the exception of that recently collected by the S.S 'Fraser' and in this example the red spots are considerably larger than indicated in de Haan's figure. I take this opportunity of giving a fresh figure of the species.

¹ De Haan, in Siebold's *Fauna Japonica, Crust.*, p. 49, pl. V, fig. 1 (1835).

EXPLANATION OF PLATE X.

- FIG. 1.—*Lissocarcinus arkati*, sp. nov. Dorsal view of an ovigerous female. Enlarged about three times.
- FIG. 2.—*Liagore rubromaculata* de Haan. Dorsal view of a male from the mouth of the River Hughli, showing the markings on carapace and legs. Slightly enlarged.



1. *Lissocarcinus arhati*, sp. nov.
2. *Liagore rubromaculata* de Haan.