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REPORT ON THE
AQUATIC FAUNA OF SEISTAN
WITH SUBSIDIARY STUDIES.

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ERRATA.

In the twenty-first line from top of page 45 for "are neither swollen" read "are neither greatly swollen."

In the twenty-fourth line from bottom of page 59 for "*L. jenkinsonianus*" read "*L. jenkinsianus*."

In the twenty-third line from bottom of page 81 for "rice-beds" read "reed-beds."

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[*N.B.*—An asterisk (*) preceding a line denotes a new variety or subspecies; a dagger (†) indicates a new species; a double dagger (‡) a new genus; synonyms are printed in italics.]

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REPORT ON THE AQUATIC FAUNA OF SEISTAN.

Prefatory Note.

The series of papers of which the first instalment is now published will be based mainly on the collections made by Mr. S. W. Kemp and myself in Seistan and Baluchistan in November, December and January, 1918-19. The main object of our tour was to enquire into the etiology of the disease Bilharziasis or Schistosomiasis, and particularly to discover whether the parasite occurred in Seistan, or whether any known intermediate molluscan host was found to be in that country. For this and other work on the zoological aspect of the disease a generous grant of money was made by the Council of the Indian Medical Research Fund. So far as it was concerned our results were entirely negative; but we took the opportunity to make as large and complete a collection of the aquatic fauna as the time at our disposal permitted. As this fauna is a limited one (*i.e.* includes few species but large numbers of individuals) we were able to obtain a more representative set of specimens than would have otherwise been the case. Our material, moreover, is supplemented by the specimens collected by the Seistan Boundary Commission of 1902-03 under the command of Sir Henry McMahon.

To Mr. Kemp my first acknowledgments are due. Indeed, a great part of the zoological success of our little expedition must be attributed to him. I only regret that it is impossible for his name to be more intimately associated with my own in the preparation of this report. The reason is the stress of other work and the necessity for a visit to Europe on his part. I have also to thank the political officers in Baluchistan and Seistan, in particular, Mr. B. J. Gould, I.C.S., His Britannic Majesty's Consul in Seistan, Major D. Heron, I.M.S., C.I.E., Medical Officer and Vice-Consul, and Major W. G. Hutchinson, Political Agent, Chagai. The officers serving on the Eastern Persian Cordon also gave us much assistance in the way of transport and supplies. Babu J. N. Bagchi, Head Clerk, Zoological Survey of India, accompanied us and did good work. I have to thank Mr. E. Vredenburg of the Geological Survey of India for valuable suggestions embodied in the Introduction, while Dr. Baini Prashad, Offg. Director of Fisheries, Bengal, Bihar and Orissa, has helped me in various ways.

In examining the collection from Seistan it has been necessary also to examine much material of other *provenance*, and I have found it convenient to include in this volume certain studies of wider geographical scope.

N. Annandale.

Calcutta,
17-v-19.

GEOGRAPHICAL INTRODUCTION.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India.*

(With Plates I–II.)

Seistan and the Helmand River.

The Persian district of Seistan, at periods in its history an independent state and at others a part of Afghanistan, lies roughly between long. 61° and 62° E., lat. 30°50″ and 31°50″ N.; but its precise boundaries are not delimited to the west and south. It consists of the delta of the R. Helmand and the Hamun or basin into which that river flows. These lie, surrounded on all sides by stony desert, in a depression less than 2000 feet above sea level. The Helmand rises in the Hindu Khush in about lat. 68°40″ and long. 34°30″ and flows for three hundred miles through the mountains of Afghanistan, receiving many tributaries on its way. It then debouches on the desert plateau of Registan and, some distance after doing so, is joined by its largest tributary, the Arghandab. The course of the united waters, which flow in a deep bed through the desert, is S.S.W. for some seventy miles. They are then deflected by a small range of hills through which they have been unable to cut their way, and continue westward, with a distinct southward bend, for about another hundred and fifty miles. Then, on reaching the southern limits of the old delta, the river breaks up into innumerable channels, partly natural, partly artificial, which turn northwards. In these channels, the chief of which is ultimately known as the Rud-i-Pariun, much of the water is dissipated, but what remains finally drains westward into the Hamun-i-Helmand or Hamun-i-Seistan, a large basin (or rather series of basins) which occupies a considerable but extremely variable area. After the junction of the Arghandab and the Helmand very little additional water, not nearly enough to compensate for evaporation, enters the system; for the desert is practically rainless, even in Seistan the rainfall is only a

little over $2\frac{1}{2}$ inches a year,[1] and there are no permanent affluent streams. Seistan is a well-watered country, but its water-supply, like that of Egypt, depends not on local rainfall but on the rainfall and the snows in a mountainous region many miles away. The fact that, unlike most of the lake-systems of Central Asia and Persia, that of the Hamun-i-Seistan has not dried up is to be explained only by the peculiar course of the Helmand, the greater part of which traverses comparatively damp mountainous country.

The Hamun, however, is not the final repository of the soluble matter which the river inevitably brings into it. If it had been so, with its limited area, all its water would have been salt long ago. On maps of Persia and the adjacent countries a river, named the Shelagh (or Shila) river, is marked running southwards and eastwards from the Hamun into another basin, the Gaud-i-Zirreh, which occupies a very large area in the great desert of south-western Afghanistan. This is the Dead Sea of the

[1] The following tables of rainfall (in inches) are derived from official sources :—

Season.	Quetta.	Chaman.	Hindu Bagh.	Kabul.	Seistan.	Meshed.	Teheran.	Baghdad.
October to March ...	7·58	8·06	4·51	8·45	2·06	5·01	7·93	7·14
April to September ...	2·40	1·72	0·81	3·40	0·45	3·49	1·92	1·20
TOTAL ...	9·45	9·78	5·32	11·85	2·51	8·50	9·85	8·34

RAINFALL AT NASRATABAD, SEISTAN.

Month.	1902.	1903.	1904.	1905.	Total.	Average per month.
January ...	...	1·46	0·60	0·44	2·50	0·83
February ...	Not recorded.	0·42	0·15	0·28	0·85	0·28
March ...	...	0·97	0·19	0·37	1·53	0·51
April ...	0·03	1·19	...	...	1·22	0·41
May ...	...	0·05	...	...	0·05	0·02
June ...	...	0·07	...	...	0·07	0·02
July ...	..	...	...	...	...	...
August ...	..	...	...	...	...	...
September ...	...	...	...	...	...	...
October ...	0·27	...	...	...	0·27	0·09
November ...	0·17	0·07	0·06	...	0·30	0·10
December ...	0·60	0·13	0·01	...	0·74	0·25
TOTAL ...	1·07	4·36	1·01	1·09	7·43	2·51

Helmand system.[1] Except in times of exceptional flood the Shelagh is a deep stream-bed, dry except for scattered pools of water so saline that tamarisk twigs at the edge are coated half an inch thick with salt; but the water in flood-times, at the very site of these pools, becomes readily drinkable and the river is a raging torrent. Similarly the Gaud-i-Zirreh is at most seasons a wide plain covered with a thick deposit of salt and containing pools and swamps of saline water; but it may become a real lake for the time being, with water of comparatively but not actually low salinity.

The climate of Seistan, though regular from year to year, is one of considerable extremes and with only two seasons, summer and winter. In December and January the temperature usually falls below freezing point at night, while in summer it frequently rises to 115°F. in the shade by day, with a maximum of about 117°. It is, however, very exceptional for the larger bodies of water to freeze completely, while the summer heat is tempered by an almost unceasing wind. Wind,[2] indeed, seems to be the most constant feature of the climate, and its direction seldom changes. The direction is about N.N.W. For weeks on end in summer time it does not stop, and even in winter windy days are commoner than calm ones, and the wind is as a rule practically N.N.W. Such rain as falls, falls mainly between the end of December and that of April, in which thunderstorms accompanied by hail and causing sudden floods sometimes occur; but the real flood-season takes place when the snows begin to melt in Afghanistan between March and May.

Different Types of Aquatic Environment in Seistan.

A summary description of the Helmand-system and the climate of Seistan has been necessary to explain the very existence of the Hamun-i-Helmand as a lake, and of an aquatic fauna in the country. A detailed account[3] of the system would be impossible

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[1] In high floods a certain amount of water runs from the Helmand direct into the southern part of the Hamun system through a channel probably of artificial origin, and in exceptionally high floods some may flow direct into the Gaud-i-Zirreh, but this is not the normal course.

[2] "At the end of May, or middle of June, the celebrated *bad-i-sad-o-bist ruz* (120 days' wind) sets in and blows with but little cessation till the middle or end of September. It blows unceasingly for four or five days at a time, usually attaining its maximum daily velocity between midnight and 5 A.M and again between 8 A.M. and 5 P.M. It moderates a little in the early morning and evening. After four or five days it drops a little for a day or two, only to recommence with renewed violence. It blows with appalling violence, reaching the maximum velocity, as recorded by the Mission anemometers, of 72 miles per hour. It blows always from one direction, viz. a little west of north, i.e. between $316\frac{1}{2}°$ and $333\frac{3}{4}°$." (From an official document).

[3] The most complete account of the topography of Seistan yet published is to be found in Tate's *Seistan. A Memoir on the History, Topography, Ruins and People of the Country*, Parts I–IV (Calcutta, 1910 and 1912). See also McMahon "The Southern Borderland of Afghanistan," *Geog. Journ.* IX, pp. 393–415 (1897), *id.*, "Recent Survey and Exploration in Seistan," Vol. XXVIII, pp. 333–340 (1906), and Rawlinson "Notes on Seistan," *Journ. Roy. Geog. Soc.* XIII, pp. 272–294 (1873).

without further knowledge and greater space than are at my disposal. It is necessary, however, if the peculiarities of the fauna are to be demonstrated that a somewhat fuller description should be given of the physical conditions in which it lives. I have referred to Seistan as a well-watered country. One might go further and describe it as almost a water-logged country; and yet at first sight, at any rate in winter, it appears to be a desert of hard grey clay, only clothed with a sparse growth of camelthorn, only mitigated by the astounding play of the mirage. The apparent barrenness is because the soil is full of mineral salts dissolved in the water which permeates it a few feet below the surface. By capillary action the salts are drawn up towards the surface and assist in forming a hard, almost cement-like crust, which has to be removed before the operations of agriculture become possible. If a field or a garden be neglected for a few years a new crust of the kind is formed, and so it is only those parts of the country actually under cultivation that have any appearance of fertility.

The whole country is covered with a network of small water-channels ultimately connected with the branches or effluents of the Helmand. In these the flow of water is carefully regulated and for a great part of the year many of them are permanently or periodically dry. Even in their immediate vicinity the clay is almost lifeless. It is only in exceptional cases that the channels themselves support an aquatic vegetation, but in the one that supplies the Consulate garden at Nasratabad, there is a sparse vegetation of Characeae and *Potamogeton*, while in brick-pits close at hand on the parade-ground *Zannichellia palustris*,[1] L., grows with fair luxuriance. A green filamentous alga is more common and forms felt-like masses as it dries. These masses are often seen coating and sometimes completely burying the camelthorn in occasionally flooded country.

We did not have time to visit the main channels of the Helmand, but at a place near Jellalabad about twelve miles north-east of Nasratabad we examined the bed of one of the larger effluent streams. At the end of November, 1918 this stream-bed was almost dry, but shallow pools remained in which the water, though not very salt, was turbid and extremely foul owing to the presence of large flocks and herds which watered at the pool, and to the enormous number of small fish and mayfly larvae (*Palingenia*) that were dying in it. There was no vegetation in an active state in these pools, but peculiar roots with large globular swellings were still alive in the mud, and we found at some places the remains of reeds. Still nearer Nasratabad we examined a narrower but more active water-course, probably in part of artificial formation, which was connected with a small lake or large backwater. In this lake the only vegetation consisted of reeds in a withered condition, but

[1] I have to thank my friend Dr. H. G. Carter for the name of this and other plants mentioned in this report.

near it was a smaller pool in which were scattered plants, almost moribund, of a species of *Potamogeton.*

By far the most peculiar and most interesting body of water in the country, however, is that which occupies the Hamun. To appreciate the structure of the Hamun it must be realized that the word means lake-basin rather than lake, and is sometimes applied to large hollows that are quite dry. Moreover, in Seistan at any rate, it is used in a collective sense to indicate a whole series of basins only joined together in high floods. In this sense the full name is the Hamun-i-Seistan or Hamun-i-Helmand, but it is common to speak merely of the Hamun. On some maps of Persia and the adjacent countries the Helmand is shown as flowing into a compact body of water some eighty miles long and from ten to thirty broad. This state of affairs, however, only exists in exceptionally high floods and probably does not occur more than once in a decade. The Hamun is ordinarily divided into several distinct basins, of which two may be recognized as of most importance and most distinct. These may be conveniently referred to as the Hamun-i-Sabari and the Hamun-i-Koh-i-Khwaja. The Hamun-i-Sabari,[1] to use the name in the wider sense in which it is often used in Seistan, is the northern half of the Hamun-i-Seistan, and the only part of it that contains water not strongly saline at any season but flood-time. It rarely dries up completely. In normal winters it probably covers an area about ten to twenty miles long by six to twelve miles broad. The Rud-i-Pariun and other branches of the Helmand enters this basin on the eastern side. It is separated from the Hamun-i-Koh-i-Khwaja by a broad bar which is, except in flood-time, quite dry. Except at this season, the southern basin is dry or contains only pools of strongly saline water. It is only when the Hamun-i-Sabari overflows that it fills up, and when it itself overflows the Shelagh becomes a real river.

At the time of our visit the Hamun-i-Koh-i-Khwaja was said to be almost completely dry and we did not visit it. I shall confine my further remarks on the Hamun system, therefore, to the Hamun-i-Sabari. Of this lake we visited only the southern part, the northern extremity lying in Afghan territory.

The shores of this part of the Hamun are for the most part low and shelving, composed of mud more or less firmly caked and with frequent beds of reeds. Along the western shore there are, however, cliffs in some places over 50 feet high. The water reaches the base of these cliffs only in very high floods and the beach below them is strewn with water-worn pebbles. They are themselves composed of hard greenish-white clay formed of

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[1] On most maps, including those issued recently by the Survey of India, this name is confined to the extreme northern part of the system, which is often isolated if not completely dry, the more important basin into which the waters of the Helmand actually flow being left nameless. At Lab-i-Baring, however, the whole lake is called Hamun-i-Sabari.

very fine particles of even structure.[1] Along their summits a comparatively thin layer contains numerous pebbles similar to those that cover the surrounding desert,[2] and it is from this layer that the pebbles of the beach are derived. The cliffs themselves are being continually eaten away by wind and occasional rain and undermined by floods, which cause great blocks of clay to fall down on to the shore.

No trace of shells or other animal remains has been found in the clay of the cliffs. The clay of the bottom of the open lake in their vicinity is very similar in general appearance though naturally much softer, but contains empty shells of *Lamellidens* and *Corbicula* in a remarkably unworn condition.

The normal flood-level is marked on the shores of the lake by a drift-line consisting mainly of the broken stems and the inflorescences of reeds.

Perhaps the most prominent feature of this part of the Hamun is the enormous beds of reeds that cover a large part of its area. These reeds are of three kinds. Each kind grows separately but beds of each are to be found in the midst of those of the other two. The most abundant species is a form of *Phragmites* exactly intermediate, as my friend Dr. H. G. Carter informs me, between the Palaearctic *P. communis* and the Indian *P. kharka.* This reed covers hundreds of square miles in the flood season and gives its name (*nai*) to the Naizar or reed-country that affords valuable pasturage for sheep and cattle. When the floods sink the reeds die down as the soil dries, but those that have established themselves in deeper water flourish throughout the year. Next in abundance is *Scirpus littoralis*, which also covers large areas but does not extend so far out from the lake, and finally we have a bulrush of the genus *Typha*, which is rather less abundant than the other two species.

The reed-beds provide the means of life to two distinct classes of people who live on the shores of the Hamun—the Gaodar or cowherds and the Saiyads or hunters. The Gaodar have large herds of cattle, which they feed on the young shoots of *Phragmites* and *Typha*, both fresh and dry, and particularly on the *Scirpus.* Both tribes construct their dwellings entirely of *Phragmites*, and both make curious little skiffs, not unlike the papyrus skiffs of ancient Egypt, of the leaves of the bulrush—the only craft on the waters of Seistan.

The reed-beds are penetrated in all directions by narrow channels said to be made by the cattle of the Gaodar wading out to pasture, but probably kept open by the people themselves for use in bird-catching and fishing. The water in these channels is turbid near the shore of the lake but clear and of a yellowish tinge

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[1] For sections of the cliffs of Seistan see Huntington's account of "The Basin of Eastern Persia and Seistan", in *Explorations in Turkistan* (*Expedition of* 1903), published by the Carnegie Institution of Washington (1905).

[2] See Vredenburg, *Mem Geol. Surv. Ind.* XXXI, p. 179 (1901).

further among the reeds. The bottom is covered with a thin layer of peaty material, below which it is malodorous and black. It is as a rule from four to seven feet deep in the winter season. The channels widen out at intervals into open pools of two sorts, the larger of which are devoid of phanerogamic plants. Those of the smaller sort, which are rarely more than about six to ten yards wide, are rather deeper than the channels and are blocked with aquatic vegetation. This consists mainly of *Potamogeton pectinatus*, which with its narrow, grass-like leaves forms fairly dense masses from the bottom to the surface. Interspersed with it are single plants of *P. perfoliatus*, *Naias major* and Characeae. In the channels themselves single plants of *P. lucens* and at some places rather more densely congregated plants of *Vallisneria spiralis* form the only phanerogamic vegetation apart from the reeds.

The reeds act in all the channels and pools as a very effective wind-screen, so that even when a blizzard is blowing outside there is calm in the reed-beds. They also protect the water to some extent from frost.

Immediately outside the reed-beds, towards the open lake, there are at some places beds of *Potamogeton perfoliatus*, but the bottom of this part of the lake is usually bare. In calm weather the water is clear, but calm is exceptional in Seistan and as a rule it is turbid and of a milky appearance.

All the subaqueous plants of the Hamun are in a more or less moribund state in winter, the *Vallisneria* and *Potamogeton pectinatus* less so than the rest. Of the other species we found only occasional living shoots.

In the southern part of the Hamun-i-Sabari we made no sounding greater than 7½ feet, but rather deeper pockets are said to exist further north. It will be remembered, moreover, that our visit took place at the season at which the lake is almost at its lowest.

From a biological point of view the periodic and occasional changes in the level of the lake are of great importance. These are produced mainly by two causes, evaporation and changes in the supply from the Helmand due chiefly to the rate of melting of the snows of the Hindu Kush. The direction of the wind is so constant that its effects need not be considered. When it ceases to blow the water retreats a little but the result is quite temporary. In the year 1885, in which the Hamun was unusually full, the water reached its maximum in April, remained at its highest level up to the end of May and sank a little over three feet between that month and December.

In a climate like that of Seistan the loss of water by evaporation is very considerable in summer-time. The actual rate of evaporation apparently differs in different parts of the country in correlation with differences in the chemical composition of the water, being in the Gaud-i-Zirreh half of what it is in pools in the northern parts of Seistan. The whole question, however, is very

imperfectly understood and calls for further investigation. By calculation about ten feet of surface water should be lost annually from this cause in Seistan proper, but observations show that the actual amount is considerably less.

The loss of water through occasional failure of the Helmand supply is still more important to the aquatic fauna of the Hamun. Both fish and molluscs are said to have been abundant at one time in the lake, but it dried up completely in 1871 and again in 1903,[1] and since these dates the fauna is believed to have become much impoverished.

There is only one other kind of body of water to which I need refer here, viz. the springs that well up in the stony desert surrounding Seistan. These springs vary considerably in size and in salinity. None of them possess any great volume of water and few are quite fresh, the majority containing a more or less strong solution of magnesium sulphate, which has a devastating effect on the entrails of those who drink the water. An exception to this is to be found in the spring at Hurmuk, just across the Persian frontier and only a few miles from the point at which those of Persia, Afghanistan and Baluchistan meet. The water of this spring, which is fairly copious, is fresh and is stated locally to be the best in all Iran. Whether they be fresh or salt these springs are usually devoid of aquatic vegetation other than algae, at most, as at Saindak, having a scanty growth of *Potamogeton*, but a small *Scirpus* often grows at the edge, and the water is usually edged with willow trees (*Salix acmophylla*), perhaps planted. As a rule there is a small pool, more or less artificial, where the water comes out of the earth, with a streamlet or mere trickle passing from it into the desert and disappearing at no great distance.

Origin of the Hamun-i-Helmand.

It would be out of place in the present paper to discuss the geological history of Seistan[2] in any great detail, but there is one problem, that of the age of the Hamun, which has too important a bearing on the origin of the aquatic fauna to be entirely ignored. It has sometimes been assumed that the Hamun is the shrunken relic of a great freshwater lake, which has even been compared to the Caspian Sea. As I have already pointed out (*antea*, p. 4) the existence of a lake of practically fresh water in Seistan is to be explained by the peculiar course of the Helmand and by the fact that the whole system is occasionally flushed into the Gaud-i-Zirreh, and if, as the body of evidence[3] seems to show, the whole of

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[1] Huntington, E., "The depression of Seistan in Eastern Persia," *Bull. American Geog. Soc.* XXXVII, p. 276 (1905).

[2] See Huntington's account of "The Basin of Eastern Persia and Seistan" in *Explorations in Turkistan* (*Expedition of* 1903) published by the Carnegie Institution of Washington (1905).

[3] There is an extensive literature on this subject. For a good recent summary see the chapter on "The Ancient Climate of Iran" in Huntington's book "The Pulse of Asia" (London, 1907). Blanford's volume on the *Zoology and*

Eastern Persia and the neighbouring countries have become desiccated in the recent period, we may be certain that the basin of the Helmand contained more water at a period geologically not remote than it does now. More water must have entered the river, there must have been less loss by evaporation and possibly less by absorption in recent alluvium. Moreover, the structure of the Afghan-Baluch desert leaves little doubt that lakes of considerable area once existed within its confines, even if it never formed a single great lake-basin. It needs no great exercise of the imagination, for example, to believe that the Gaud-i-Zirreh, which is over eighty miles long and some twenty miles broad, was once a comparatively deep lake, which gradually silted up, as most lakes do in the course of time. Further, the clay of which the cliffs at Lab-i-Baring at the edge of the Hamun-i-Sabari (*antea*, p. 7) are composed has all the appearance in its fine texture, uniform structure and lack of stratification, of being a lake deposit.[1] My friend Mr. E. Vredenburg of the Geological Survey of India, who has been kind enough to examine specimens of this clay, reports that they closely resemble that of certain tertiary deposits in the Siwaliks which he believes to be of lacustrine origin. I have pointed out above (p. 8) that, *except in being totally devoid of animal remains*, it closely resembles the deposit now being formed at the bottom of the Hamun in the immediate vicinity of the cliffs.[2]

This, however, does not prove that the existing Hamun is the actual remains of an ancient freshwater lake. All that it indicates is that the Hamun occupies part of an old lake-basin. As the cliffs are over fifty feet high, this old basin must have contained a large body of water and existed for a long period, in order that so much silt should have been deposited.

The structure of the cliffs at this place is uniform except for a layer of a few feet on the surface. This layer is composed of dry earth more friable than the clay beneath it and full of water-worn pebbles, either of limestone or of volcanic origin. The following report on specimens of the limestone pebbles by Mr. Vredenburg shows that they do not differ from those found in the neighbouring desert[3] (with which this layer is, indeed, in continuity both structurally and geographically), and that, therefore, they have been brought from distant hills by occasional floods and not shaped by the waves of a lake. Mr. Vredenburg writes:—

"The three pebbles of dark-grey limestone contain a few specimens of *Nummulites atacicus*, Leym., a fossil characteristic of

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Geology in Eastern Persia, pp. 448–451, may also be consulted and the reports of the Expedition to Central Asia organized by the Carnegie Institution of Washington.

[1] Huntington, *op. cit.*, 1905, p. 285.

[2] It should be noted in this connection that in the Siwaliks proper of the sub-Himalayan area, which were not formed under desert conditions, freshwater fossil shells are abundant at certain places. Precise information about the species, etc., is, however, still lacking.

[3] See Blanford, *op. cit.*, p. 465 (London, 1876), and Vredenburg, *op. cit.*, p. 189.

the "Lybian" division of the eocene, a stage widely developed throughout the Mediterranean countries, and intermediate in age between the "Londinian" and "Parisian" of North-Western Europe where it is missing.

"This species is very scantily represented in the pebbles under examination, which are crowded with an *Alveolina* that occurs in profusion in the Lybian limestones of India which, consequently, have frequently been referred to under the name of "Alveolina limestones." Carter (*Journ. Bombay Br. Roy. As. Soc.*, Vol. V, p. 134, pl. ii, fig. 16, 1853), and d'Archiac and Haime (*Descr. an. foss. groupe numm. Inde.*, 1854, p. 348) have regarded this fossil as specifically identical with *A. sphaeroidea*, Lam. (*An. sans vert.*, 1822, Vol. VII, p. 615), which abounds amongst the rocks of the same age in the Pyrenean region.

"The Alveolina limestone, showing the same dark colour as the Seistan pebbles,[1] occurs in great abundance in the neighbourhood of Koh-i-Malik-Siah."

From this it follows that the deposit of which the cliffs are a section must have completely filled up the basin in which it was formed, at any rate at the site of the cliffs, and had been covered by a layer of entirely different and more recent origin that constitutes the surface of the desert over a great area in Persia, Afghanistan and Baluchistan.

The lack of animal remains in the clay of the cliffs at Lab-i-Baring is a very important difference between it and the deposit now being formed in the Hamun in their immediate vicinity. The freshwater shells found subfossil in many parts of Seistan are in a remarkably good state of preservation, while those of the individuals that still live in the Hamun are so free from erosion that even in adult individuals of *Lamellidens* the larval shell of the glochidium can often still be distinguished. It is, therefore, very improbable that shells, if they had ever existed in the cliffs, would have been completely destroyed. The lake of which the cliffs represented the bottom can, indeed, hardly have had a molluscan fauna. In this respect it resembled most Persian lakes, and the reason of its barrenness was the same:—its water was too salt, or rather contained too large a proportion of deleterious [2] salts in solution. The clay of the cliffs is consolidated with mineral salts and the little streams that arise in clay hills of exactly the same structure and run down through little gorges towards the lake contain water of such salinity that the salts crystallize out at their margin (*postea*, p. 15).

Now, the waters of the Helmand are fresh and those of Seistan become saline when they absorb salts from the soil. This was brought home to us in a very striking manner at Lab-i-Baring.

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[1] These pebbles have probably been brought by occasional floods from hills lying a considerable distance to the west or north-west of the lake.

[2] The macroscopic fauna of the saline streams in the cliffs at Lab-i-Baring consists of a few small insects.

While we were staying there the wind dropped and there was a dead calm for three days. The wind had previously been blowing from the north, the direction roughly from the point at which the Helmand enters the lake, and the water of the Hamun had been quite fresh to the taste. As soon as the Helmand water, however, ceased to be blown in our direction, that of the Hamun became perceptibly brackish. As the present Hamun system has an occasional outlet into the Gaud-i-Zirreh and its waters remain, at any rate in the Hamun-i-Sabari, fairly fresh because of the scouring of the floods, we may suppose that the salts in the soil round the basin near Lab-i-Baring are derived from an old lake which had no outlet of the kind.

There is much historical evidence that the outflow of the Helmand has moved northwards in recent times. For example, there are ruined cities in the south of Seistan where there is now no water at all, while ruins are exposed in the bed of the Hamun-i-Sabari in times of exceptionally low water. In its course through the desert the river has gradually cut for itself a deep bed. Before it did so its course may have been quite other than it is now, and the filling up and desiccation of lake-beds may have been correlated in a complex manner with changes in level. It is by no means improbable on general grounds that the river, as the Jordan does now, once terminated in a saline lake which was practically lifeless. Indeed, there is evidence that it did so in the historical period. I have to thank Mr. Vredenburg for the following note on this point:—

"With regard to the change in the course of the Helmand, it seems possible that the northward bend at the Band-i-Kamal Khan may be partly artificial. From the historical evidence of Arab geographers, this spot must correspond with the original head of the delta which, originally, therefore, would have spread mainly over Southern Seistan and would have communicated more directly than it does now with the Zirreh Lake. It is nevertheless conceivable that the diversion may have been natural or partly natural; the shifting beds of the distributaries, both natural and artificial, being gradually raised by the deposition of silt, a process which might have gradually involved the whole of Southern Seistan till the main body of the Helmand found an easier course northward. The present Hamun-i-Sabari, in its present relatively extended form, would be therefore quite modern—as shown, indeed, by the ruined city in its bed; though a comparatively small and intermittent pool may have previously been formed by the flood-waters of the Farah-Rud. It is also quite conceivable that, as it became increasingly difficult to keep open the irrigation channels in Southern Seistan, the Helmand may have been artificially deflected northwards over the more easily watered northern tract.

"So long as the delta spread chiefly over Southern Seistan, the Zirreh Lake must have been much more obviously and much more permanently than it is now the true termination of the Helmand system. The true relic of the large prehistoric lake alluded to by

Dr. Annandale would therefore be represented by the Zirreh Lake and not by the adventitious bodies of water in Northern Seistan, which, in their present form, are perhaps not more than six or seven centuries old.

"Whether the Shelagh is the original outlet of the whole body of water in times of exceptional flood also appears somewhat doubtful, and it is also quite possible that it has acquired its present importance within late historical times as a result of the silting up of the eastern portion of Southern Seistan. Originally the exceptional floods need not have collected as they do now in a single channel, but may have reached the Zirreh Lake directly through the various distributaries of a delta. Much more information than is at present available would be necessary to settle these various points which nevertheless are of great importance and interest from the various points of view of history, geology and physical geography."

The fauna of the Hamun shows no evidence of ancient origin, or of evolution in a great lake. It is a very poor fauna, as may be seen most readily by comparing it with that of the lake of Tiberias, in which the water is actually salter though other conditions are rather more favourable. From the Lake of Tiberias [1] twenty-five species of fish are known, from the Hamun only two; from the former at least fifteen species of molluscs, from the latter only five; from the former two species of Polyzoa, from the latter the same number; from the former five species of sponges, from the latter two. Moreover, the fauna of the Seistan Lake is by no means a highly specialized one. The fish belong to genera common either in the mountains of central Asia or in those of North-western India, the molluscs are closely related to widely-distributed Palaearctic forms, the sponges are cosmopolitan, while the Polyzoa are closely related either to tropical or to cosmopolitan forms. Had this fauna been lineally descended from that of a great lake, I cannot believe that it would have shown no trace of its origin.[2] Moreover, subfossil shells found in the neighbourhood of the Hamun are identical with the recent ones.

From all these facts and lines of argument it seems to me evident, firstly that the Hamun occupies in part the bed of an old salt lake, secondly that it has only a casual connection with that lake, and thirdly that in its present state it is of recent origin. There has been no biological continuity between the old lake and the recent one. I am not particularly concerned with the history and origin of the former, but I suppose that they were similar to those of other lakes in Persia.[3]

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[1] Annandale, *Journ. and Proc. As. Soc. Bengal* (New Series), Vol. XI, Nos. 10 and 11, p. 437 (1915).

[2] See Annandale, *Rec. Ind. Mus.* XIV, p. 172 (1918).

[3] See the works of Blanford and Huntington already cited, and also de Morgan's note in *Revue de L'Ecole D'Anthropologie for* 1907 (Paris), pp. 214–215.

The Water of Seistan.

We collected a considerable number of samples of water in the Hamun-i-Sabari and other bodies of water in Seistan, but unfortunately several of the bottles were broken on our journey. By the kindness of Dr. H. H. Hayden, F.R.S., Director of the Geological Survey of India, the samples that remain have been examined in the laboratory of that department. They are not sufficient to ensure an accurate and detailed analysis, but indicate with sufficient clearness the general character of the salts present. Our sample of water from the Shelagh river was lost, but one of the salts crystallized on its shore has been analysed.

The following are the results :—

Analysis of Water Samples from Seistan.

	From south shore of Hamun about 4 miles east of Lab-i-Baring. Between reed-beds and muddy shore.	From a small saline stream running down to but not quite reaching the Hamun. About a mile and half north of Lab-i-Baring.	From edge of Hamun about one mile north of Lab-i-Baring. On stony shore below cliff.
Quantity received	560 c.c.	500 c.c.	470 c.c.
	Given in grammes per 1000 c.c.		
Al_2O_3 and Fe_2O_3	*nil*	Trace	*nil*
CaO	0·0496	0·8629	0·0345
MgO ...	0·2220	2·4476	0·1542
Alkalies weighed as chlorides ...	1·4640	20·2650	0·9100
Na_2O ...	0·721	10·683	0·313
K_2O	0·0664	0·069	0·201
Cl	0·5293	10·8985	0·3399
SO_3	0·4759	5·2136	0·2948
Suspended matter	0·0426 grammes	0·1200 grammes	0·0872 grammes.

Analysis of Salt from the edge of Shelagh River, near Girdhi, Seistan.

Amount insoluble in boiling water ..	29·78
Al_2O_3 and Fe_2O_3	0·10
Ca	4·64
Mg	0·27
Na	13·10
K	2·57
Cl	15·62
SO_4	22·39
CO_3	1·14
Water of Composition	10·75
Total ..	100·36

From this report it is evident that considerable amounts of salt are present even in waters that are potable, as that of the Hamun near Lab-i-Baring; that the salt is not merely sodium chloride but of mixed composition, and that its composition varies greatly even in the same part of the Hamun in different circumstances. I have already noted the changes in salinity produced in the water by a cessation of the normal wind (p. 13, *antea*). In both samples from the Hamun salts of sodium are the most prevalent, but salts of magnesium, which are usually more deleterious to animal life, are present in considerable quantity, and in one sample those of potassium are also fairly well represented.

The sample of water from the small stream was taken about a hundred yards up from the beach of the lake, in a little gully in the clay cliffs. The stream was a very small one and rose in clay among small hills at no great distance from the lake. We may take it as representing a solution of the soluble salts in the clay of the cliffs.

The salt from the margin of the Shelagh river, on the one hand, represents the offscouring[1] of the whole Hamun system. Here magnesium is poorly represented, while both sodium and potassium are present in fairly large amounts.

We have as yet no data, therefore, to estimate the differential effect of water of different chemical composition on the aquatic fauna of different parts of Seistan, and, indeed, to arrive at any results of the kind would necessitate a very long and arduous investigation carried out through the seasons and under all possible conditions of flood and the reverse. All that can be said is that the aquatic fauna throughout the country lives in abnormal and variable types of environment so far as the composition of the water is concerned.

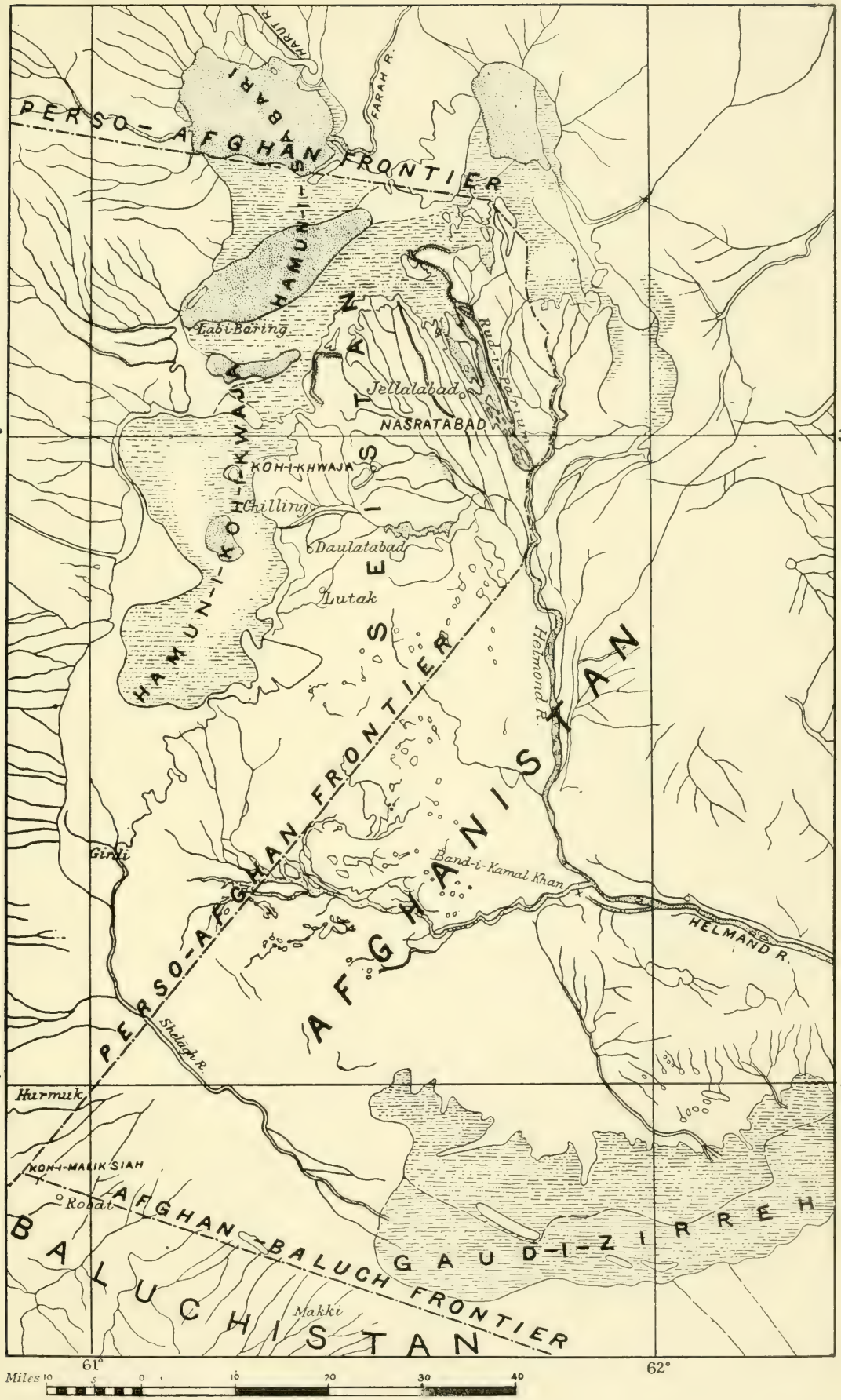
[1] It cannot, however, be composed of the same proportions of the different salts that occur in the water in solution, for some salts crystallize out before others.

EXPLANATION OF PLATE I.

Map of Seistan and the Neighbouring Country.

Bodies of water that are permanent or practically so are shown densely dotted, while areas that are periodically or occasionally flooded are indicated by broken transverse lines.

Most of the water-courses marked on the map are usually dry.



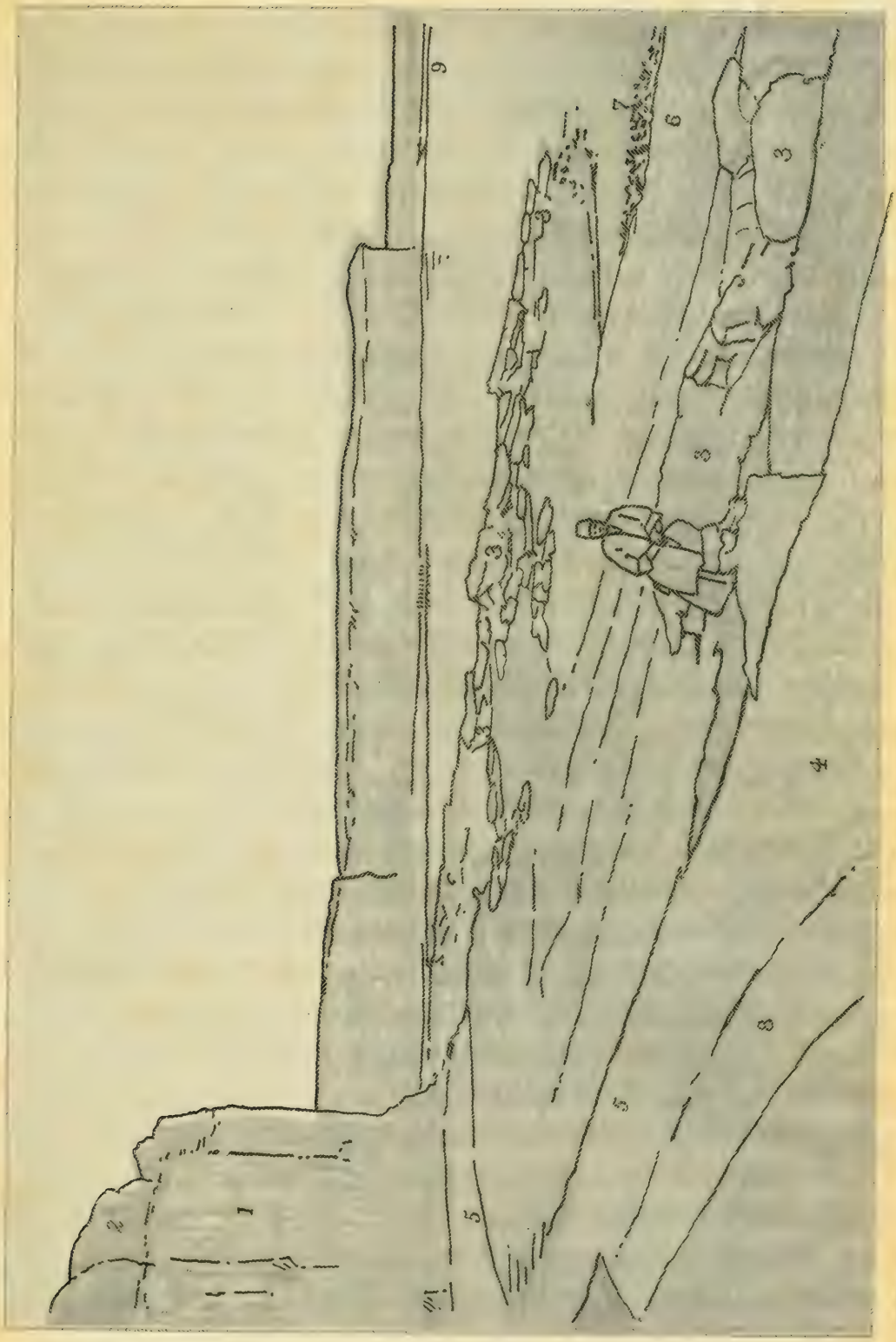
A. Chowdhary del.

EXPLANATION OF PLATE II.

CLIFF ON THE WESTERN SHORE OF THE HAMUN-I-HELMAND NEAR LAB-I-BARING. DECEMBER, 1918.

The photograph was taken on a calm day two days after the wind had fallen.

1. Uniform lacustrine deposit of stiff clay.
2. Superficial layer of more friable earth and water-worn pebbles.
3. Blocks of clay fallen from the cliff.
4. Beach of water-worn pebbles derived from superficial layer of cliff.
5. Normal flood-level marked by fragments of reeds and other vegetable debris.
6. Winter water-level in windy weather.
7. Water-level after two days' calm.
8. Footpath.
9. Reed-beds.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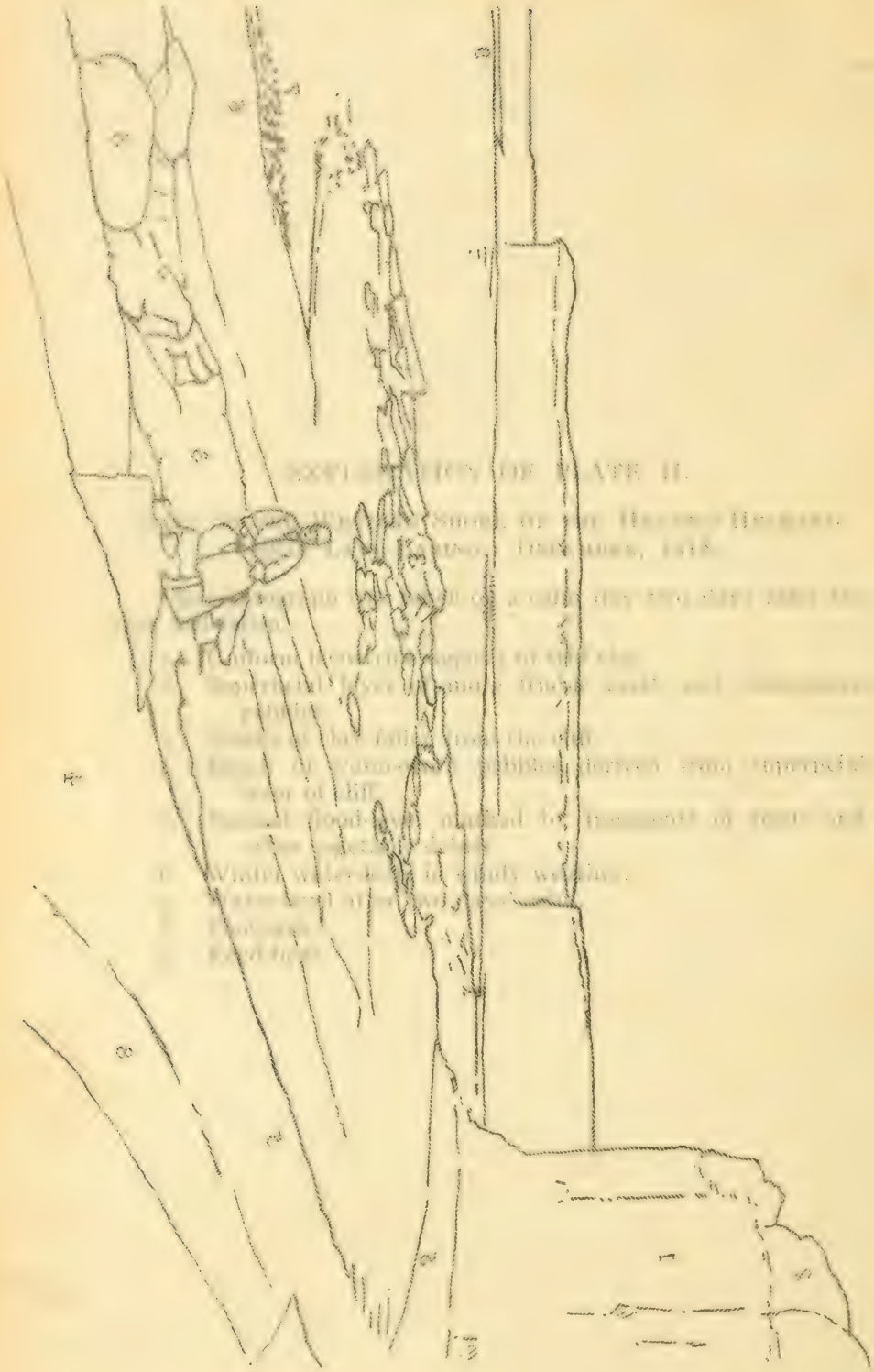

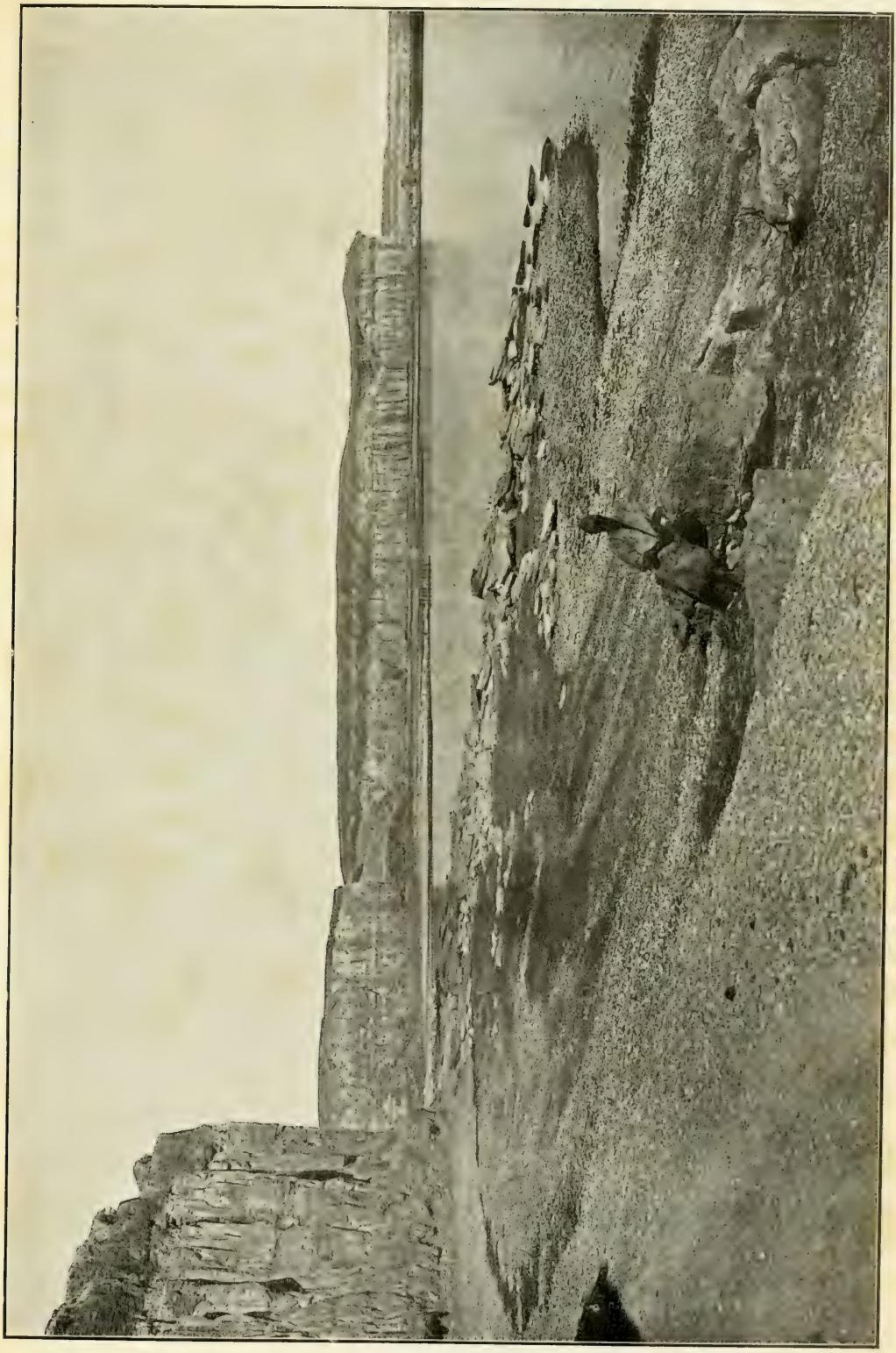

HAMUN NEAR LAB-I-BARING. Dec., 1918.

S. W. Kemp, photo.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1919.

THE MOLLUSCA OF THE INLAND WATERS OF BALUCHISTAN AND OF SEISTAN.

(With Plates III—VIII).

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India, and* BAINI PRASHAD, *D.Sc., Offg. Director of Fisheries, Bengal, Bihar and Orissa, with a note on the Liver-Fluke of Sheep in Seistan, by* S. W. KEMP, *B.A., Superintendent, Zoological Survey of India.*

In studying the aquatic Mollusca of Seistan we have found it necessary to study also those of Baluchistan, from certain parts of which abundant material was available. These parts are the hill-country of the Quetta and Pishin districts in Northern Baluchistan, in which one of us collected the material himself, the great Baluch-Afghan desert, in which a collection was made by Dr. N. Annandale and Mr. S. W. Kemp, and Persian Baluchistan, in which, many years ago, the late Dr. W. T. Blanford[1] obtained many specimens now in the Indian Museum. We have seen no shells from the British district of Mekran, which, however, marches with Persian Baluchistan on the west, from Las Bela and the neighbouring states, or from the Indus plain south of Sibi, in which the fauna is probably quite Indian.

The following is a list of the species and varieties now known, arranged according to the classification set forth by Pelseneer in Lankester's *Treatise on Zoology*, Vol. V (1906).

List of Freshwater Molluscs of Baluchistan and Seistan.

Gastropoda.

PECTINIBRANCHIA.

Fam. Hydrobiidae.	
Amnicola (*Alocinma*) *sistanica*, sp. nov.	Seistan.
? *Amnicola parvula* (Hutton).	N. Baluchistan.
Fam. Viviparidae.	
Vivipara hilmandensis, Kobelt.	Seistan; Afghan desert.
Fam. Melaniidae.	
Melanoides pyramis (Hutton).	N. Baluchistan.
M. pyramis var. *flavida* (Nevill).	W. Baluchistan.
M. pyramis var. *luteomarginata* (Nevill).	Persian Baluchistan; S. Persia.

[1] All the zoological collections made by Dr. Blanford and labelled "Baluchistan" are from this district, in which there happens to be a place called Pishin.

M. tigrina (Hutton).	N. Baluchistan.
M. scabra var. *elegans* (Hutton).	N. Baluchistan.
Melanopsis deserticola, sp. nov.	Persian Baluchistan.

PULMONATA.

Fam. Limnaeidae.	
Limnaea persica, Issel.	Baluchistan desert; S. Persia.
Limnaea iranica, sp. nov.	Persian Baluchistan.
Limnaea bactriana, Hutton.	N. Baluchistan; Seistan.
Limnaea gedrosiana, sp. nov.	Do. do.
L. gedrosiana var. *rectilabrum*, nov.	Do. do.
Limnaea truncatula, Gray.	N. Baluchistan.
Limnaea hordeum, Mousson.	Seistan.
Fam. Planorbidae.	
Gyraulus convexiusculus (Hutton).	N. Baluchistan; Seistan.
Gyraulus euphraticus, Mousson.	Do. do.
Segmentina calathus (Benson).	Seistan.

Lamellibranchia.

Fam. Unionidae.	
Lamellidens marginalis, subsp. *rhadinaeus*, subsp. nov.	Seistan; Afghan desert.
Fam. Cyrenidae.	
Corbicula fluminalis (Müller).	Baluchistan; Seistan.
? *Pisidium paludosum*, Hutton.	N. Baluchistan.

GEOGRAPHICAL DISTRIBUTION.

The molluscs to be considered in this paper come mainly from three districts, (1) the hill-country of Baluchistan watered (so far as it is watered at all) by the Lora or Pishin river, which has more or less saline water and makes its way down to the desert, where it disappears in the Zanginawar lakes; (2) Seistan, the delta and basin of the Helmand river, which rises in the Hindu Kush a considerable distance to the north of Baluchistan and passes a great body of fresh water, and (3) Persian Baluchistan, a mountainous district lying some considerable distance south of Seistan and reaching to the Arabian Sea. These three districts are separated by the great Afghan-Baluch desert, through which the Helmand flows. As even the desert is not devoid of aquatic molluscs, we have actually four districts to consider.

MOLLUSCA OF THE HILL-COUNTRY OF BALUCHISTAN. The molluscs of this district were described seventy years ago by Hutton, and we have no species to add to his list, though we do not accept all his identifications. The forms known from this district are:—

Melanoides pyramis.	*Melanoides scabra* var. *elegans.*
Melanoides tigrina.	? *Amnicola parvula.*

Limnaea bactriana.
Limnaea gedrosiana.
Limnaea gedrosiana var. *rectilabrum.*
Limnaea truncatula.
Gyraulus convexiusculus.
Gyraulus euphraticus.
Corbicula fluminalis.
? *Pisidium paludosum.*

MOLLUSCA OF THE AFGHAN-BALUCH DESERT. The following forms have been found in this desert:—

Melanoïdes pyramis var. *flavida.*
Vivipara hilmandensis.
Limnaea persica.
Gyraulus euphraticus.
Corbicula fluminalis.
Lamellidens marginalis subsp. *rhadinaeus.*

MOLLUSCA OF SEISTAN. In the alluvial plain of Seistan the following forms occur:—

Amnicola (*Alocinma*) *sistanica.*
Vivipara hilmandensis.
Limnaea bactriana.
Limnaea gedrosiana.
Limnaea gedrosiana var. *rectilabrum.*
Limnaea hordeum.
Gyraulus convexiusculus.
Gyraulus euphraticus.
Segmentina calathus.
Corbicula fluminalis.
Lamellidens marginalis subsp. *rhadinaeus.*

MOLLUSCA OF PERSIAN BALUCHISTAN. Most of the molluscs known from this district were obtained by the late Dr. W. T. Blanford, but Mr. W. J. Good has recently added an interesting species. The following is a list of the known forms:—

Melanoides pyramis var. *flavida.*
Melanoides pyramis var. *luteomarginata.*
Melanoides scabra.
Melanopsis deserticola.
Limnaea iranica.

Of the lists, those of the species of the hill-country of Baluchistan and of Seistan are probably the most complete. Moreover, these two are very similar and the discrepancies between them are probably more apparent than real. In the Seistan list five (out of eleven) specific names are, indeed, present that are absent from the other, viz. *Amnicola sistanica*, *Vivipara hilmandensis*, *Limnaea hordeum*, *Segmentina calathus* and *Lamellidens marginalis*. The *Vivipara*, however, seems to be essentially a fluviatile species, probably unable to live in any but pure fresh water, and rivers with pure fresh water (or water of any kind) are proverbially scarce in Baluchistan; the *Limnaea*, which is also known from Mesopotamia, is exceedingly rare; *Segmentina calathus*, which is not uncommon at some places in the plains of North-western India, is local in its distribution, and the bivalve, though not yet found in Baluchistan, is common (in a distinct racial form) in the neighbouring country of Afghanistan. Of the species probably common to the two countries this bivalve is the only one in which even subspecific distinction is possible, but several others (e.g. *Limnaea gedrosiana*) exhibit slight local dfferences. *Amnicola sistanica* is the only species probably peculiar to Seistan, and

Limnaea hordeum (otherwise known only from lower Mesopotamia) the only true western form.

The Helmand, which, so far as the aquatic fauna is concerned, is the connecting link and the only highway for aquatic animals between the mountains of Baluchistan and eastern Afghanistan and the Seistan basin (or, indeed, between Seistan and all other countries), has naturally a molluscan fauna identical with that of the basin into which it flows. In the small springs of the desert, the water of most of which is more or less saline, only a few very tolerant species (e.g. *Gyraulus euphraticus* and *Corbicula fluminalis*, both of great geographical range) can live, and we found but one form (*Melanoides pyramis* var. *flavida*) probably peculiar to situations of the kind. It occurs in Persian Baluchistan as well as the Afghan-Baluch desert. *Limnaea persica* has only been found as yet in the southern part of the Persian plateau and in the basin of the Lora river in the eastern part of the desert.

The molluscan fauna of Persian Baluchistan is still imperfectly known, but the inclusion of a species of *Melanopsis* indicates the presence of a true western Asiatic element absent from other parts of the area under consideration.

The general absence of this western Asiatic element is perhaps the most striking feature of the fauna considered as a whole. Another point to be noted is the absence of certain large and conspicuous Palaearctic forms (e.g. *Limnaea stagnalis*) common in Kashmir at altitudes no higher than those of the Quetta district. This, however, does not imply that the fauna is essentially Oriental in the strict zoogeographical sense, for conditions of life are clearly inimical to large forms. The fauna is a starved one in which only species of great adaptability can survive. Such molluscs as *Vivipara hilmandensis* and *Lamellidens marginalis*, though evidently of Oriental origin, have spread into Palaearctic districts on the limits of their range, while the species of *Limnaea*, though here described as distinct, have a clear Palaearctic facies and most of them are probably descended from Palaearctic rather than true Indian forms, from which they differ considerably in all but one instance. The species of *Gyraulus* and *Segmentina*, though they occur in Oriental districts, are closely related to and probably derived from European forms.

The molluscan fauna of Seistan and Baluchistan, therefore, has little true geographical significance.

BIONOMICS.

The bionomics of the molluscan fauna of the inland waters of Baluchistan and Seistan are perhaps more interesting than its geographical distribution, but here again characters are negative. The fauna is one that lives habitually in water of abnormal chemical composition, for even potable water in these countries contains far more than its usual allowance of mineral salts (see p. 15, *antea*). The molluscs have not, however, responded to the

chemical stimulus with the facility sometimes associated with this factor in their environment, and are not particularly plastic or variable or at all exuberant in shell-sculpture. This is probably because other conditions are unfavourable—extremes of temperature, drought and lack of food—and the struggle for existence is too keen. The composition of the water has, indeed, had one effect, physical rather than biological, in preserving such sculpture as the shells possess intact from erosion. Probably it has acted indirectly, by discouraging the growth of corroding algae. But, even so, the *Limnaeae* do not develop the strong longitudinal ribs formed on the shells of those that live in saline waters in North America.[1]

The shells of all the species of Gastropods are small and in most cases very thin. They are of perfect form, neither distorted nor abnormal in other respects. Their colours, both of shell and soft parts, are pale. They constitute, in fact, a limited but very normal paludine fauna such as might be found in any temperate region.

No peculiar lacustrine species or even well-marked phases have as yet been evolved in the Hamun-i-Helmand.

In Seistan the recent geological history of the country has been of such a nature that subfossil shells are extremely abundant nearly everywhere except in the central parts of old lake-basins, while owing to the annual floods enormous numbers of quite recent shells are scattered over the country. In the deposits, both recent and historically ancient, examined both in the northern and the southern districts only two species were found (*Limnaea hordeum*, evidently a scarce form, and *Segmentina calathus*, a widely distributed but somewhat sporadic one) which were not found living in the country. The absence of Melaniidae from these deposits was a noteworthy feature. The commonest species in them at most places were *Amnicola sistanica*, *Limnaea gedrosiana*, *Gyraulus convexiusculus*, *G. euphraticus* and *Corbicula fluminalis*. At some spots, evidently those reached with fair regularity by recent floods, *Lamellidens marginalis* was also present in large numbers, and at one place *Vivipara hilmandensis* was common.

An interesting question in the bionomics of freshwater molluscs in a country like those under consideration is that of hibernation and aestivation and their effect on sexual activity. We give evidence below that certain species (mainly those of the genera *Melanoides*, *Corbicula* and *Lamellidens*) burrow into mud or sand either at the approach of winter or on the sinking of the annual floods. Perhaps this is also true of *Amnicola sistanica*. The Limnaeidae and Planorbidae, however, remain active throughout the winter. In Seistan and northern Baluchistan, and also at certain places in the North West Frontier Province, the eggs of

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[1] See Baker, *Chicago Academy of Sciences*, special publication 3, p. 30 (1911).

Limnaea were observed in great abundance in November, December and January, and in females killed at this time of the year the female part of the reproductive organs was found to be in a state of activity. No individuals were, however, observed paired, and the male part of the hermaphrodite gland seems to be aborted. It is probable, therefore, that *Limnaea* is protandric in the peculiar conditions which exist in Seistan and Baluchistan, that pairing takes place in summer, and that the spermatozoa are stored up for considerable periods.

PARASITES AND INCOLAE.

The main object of the tour on the collections of which this paper is mainly based was to discover what could be discovered about the distribution of the aquatic molluscs and their trematode parasites in reference to the etiology of the disease Bilharziasis or Schistosomiasis. Living molluscs were examined in the field by Mr. S. W. Kemp, who has been kind enough to supply us with the following information. His examinations were made in November and December.

The only molluscs in which trematodes were found in water brackish to the taste was *Melanoides pyramis* var. *flavida*. Of twenty-five individuals of this form from a small water-course at Saindak in the western part of the Baluchistan desert one was infected by the young rediae (indeterminate) probably of a *Xiphidocercaria*. The water was potable but tasted salt and bitter.

Sixty specimens of *Limnaea gedrosiana* from the reed-beds of the Hamun near Lab-i-Baring were examined and none found infected. Of another sixty of the var. *rectilabrum* of the same species from a small pool in the desert near Nasratabad only one was parasitized, its parasite being a small cercaria of the family Schistosomatidae. One hundred specimens of *L. bactriana* (fifty of the long-spired and fifty of the short-spired form) were examined at Nasratabad, from an irrigation channel. Ten contained trematode cercariae; in eight of these the parasite was a large monostome, while in one it was a Schistosomatid (apparently the same species found in *L. gedrosiana*) and in one the infection was a mixed infection of these two parasites.

Seventy-four specimens of *Gyraulus convexiusculus* from the reed-beds of the Hamun were examined and seven were found infected by Trematodes, two by indeterminate elongate sporocysts, three by Schistosomatid cercariae without eyespots and two by similar fork-tailed cercariae with eyespots. Only two specimens of *Gyraulus euphraticus* were examined, from the same locality; one was uninfected, while the other contained Schistosomatid cercariae without eyespots, apparently of the same species as was found in *G. convexiusculus*.

The Schistosomatid cercaria found in aquatic Pulmonate molluscs in Seistan does not appear to belong to any of the species known to parasitize man. A liver-fluke of the genus *Fasciola* (*s.s.*) is common in that country, but its cercariae were

not found, probably because their incidence is seasonal. Mr. Kemp has given us a note on this species (*F. gigantea*) which is appended to our paper. He hopes to describe all other parasites later.

Small red nematodes were common in *Gyraulus convexiusculus* in the Hamun in December.

The Oligochaete worm *Chaetogaster* was found in abundance at the edge of the mantle and in the branchial chamber of *Limnaea gedrosiana* var. *rectilabrum* in a pool in the desert near Nasratabad in the same month. Col. Stephenson has identified the worm as *Ch. bengalensis*, Annandale, a species common in Northern India.

SYSTEMATIC ACCOUNT OF THE FAUNA.

Class GASTROPODA.

Fam. HYDROBIIDAE.

1915. Paludestrinidae, Preston, *Faun. Brit. Ind., Freshw Moll.*, p. 67.
1919. Paludestrinidae, Godwin-Austen, *Rec. Ind. Mus.* XVI, p. 209.

Genus **Amnicola**, Gould and Haldeman.

1865. *Amnicola*, Stimpson, *Smiths. Misc. Coll.*, 201, p. 12.

The excellent account of this genus given in the work cited enables us to relegate to their proper genus certain Indian, Burmese and Persian species that have usually been placed in *Bithynia*. These species, however, differ in some respects from the American forms—sufficiently in our opinion to be regarded as constituting a new subgenus, for which we propose the name:—

Subgenus **Alocinma**, nov.

The shell agrees precisely with that of the American *Amnicola* and the Palaearctic *Pseudamnicola*, being globose or subglobose or slightly elongate, imperforate or subumbilicate, small, thick and smooth, with swollen whorls and having its mouth oval or ovate with a continuous but not greatly thickened peristome. The animal has a relatively short foot, which projects very little if at all beyond the shell. It is rounded or pointed behind and angulate in front. *The snout is long and narrow.* The tentacles are hardly longer than the shell, thin and filiform, and bear the eyes, which are small, at their base externally. The edge of the mantle is simple. The penis is large, flattened, lunate in outline and provided with a long and stout lateral process, which projects on the left side from its concave margin almost at right angles. It is situated almost in the middle of the "neck." *The operculum is of large size, and incapable of withdrawal into the shell, thick and calcareous but usually hyaline or subhyaline, distinctly spiral and with a slightly eccentric nucleus, but ornamented round the margin with concentric lines.*

The radula is very like that of *Amnicola, s.s.*, its central tooth being produced at either side and bearing a central process on its disk which projects downwards below its lower margin, as well as two or three lateral basal denticulations on each side.

Type-species. Amnicola sistanica, sp. nov.

This new subgenus is very closely related to *Amnicola, s.s.*, but differs in its long snout, calcareous oval or ovoid operculum and lunate penis. From *Pseudamnicola* it differs in its much larger, spiral operculum and in having more than one basal denticulation on each side of the central tooth of the radula. It is, indeed, a link between the two groups of species, each of which we regard as having subgeneric rank.

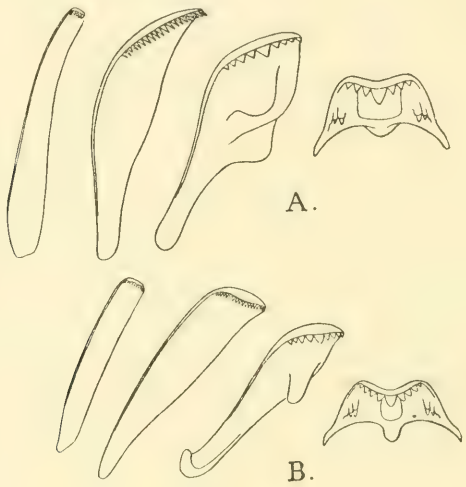

FIG. 1.—Radular teeth of *Amnicola* (× 500).

A. Teeth of *Amnicola* (*Alocinma*) *sistanica*, sp. nov., from the reed-beds of the Hamun-i-Helmand.

B. Teeth of *Amnicola* (*Alocinma*) *alticola* (Annandale), from the Inlé Lake, Southern Shan States.

Among the species that must be placed in the new subgenus are the common "*Bithynia*" *orcula* of Bengal and also *Amnicola alticola* (fig. 1 B) from the Southern Shan States. In the former as well as the latter the operculum is distinctly spiral and both have the other subgeneric characters.

Amnicola (Alocinma) sistanica, sp. nov.

(Pl. iii, figs. 1–5.)

This species is very closely related to *Amnicota orcula*, but the shell is more hyaline and more globose and has the suture more oblique and more impressed. It may be described as follows:—

The shell is small, ovato-conical, short, broad and obese, with five whorls, fairly thick but naturally quite colourless and hyaline, rapidly, however, becoming milky after the death of the animal, polished and ornamented with delicate longitudinal striae on the surface. The suture is impressed and very oblique, so that the spire is much longer in dorsal than in ventral view. The whorls increase rapidly in size and are highly convex; they are flattened outside the suture but rounded externally. The apex is minute but blunt and flattened. The basal whorl in ventral view is at least nearly three times as long as the spire, but these proportions are variable The mouth is large and somewhat expanded, oblique, never much longer than broad, ovate, rounded or bluntly pointed above and broadly rounded below. The peristome is continuous and there is a band-like callus on the inner lip. The outer lip is hardly thickened, but distinctly though slightly flattened and very narrowly retroverted; its inner corner is subangulate. The umbilicus is rimate and the columellar callus is expanded over it. The columella is straight.

Measurements of Shells (in millemetres).

	A	B	C	D	E	F
Length ..	6·5	8·2	7·8	7·2	5	3·8
Breadth ..	4·2	5·2	6·1	4·7	4	2·7
Length of mouth ..	2·5	3·1	3·7	3·2	2·4	1·9
Breadth of mouth ..	2	2·6	2·6	2·3	2	1·5

The operculum, which cannot be retracted into the shell, is when fresh of glassy transparency. It has three whorls. The nucleus is situated some distance from the antero-internal border. The shape is ovate, broadly rounded anteriorly and bluntly pointed posteriorly.

The radula is of the type normal in *Amnicola, s.s.* The central tooth is small and transverse, produced at each side into a bluntly pointed, narrow process, which points downwards and a little outwards. The disk bears a large quadrate raised area and a series of basal denticulations at each side, remote from both the lateral and the basal margin. In each series there are two distinct denticulations and an obscure, imperfectly developed external one. The upper margin of the tooth is slightly concave. The central cusp is enlarged and there are several smaller denticulations on each side of it; all are triangular, at least as long as broad at the base, and pointed at the tip. The lateral tooth is broad above but slender towards the base. It bears numerous small sharp cusps, the central one of which is slightly enlarged on the inner lateral. This tooth bears a broad blunt process on its disk and has its inner margin broadly and irregularly emarginate below. The outer marginal is very long and narrow, but broadens somewhat at the base. Its cusps are very minute and sharp.

The intromittent organ of the male is of relatively large size and distinctly flattened. Its external (right) margin is semi-circu-

lar and its internal margin concave in the same degree. The tip is pointed. The internal margin bears near its middle a long straight process terminating in a crateriform sucker-like structure, from the centre of which protrudes an elongate muscular papilla. The main body is smooth, the process obscurely annulate. Before entering the penis the vas deferens is highly convoluted and would be of immense length if unravelled. In the penis it pursues a sinuous course near the concave margin and remains distinct nearly to the aperture at the tip of the organ. The outer part of the penis appears to be glandular internally, but is provided with a well-developed layer of transverse muscle fibres externally.

The living animal was thus described in the field:—"Animal white with black clouding and minute golden yellow specks on the mantle; a suffusion of black pigment on the snout and tentacles. Tentacles slender, when fully expanded no longer than shell. Eyes small, black, prominent, situated near the base of the tentacles

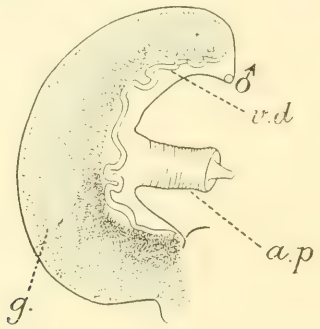

FIG. 2.—Male intromittent organ of *Amnicola* (*Alocinma*) *sistanica*, sp. nov. (×20), seen from below.

a.p.=accessory appendage: *g.*=glandular region: *v.d.*=vas deferens.

externally. Snout rather long and narrow, with parallel sides, slightly notched in front. Foot relatively small, rounded in front and bluntly angulate at the anterior corners, bluntly pointed behind."

Type-specimens. M 11538/2, Zoological Survey of India (Ind. Mus.).

Distribution. All over the dry *Naizar* or reed-country of northern Seistan shells of this species are common in the soil, as they are also in the debris of floods. We found fresh shells in the larger pools in the reed-beds of the Hamun near Lab-i-Baring and a few living individuals among the algae on the roots of *Phragmites* in narrow channels in the same beds.

These living individuals, which were very scarce, were all small and were only found in protected situations. Very large numbers of the mollusc evidently perish annually with the sinking of the floods and the majority of those that survive probably burrow into the mud and hibernate in winter.

The shell of this species bears a close resemblance, perhaps superficial, to that of the Syrian "*Paludina*" *badiella* as figured by Küster,[1] but the mouth is broader, the umbilicus narrower, the whorls less flattened above and pigment entirely absent. There has been much confusion about this Syrian species and we have no means of estimating the true relationship, if any exists, between it and our Seistan mollusc. There is also a resemblance to *Pseudamnicola macrostoma* from Greece, specimens of which we have examined; but the operculum of that species is much thinner, of different structure and of small size as compared with the mouth of the shell, which is much smaller than that of the Persian species.

? **Amnicola parvula** (Hutton).

1850. *Paludina parvula*, Hutton, *Journ. As. Soc. Bengal* (2) XVIII, p. 655.
1876. *Amnicola parvula*, Hanley and Theobald, *Conch. Ind.*, p. XVII, pl. cli, figs. 8, 9.

We have not seen this species and have no means of ascertaining its true generic and subgeneric position. Hutton says that the operculum is horny, and it would appear, therefore, to belong possibly to *Amnicola*, *s.s.* The other known species of this subgenus are, however, American. Nevill's[2] *Bithynia orcula* var. *parvula* is quite distinct and probably a true variety of *Amnicola* (*Alocinma*) *orcula* (Frauenfeld).

Hutton's species was found in a marshy patch of ground in the Kojak Pass at Chaman (Chammun), now on the Afghan frontier of Northern Baluchistan.

Family VIVIPARIDAE.

Genus **Vivipara**, Montfort.

Vivipara hilmendensis, Kobelt.

1909. *Vivipara* (*dissimilis* var.?) *hilmendensis*, Kobelt, *Paludina* in Martini and Chemnitz's *Conch-Cab.* (*ed.* Küster and Kobelt), p. 289, pl. lix, figs. 9–12.

The complete synonymy of the forms included by Kobelt under the name *Vivipara dissimilis* has not yet been worked out, and we leave the Helmand form provisionally as a distinct species. We have very little to add to Kobelt's description except that the natural colour of the shell is dark olivaceous with curious round whitish spots, and that the opercula of the specimens he examined were unnaturally thin owing perhaps to sand erosion.

The species was described from the Afghan desert and is

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[1] Küster, "*Paludina*, *Hydrocena* and *Valvata* in Martini and Chemnitz's *Conch. Cab.* (*ed.* Schubert and Wagner), p. 62, pl. xi, figs. 25–28 (1852).
[2] Nevill, *Hand List Moll. Ind. Mus.* II, p. 37 (1885).

evidently rare in most parts of Seistan. Single fairly fresh but empty shells were collected at the edge of pools near Nasratabad and Jellalabad and at that of the Hamun near Lab-i-Baring, while a considerable number of bleached specimens were also observed in the soil of occasionally flooded country near Chilling towards the south of Seistan. It is not improbable, therefore, that *V. hilmendensis* is common on the banks of the lower Helmand and is essentially a fluviatile species.

Type-series. M 5087/1, Zoological Survey of India (Ind. Mus.).

Family MELANIIDAE.

Melanoides, Olivier.

1807. *Melanoides*, Olivier, *Voy. l'Emp. Ottoman* II, p. 40.
1854. *Plotia*, N. and A. Adams, *Gen. Rec. Moll.*, p. 295.
1874. *Plotia+Striatella* (? in part), Brot, *Melaniaceen* in Martini and Chemnitz, *Conch. Cab.* (*ed.* Küster), p. 7.
1897. *Melanoides+Plotia*, v. Martens, "*Suss. und Brackw. Moll.*", pp. 50, 62 in Weber's *Zool. Ergebn. Niederl.-Ost-Indien* IV.
1898. Neomelanien, P. and F. Sarasin, *Sussw. Moll. Celebes*, p. 38.
1915. *Striatella+Plotia*, Preston, *Faun. Brit. Ind., Freshw. Moll.*, pp. 15, 35.

In discussing the species of *Melania* (*s.l.*) that occur in Baluchistan and Seistan we have had to overcome two difficulties, firstly to settle the somewhat complicated specific synonomy, and secondly, to decide what characters should be regarded as of generic importance. So far as the second of these questions is concerned we have followed in the main the classification adopted by the Sarasins in the work cited above. We have, however, regarded the groups that they include under the name *Melania* as of generic value, believing that by so doing we are following sound lines in estimating such structures as the operculum and radula as of equal value in this family to the sculpture of the shell and the precise form of its mouth. The groups or subgenera *Plotia*, and *Striatella* (=*Melanoides*) as defined by Brot in his monograph and accepted by Preston in the *Fauna of India*, fade imperceptibly one into the other, and Brot's diagnosis of *Plotia* is, as we have pointed out elsewhere,[1] by no means applicable to all shells even of the type-species.

The question of specific identity and nomenclature in the Indian and Persian species of the genus is complicated by imperfect descriptions, particularly on the part of Troschel and Philippi.

In considering the question due but not excessive attention must be given to the locality of specimens and it must be remembered that the names *Melania pyramis* and *M. elegans* are due to Hutton, and not to Benson, who merely distinguished certain forms by letters, and that, further, Hutton was dealing very largely

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[1] *Rec. Ind. Mus.* XIV, p. 147 (1919).

when he first used these names with a collection from what is now British Baluchistan and the Afghan frontier. We have been greatly helped by an examination of specimens named by Hutton himself.

The conclusions to which we have come are these, (1) that three species, one of which has several varieties, have been as yet found in Baluchistan and the extreme south of Persia; (2) that

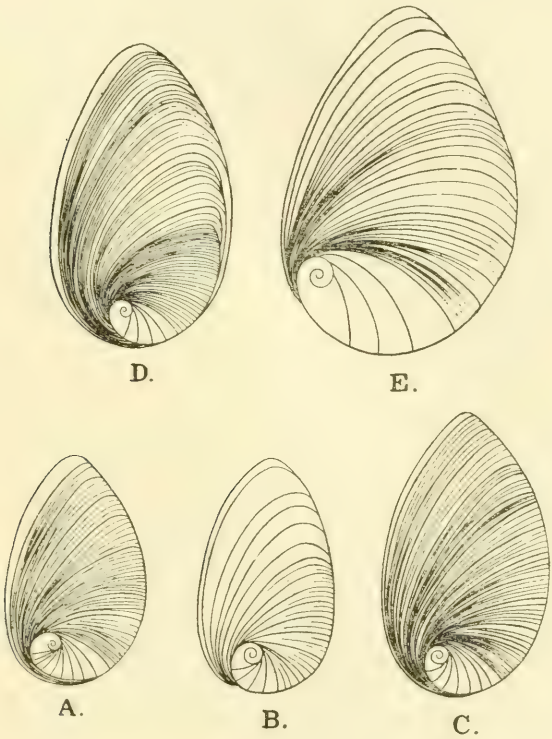

FIG. 3.—Opercula of Melaniidae.

A. *Melanoides tuberculata* (Müller), from large artificial reservoir in Hyderabad State.
B. *M. pyramis* var. *flavida* (Nevill), from spring in the Afghan-Baluch desert.
C. *M. pyramis* var. *luteomarginata* (Nevill), from Persian Baluchistan.
D. *M. tigrina* (Hutton) from Quetta.
E. *Melanopsis deserticola*, sp. nov. from a spring in Persian Baluchistan.

the correct names of these species are *Melanoides scabra* var. *elegans* (Hutton), *M. tigrina* (Hutton) and *M. pyramis* (Hutton); (3) that Hutton has included forms of two distinct species under the name *M. elegans*, and (4) that while one of these forms must be regarded as a variety of *M. scabra*, the other is a variety of *M. pyramis*. In our opinion the last is a transitional form be-

tween the groups *Plotia* and *Melanoides*, but comes in the latter rather than the former.

The genus *Melanoides* may be defined thus:—Melaniidae in

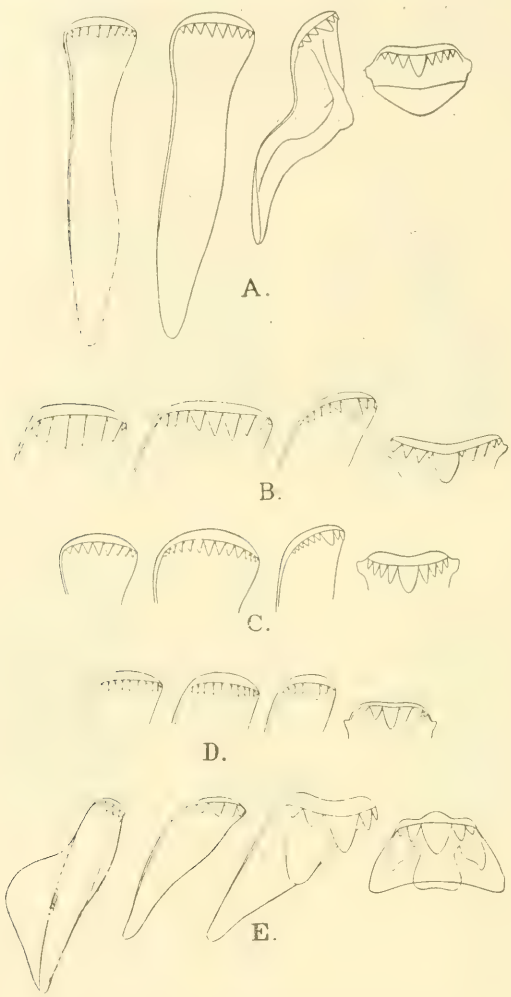

FIG. 4.—Radular teeth of Melaniidae (× 125).

A. Teeth of *Melanoides tigrina* (Hutton) from Quetta.
B. Upper part of teeth of *M. pyramis* var. *luteomarginata* (Nevill) from Persian Baluchistan.
C. Upper part of teeth of *M. pyramis* var. *leopardina*, var. nov. from Poona.
D. Upper part of teeth of *M. pyramis* var. *flavida* (Nevill) from spring in Afghan-Baluch desert.
E. Teeth of *Melanopsis deserticola*, sp. nov. from spring in Persian Baluchistan.

which the *shell* is small or of moderate size, tapering or turreted and never of very great thickness or relative breadth. The mouth is small, ovoid and not greatly produced in front; the columellar

callus moderate; the columella bent but slight and not produced anteriorly; the lip slightly or not at all thickened. The sculpture consists of longitudinal and transverse striae, which produce by their intersection a more or less granular appearance at any rate on the upper whorls. Longitudinal ribs may be present on the lower whorls; their distal extremity is either granular or spinose, as a rule more or less produced. The periostracum is thick and may bear minute hair-like processes.

The *operculum* is ovoid and relatively large, with the posterior extremity pointed. It is distinctly spiral towards the anterior, blunt extremity, but the actual whorls are relatively small and are situated near the inner anterior margin. The remainder of the surface is ornamented with curved parallel lines which radiate outwards from a point situated between the spiral region and the inner margin.

The *radular teeth* are characterized by their sharp and relatively numerous cusps. The lateral tooth is narrow, very oblique in its natural position and as a rule strongly curved or bent longitudinally.

Type-species. *M. fasciolata*, Olivier=*M. tuberculata* (Müller), var.

[**Melanoides tuberculata** (Müller).]

(Pl. iv, fig. 1.)

1774. *Nerita tuberculata*, Müller, *Hist. Verm.*, p. 191.
1837. *Melania adspersa*, Troschel, Wiegm. *Arch. f. Naturw.* I, p. 175.
1876. *Melania tuberculata*, Hanley and Theobald, *Conch. Ind.*, pl. lxxiv, figs. 1-4.
1918. *Melania tuberculata*, Annandale, *Rec. Ind. Mus.* XIV, pp. 114, 156, fig. 6, pl. xii, figs. 1, 2.
1919. *Melania tuberculata*, Annandale and Prashad, *Ibid.*, XVI, p. 146, pl. v, fig. 5 (radula).

Although this species is extremely plastic, in some respects it retains its specific characters under all circumstances. These are (1) the very gradual and even increase in size of the whorls from the apex to the mouth, (2) the distinct but not very great convexity of the whorls, (3) the absence of all swelling and comparatively small size of the body-whorl, (4) the small size of the mouth of the shell, the maximum length of which is considerably less than one-third of the total length, (5) the tubercular sculpture, especially of the upper whorls, (6) the smooth spiral ridges at the base of the body-whorl, (7) the more or less distinct longitudinal reddish markings on a background of green or brown. The total length of the shell is from a little less than three to four times the greatest transverse diameter.

We have recently figured the radular teeth (*op. cit.*, 1919, pl. v, fig. 5). The central tooth is broad and rounded at the lateral angles. It is symmetrical or nearly so and has a comparatively small central cusp with four small ones on either side. The other teeth are sub-equal and a little narrower. They have numerous small cusps. In the inner marginal one of the cusps is a little enlarged.

The operculum is regularly ovoid, bluntly pointed posteriorly and broadly rounded anteriorly. It is distinctly spiral, with two and a half whorls in the nucleus, which is situated some distance from the inner margin. The surface is ornamented with numerous lines which curve outwards from near the anterior extremity.

In spite of its extremely wide range, from the Mediterranean to Australia and China, we have no evidence of the occurrence of this species in Baluchistan or Southern Persia.

Melanoides pyramis (Hutton).

(Pl. iv, fig. 3.)

1850. *Melania pyramis* (Benson), Hutton, *Journ. As. Soc. Bengal* (2) XVIII, p. 658.

This species is distinguished from *M. tuberculata* both by shell-characters and by constant differences in the radula. The shell is considerably shorter and broader, being distinctly less than three times as long as broad. The body-whorl is relatively large and much more swollen. The mouth is more than one-third as long as the shell, which tapers much more abruptly.

The radula of forms we regard as varieties differs considerably from that of *M. tuberculata* in the shape of its central tooth, which is produced on either side in an angle, below which it is more or less constricted. It has a relatively large central cusp with the lateral cusps usually more numerous on the right side than the left. The lateral tooth is considerably narrower than the inner marginal.

We have not been able to examine fresh specimens of the typical form of this species, but Hutton states that the form which occurs in marshy land at Quetta is without markings and coarse in sculpture with the apex of the spire and epidermis eroded. A few dead shells of this type were found in a pond in the Residency garden at Quetta in January 1919, but no living individuals could be discovered in spite of a careful search. It is probable that in cold districts the species burrows into mud, as Hutton (*loc. cit.*, p. 657; 1850) states that *M. scabra* var. *elegans* does in the same country.

Measurements of Shells (in millimetres).

Length	20·5	24·6
Breadth	7·3	9·1
Length of aperture	7	8·7
Breadth of aperture ..	3·8	4·5

The shell we figure is much eroded, though the most complete we have examined in other respects. In a broken specimen of rather smaller size all the whorls but the body-whorl are ornamented with numerous curved longitudinal rows of from four to six tubercles separated by deep longitudinal grooves and divided up by narrow transverse striae.

We are able to recognize no less than four distinct varieties of this species.

[var. **leopardina**, nov.]

(Pl. iv, fig. 4.)

1876. *Melania pyramis* and var. *adspersa*, Hanley and Theobald (*nec* Troschel) *Conch. Ind.*, pl. cx, figs. 1, 2, 4.
1877. *Melania adspersa*, Brot (*nec* Troschel), *op. cit.*, p. 255, pl. xxvi, figs. 4, 4*a*.
1885. *Melania* (*Striatella*) *tuberculata*, Nevill, *Hand List Moll. Ind. Mus.*, II, p. 240 (in part).

This form has almost the same proportions as the *forma typica*, but the body whorl is slightly narrower and the anterior margin of the lip less produced. The surface of the shell is of a pale yellow colour beautifully marked with irregular longitudinal streaks of deep red. The sculpture is similar to that of the typical form but the granules are not so distinct. The shell is considerably thinner.

Measurements of Shells (*in millimetres*).

Length	28·2	28·4	22·3
Breadth	9·7	9.9	8·1
Length of aperture ..	9·9	10	8·2
Breadth of aperature ..	5·3	5·3	4·4

Type-series. 1202, Zoological Survey of India (Ind. Mus.) (from Poona).

The denticulations of the teeth of the radula are all rather blunt. The central tooth has four small cusps on each side of the central cusp. Its upper margin is slightly concave. None of the denticulations of the lateral teeth are much enlarged, the inner marginal has about thirteen and the outer about eight denticulations.

We figure the operculum.

This form appears to be the one to which the name *pyramis* has been most commonly applied. The measurements given by Troschel of his type-specimens of *Melania adspersa*, in which the apex was destroyed, preclude their belonging to it. It is not uncommon, though apparently somewhat sporadic, in the Indo-Gangetic plain and Peninsular India, but has often been confused with *M. tuberculata*.

[var. **puteicola**, nov.]

(Pl. iv, figs. 7–8.)

1834. *Melania* (No. 14), Hutton, *Journ. As. Soc. Bengal* III, p. 91.
1885. *Melania* (*Plotia*) *scabra* var. *elegans*, Nevill (specimens from Ferozepore only), *op. cit.*, p. 284.

As we have already pointed out, two quite distinct forms were confused by Nevill, and apparently at one time by Benson and Hutton, under the name *Melania elegans*. The specimens we describe here are those which Hutton found in a well at Ferozepore in the Punjab. They are the only shells we have seen.

Type-series. M 115401/2, Zoological Survey of India (Ind. Mus.).

The shells are similar in shape to *M. pyramis, s.s.*, but much smaller and thinner and with the lip slightly thickened anteriorly and the suture more impressed. Some of them, but not all, are characterized by the strong longitudinal sculpture of the upper whorls. The ribs, however, are not well defined and barely even distinctly tubercular, never at all produced, at their upper extremity. The surface is of neutral olivaceous buff with red longitudinal markings.

Measurements of Shells (in millimetres).

Length	15·3	15·7	14·8
Breadth	5·7	6	5·9
Length of aperture ..	6·2	6·3	6
Breadth of aperture ..	2·9	3	2·8

These shells, though clearly belonging to *M. pyramis*, afford an easy transition to the group *Plotia, s.s.* The fact that Nevill assigned them to *M. scabra* is, indeed, strong evidence in favour of the advisability of breaking down the separation between that group and *Striatella*.

var. **flavida** (Nevill).

(Pl. iii, fig. 6; pl. iv, fig. 6.)

1885. *Melania* (*Striatella*) *tuberculata*, subvar. *flavida*, Nevill, *op. cit.*, p. 244.

Nevill gives no description of this variety. Shells exhibit considerable variation in shape, but are usually even broader than the typical form, and have the mouth more expanded and more oblique. The longitudinal ribs are quite obsolete. There is an indistinct smooth ridge running below the suture. The shell is moderately thin and resembles the var. *puteicola*, but is usually paler in colour. Sometimes, however, the colour approaches that of the var. *luteomarginata* and the sutural ridge is often distinctly paler than the remainder of the surface.

Measurements of Shells (in millimetres).

	Hurmuk			Persian Baluchistan.		
Length ..	19·6	15·5	17·2	30·7	27·4	25·2
Breadth ..	6·2	5	7	10·3	9·9	7·7
Length of aperture ..	6·4	4·9	6·7	10·9	9·7	7·2
Breadth of aperture ..	3·8	2·7	4	6·2	5·8	4·9

The central tooth of the radula is produced at either side into a distinct angle and is asymmetrical. It has three cusps on the left side of the middle enlarged, one and two on the right. The lateral tooth is considerably narrower but has very similar cusps. The marginal teeth are subequal, both broader than the lateral, and have a large number (at least ten) of sharp cusps on each.

The operculum has a distinct notch at the lower margin but is otherwise very like that of *M. tuberculata*, except that it bears fewer curved transverse striae.

Nevill named this variety from specimens from Pishin (not to be confused with the Pishin north of Quetta) and other localities in Persian Baluchistan and from Kalagan and Kerman in the south-east of Persia proper, and we have seen a rather dark shell from lower Mesopotamia.

Type-series. The specimens from the first of those districts may be regarded as the type-series, No. M. 11541/2, Zoological Survey of India (Ind. Mus.).

This form is not uncommon in small springs in the desert of Baluchistan and the Persian frontier. We collected specimens at Saindak and Robat in water distinctly salt to the taste, and at Hurmuk in fresh water. The following description of the animal is copied from the station book of the expedition:—

"Foot hardly longer than broad, subquadrate, with both extremities subtruncate; the antero-lateral angles acute and slightly produced. The snout long, flattened, rather narrow. The tentacles very slender, as a rule hardly longer than the snout. Processes at margin of mantle elongate, pointed, 7 or 8 in number. Sole of foot greyish white, with a faint tinge of pink and an indistinct grey border, spotted with microscopic yellow specks. Dorsal surface of foot, whole of snout, tentacles and edge of mantle black, the snout clouded with white, especially towards the base, the tentacles minutely speckled with dull yellow, the mantle processes edged and tipped with black. The animal moves with the ordinary jerky gait and holds its shell parallel to the surface when moving. When at rest the apex is often held sloping upwards."

var. **luteomarginata** (Nevill).

(Pl. iv, fig. 5.)

1885. *Melania tuberculata* subvar. *luteomarginata*, Nevill, *op. cit.*, p. 244.

This is a very beautiful and distinct variety distinguished by its regularity of form, colouration and sculpture. It is, however, linked by intermediate individuals with the var. *flavida*. The form is narrower than that of *M. pyramis* (*s.s.*), but the difference is not great. The colour is a deep chocolate-brown without reddish markings but rendered distinctive by the narrow paler spiral band that runs down the shell just outside the suture. The lower part of the inner margin of the mouth of the shell is also of the same colour. The sculpture, except at the base of the body-whorl, has a regular granulose appearance due to the fact that the longitudinal striae are numerous and not much deeper or broader than the transverse ones, and there is a narrow flattened ridge outside the suture. At the base of the shell only the transverse, spiral striae are developed. The shell is moderately thick.

Measurements of the Shells (in millimetres).

	Persian, Baluchistan (*Blanford*).		
Length	37·2	29.1	29·4
Breadth	13	9·9	10·8
Length of aperture ..	11·1	10·2	10·3
Breadth of aperture ..	6·4	5·5	6·3

Type-series. 1205, Zoological Survey of India (Ind. Mus.).

We have extracted the operculum and radula from one of Blanford's specimens. The former does not differ much from that of *M. tuberculata* but is rather larger and more pointed posteriorly.

The radula, while of the same type as that of the vars. *leopardina* and *flavida*, differs slightly in the proportions and denticulation of teeth (see fig. 4), all of which are larger and broader than those of var. *flavida*. The central tooth has two extra cusps on either side and the cusps of the other teeth are much larger. Those on the outer marginal are fewer, not more than seven.

The variety is represented in the collection of the Zoological Survey of India by specimens collected by the late Dr. W. T. Blanford in Persian Baluchistan and at Kalagan in the south of Persia proper.

Melanoides tigrina (Hutton).

(Pl. iv, fig. 2.)

1850. *Melania tigrina*, Hutton, *Journ. As. Soc. Bengal* (2), XVIII, p. 658.

This species is, as Hutton pointed out in his original description, distinguished from all varieties of *M. pyramis* by the much greater smoothness of the shell, in which both the longitudinal and the transverse striae become almost obsolete towards the base. The shell resembles that of *M. pyramis* var. *leopardina* in shape, texture and colouration, but exhibits some variation in the extent to which the longitudinal reddish markings are developed. The specimens collected by Hutton and still in the Indian Museum are, as he stated, much eroded on the surface and have lost the apical whorls. We have examined, however, other examples from Quetta which are almost perfect. The shell only differs in form from that of *M. pyramis* var. *leopardina* in being still more acutely pointed, in having the whorls a little less convex and the suture slightly impressed owing mainly to a narrow flattening of the upper margin of each whorl. The sculpture on the upper whorls, in unworn shells, is distinctly though minutely granular, but it becomes gradually less distinct towards the body-whorl, on which only a comparatively small number of lightly impressed spiral striae and very indistinct longitudinal striae can be distinguished.

Measurements of Shells (in millimetres).

	Quetta.		
Length ..	34·6	33·2	32
Breadth ..	10·8	11·3	11·2
Length of aperture ..	10·6	10·5	11·1
Breadth of aperture ..	6·1	6·2	6

The radula is very like that of the varieties of *M. pyramis.*

The operculum is very similar to that of the varieties of *M. pyramis.*

The geographical range of this species is obscure and there has evidently been much confusion with *M. pyramis* and *M. tuberculata.* The only specimens we have examined are from Quetta and the Kangra Valley. They include Hutton's type-series (No. 1208 M, *Z.S.I.*).

Melanoides scabra (Müller) var. **elegans** (Hutton).

1850. *Melania elegans*, Hutton, *op. cit.*, p. 657.
1885. *Melania scabra* var. *elegans*, Nevill, *op. cit.*, p. 284 (in part).

To judge from Hutton's description, this is a large, thick, strongly sculptured and brilliantly coloured form of Müller's *Buccinum scabrum*, the specific name of which must be applied in a restricted sense to the smaller, thinner-shelled form with definite spines at the upper end of the longitudinal ribs on the body-whorl, common in South India.

We can find in the collection no specimens either from the Bolan Pass, which lies between Quetta and the plains, or from Sibb in Persian Baluchistan, from which place Nevill records specimens of the typical form. There is, however, a series stated, perhaps incorrectly, to be from the Sunderbans in the Gangetic Delta which agrees well with Hutton's description and with the remarks made by Nevill in his "Hand-List." We figure one of these shells.

The complete synonymy of *M. scabra* and its allies has still to be worked out. So far as we can say at present, the form *elegans* should not be regarded as having specific value.

Genus **Melanopsis**, Férussac.

1877. *Melanopsis*, Brot., *op. cit.*, p. 416.

This genus is represented in the southern part of the Persian Plateau[1] by several species. We have recently obtained from Persian Baluchistan a good series of specimens of a very distinct new form, for which we propose the name:—

Melanopsis deserticola, sp. nov.

(Pl. iii, fig. 8.)

The shell is smooth as a whole, tapering regularly, acuminate, fusiform, a little more than twice as long as broad. The whorls,

[1] See Nevill, *Hand List Moll. Ind. Mus.* II, pp. 206–209.

of which there are at least eight in complete shells, increase very gradually and regularly and are not at all swollen. The suture is not impressed but is, at any rate above the body-whorl, slightly undercut downwards. It is a little oblique. The spire is relatively long, nearly as long as the body-whorl in ventral and longer than that whorl in dorsal view. It is sharply pointed in the complete shell. The body-whorl is relatively narrow, much longer than broad and almost oblong in ventral view. In dorsal view the outer profile is in a straight line with that of the spire for about a third of its length and then curves abruptly inwards. The outer anterior angle is pointed and slightly produced. The mouth is rather small and relatively broad, slightly oblique and distinctly constricted posteriorly. The outer lip, which is not thickened, is sinuate and convex in its anterior part. The columella projects slightly; it is bent and its callus is moderate. The posterior canal of the mouth is short, narrow and straight. The surface of the shell is sculptured with coarse longitudinal striae, some of which on the body-whorl are irregularly thickened. In very old individuals these may have the appearance of obsolete ribs. The colour is normally a dull purplish black with the upper part of each whorl and the base of the body-whorl slightly paler; but some shells are bleached.

Measurements of Shells (in millimetres).

			Type-sp.
Length ..	.. 14·4	13·6	13·3
Breadth ..	.. 6·3	6·1	6·2
Length of aperture	.. 6	5·8	6·1
Breadth of aperture	.. 3·2	3·1	3·3
Length of spire (dorsal)	.. 7·3	6·9	6·4

The operculum is thick and has the nuclear region small and obscurely spiral.

The animal is much shrunk in the specimens examined, but some interesting features of its external anatomy are apparent. The snout is relatively short and broad and slightly notched in front. The foot is much longer that broad. The tentacles, in a contracted condition, are very short, tapering and not very thick. They bear a relatively large oculiferous lobe at their outer base. The eye is also large. The upper surface of the exposed parts is blackish with white transverse lines, the sole white.

The radular teeth are large and rather stout. The central tooth is much broader than high. It is produced into blunt angles at the base on either side. Its upper margin bears three low prominences, while the lower margin is concave. There are five cusps, of which the central cusp is more than twice as long as the others; all are bluntly pointed and directed downwards. The disk bears a very large trilobed process with the central lobe broad and truncate, the lateral lobes pointed and with sinuate inner margins. The

lateral tooth is oblique but not bent. It has five cusps resembling those of the central tooth and bears a broad blunt process on its disk. The inner marginal has four or five subequal cusps and is much narrower than the outer. The outer marginal is relatively long and narrow as a whole, with four small cusps; but its outer margin is produced some distance below its upper edge into a broad, blunt lobe. On the upper part of the inner margin there is a similar but much less prominent projection.

Type-specimens. No. M 11535/2 *Zool. Surv. Ind.* (*Ind. Mus.*).

The type-series was found by Mr. (temporary Major) W. J. Good, at the time Administrative Commandant, South Central District, Eastern Persian Cordon, at Kaindak (long. 60° 48′ E., lat. 29° 48′N.), Persian Baluchistan. The molluscs were collected on damp alga at the edge of a small spring of slightly brackish water. The water comes out of a patch of earth 20 to 30 feet square and forms a mere trickle.

At first sight the shell of this species is very like that of the dwarfed Persian form of *M. praerosa* (Linn.) called by Nevill var. *nana*. It is, however, considerably narrower and more acuminate and has the spire very much longer.

Family LIMNAEIDAE.

The molluscs of this family found in Baluchistan and Seistan all belong to the genus *Limnaea* in a wide sense, but fall into two very distinct groups, which we may call provisionally the group of *L. auricularia* and that of *L. truncatula*. Until the anatomy of the Limnaeidae of India and of Western Asia is better known it would be premature to discuss the nomenclature and status of these groups. To that of *L. auricularia* belong *L. persica*, *L. bactriana*, *L. iranica* and *L. gedrosiana*, while *L. truncatula* and *L. hordeum* represent the group of the former species.

Genus **Limnaea**, Lamarck.

The *Limnaeae* found in the countries under consideration are all of small size and, except those of *L. truncatula* group, have thin, fragile shells, which are unpigmented or of very pale colouration. They are all paludine forms. We have recognized six species. Although some of these resemble Palaearctic or Indian species in shell-characters, we have not felt justified in identifying any but the plastic *L. truncatula* with species known either from Europe, from Central Asia or from India. One peculiar species (*L. hordeum*) we assign, after a comparison of specimens, to a Mesopotamian form. The resemblances in the shell in other instances are no more than resemblances, and in most cases precise information as to anatomical characters is deficient or altogether lacking.

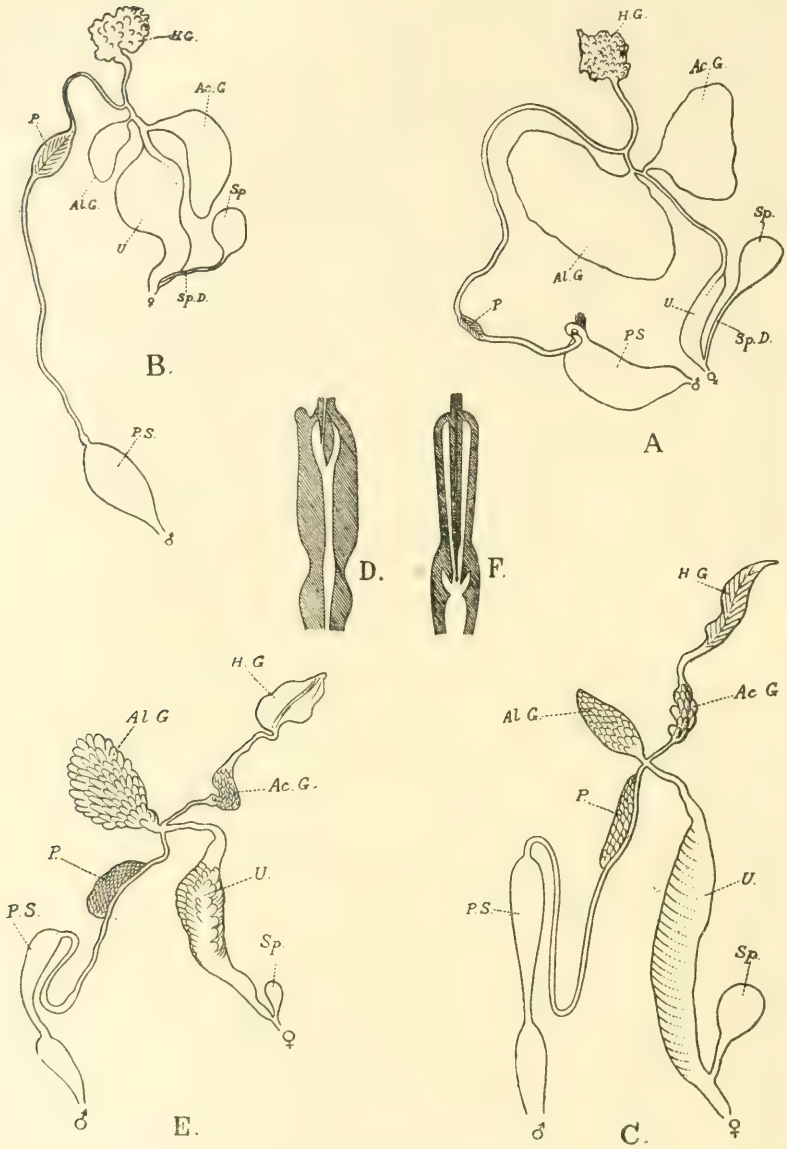

FIG. 5.—Genitalia of Pulmonate Molluscs.

A. Genitalia of *L. bactriana*, Hutton.
B. Genitalia of *Limnaea gedrosiana* var. *rectilabrum*, var. nov.
C. Genitalia of *Gyraulus euphraticus*, Mousson.
D. Penis-sheath of same specimen as seen in optical section (further enlarged).
E. Genitalia of *Gyraulus convexiusculus* (Hutton).
F. Penis-sheath of *Segmentina calathus* (Benson) as seen in optical section (× 35).

Key to the Shells of Limnaea *known from Baluchistan and Seistan.*

1. Shell thin, moderately small; its mouth large and more than half as long as the shell.
   - A. Mouth expanded and projecting posteriorly from shell at a right angle; its outer arc practically a semi-circle ... ... *L. persica.*
   - B. Mouth not or little expanded, usually projecting at an angle much less than a right angle; its outer arc less than a semi-circle.
     - i. Spire exserted, with swollen whorls and impressed suture; main axis of mouth forming an acute angle with that of shell ... *L. bactriana.*
     - ii. Spire much less exserted; its whorls not swollen and its suture not impressed; main axis of mouth parallel to that of shell.
       - a. Outer arc of mouth quite regular; apex sharply pointed ... ... *L. iranica.*
       - b. Outer arc of mouth irregular; apex bluntly pointed.
         - 1. Curve of outer arc of mouth only slightly flattened ... ... *L. gedrosiana, s.s.*
         - 2. Curve of outer arc of mouth flattened to a straight line ... ... *L. gedrosiana* var. *rectilabrum.*
2. Shell moderately or very thick, of very small size, elongate, with the length of the mouth much less than half the total length.
   - 1. Apex pointed; whorls of spire moderate ... *L. truncatula.*
   - 2. Apex blunt; whorls of spire very large ... *L. hordeum.*

Limnaea persica, Issel.

(Pl. v, figs. 3–6.)

1865. *Limnaea auricularia* var. *persica*, Bourguignat, Issel, *Moll. Miss. Ital. Persia* (*Torino*), p. 47.
1883. *Limnaea persica*, Locard, *Arch. Mus. Hist. Nat. Lyon* III, p. 285.

Issel gave a very brief description of this form, which he did not figure, merely comparing it with *L. auricularia* and stating the length and breadth of the shell. Locard had probably seen specimens, as he compared his *L. subpersica* with it, but gave no further details. It seems to us impossible that the form which Nevill[1] called *Limnaeus lagotis* var. *persica*, Issel (= *L. iranica*, nobis) can be identical, as that form has no particular resemblance to *L. auricularia*.

We have before us a series of shells[2] collected by the late Dr. W. T. Blanford at Saidabad, S.W. of Kerman (the type locality). The measurements of one of these agree almost precisely with those given by Issel. We have also a much larger series from the Baluchistan desert clearly belonging to the same species but differing slightly. Fully adult shells from the former locality are somewhat broader than Issel's type, the specimen that agrees with it being not quite full-grown, and we do not know from what kind of

[1] Nevill, *Hand List Moll. Ind. Mus.* I, p. 237 (1879).
[2] Identified by Nevill as *L. auricularia*, var. (*op. cit.*, p. 238).

environment either Philippi's or Blanford's specimens came. It is possible, therefore, either that Issel's type was immature, or that the specimens from the desert are more near the typical form than those which chanced to be collected in the same district as it. We will describe and figure shells from the Kerman district and point out the characters wherein those from the desert (examples of which we also figure) differ from them.

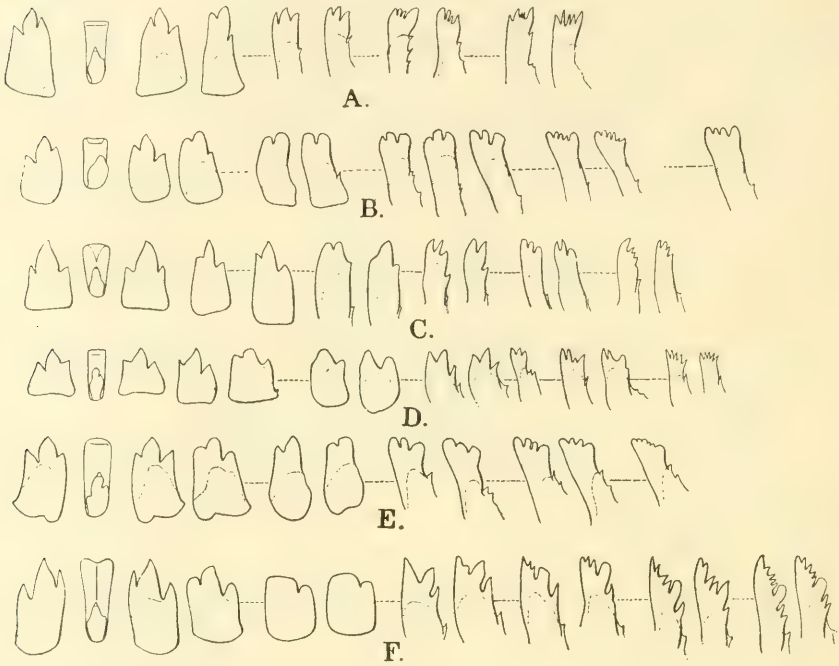

FIG. 6.—Radular teeth of *Limnaea* (× *ca.* 185).

A. Teeth of *Limnaea gedrosiana*, sp. nov. from pond in garden in Quetta.
B. Teeth of same species from the reed-beds of the Hamun-i-Helmand.
C. Teeth of *L. gedrosiana* var. *rectilabrum*, var. nov. from stones at edge of Kushdil Khan reservoir, Northern Baluchistan.
D. Teeth of same variety from small pool in desert near Nasratabad, Seistan.
E. Teeth of *L. bactriana*, Hutton, from irrigation channel, Nasratabad, Seistan.
F. Teeth of *L. iranica* from Persian Baluchistan.

Form from the Kerman district. The shell is small and thin, of a pale horny colour and (perhaps through age) opaque. The spire is short but prominent, acutely pointed and slightly oblique as a whole. It is considerably longer on the dorsal than on the ventral aspect of the shell, occupying about $\frac{1}{5}$ of the total length on the former and on the latter nearly $\frac{1}{8}$. The body-whorl is relatively large but not greatly inflated; its outlines are sinuous and it has considerable obliquity. The mouth of the shell is large

and oval; its main axis lies nearly parallel to but considerably outside that of the shell; it is hardly pointed posteriorly. The outer lip is sharp, broadly and fairly regularly arched; it extends far beyond the body-whorl posteriorly. The antero-internal angle is broadly rounded and a little expanded, the anterior border slightly flattened in its immediate vicinity. The columella is straight, its callus well-developed and broad but not coarse; it is slightly or not at all folded and is extended over the narrowly rimate umbilicus. The sculpture consists of fine, somewhat irregular longitudinal ridges with microscopic striae running parallel to them; the former are often developed only on the body-whorl.

Form from the Baluchistan desert. Our specimens from the Baluchistan desert were collected in December, 1918 by Mr. S. W. Kemp at the edge of the Zanginawar lakes, 20 miles east of Nushki. These lakes are a series of small basins which retain the overflow from the Pishin river and contain water that is nearly fresh in winter and supports a luxuriant submerged vegetation. Mr. Kemp found only empty shells. These were abundant on the shore of the lakes one to two feet above the water-level.

The shells from Zanginawar only differ from those from the Kerman district in being rather smoother and distinctly narrower and in having the columellar callus narrower and slightly more folded. As may be seen from the figures on plate V, they vary somewhat in outline, and young shells are narrower and have the mouth less expanded than old ones.

Unfortunately we have no information about the radula or soft parts of either race of this species.

Measurements of Shells (in millimetres).

Specimens A—C are from Saidabad, S.W. of Kerman, S. Persia; specimens D—F from Zanginawar in the Baluchistan desert, 20 miles west of Nushki.

	A	B	C	D	E	F
Length	13·3	11·2	10·8	12·8	12·4	12·3
Breadth	10·0	7·0	7·0	7·7	7·6	7·9
Length of aperture ..	11·1	7·8	8·0	9·5	9·2	9·4
Breadth of aperture ..	7·0	5·0	5·0	6·4	6·1	6·5
Length of spire (dorsal) ..	2·5	2·7	2·0	2·1	2·3	2·4
Breadth of base of spire ..	2·5	2·5	2·5	2·0	2·4	2·6

It seems better, in the lack of anatomical information, not to dogmatize as to the precise relations of this form. There can, however, be little doubt that it belongs to the same group as *L. auricularia.*

Limnaea iranica, sp. nov.

(Pl. vii, fig. 1.)

1878. *Limnaea lagotis* var. *persica*, Nevill (*nec* Issel), *Hand List Moll. Ind. Mus.*, I, p. 237.

Shell. The shell is of small or moderate size, fairly thin, dull on the external surface, of a pale, dull opaque buff colour, orna-

mented with very fine longitudinal ridges and striae but without transverse striae. The shape is regularly, narrowly ovate, with the apex sharply pointed. The suture is not impressed and slightly oblique. The whorls, of which there are $4\frac{1}{2}$, increase gradually in size. The spire is prominent, but short, slightly oblique as a whole. It occupies a little less than $\frac{1}{4}$ of the total length in dorsal view and is only a little longer in ventral view. The body-whorl is ovate and not at all swollen, almost bilaterally symmetrical. In dorsal view the internal profile forms for the greater part of its length from the base of the spire a regular arc a little less than a semi-circle but is distinctly constricted in front of the internal anterior angle, which is broadly rounded and slightly produced. The mouth of the shell is long and narrowly pear-shaped, pointed and slightly introverted posteriorly. It runs backwards for about the length of the body-whorl. The outer lip is sharp, not at all thickened internally, broadly and regularly arched but not expanded. The columella is straight and slightly folded. Its callus, which is continuous with the outer lip posteriorly, is moderately developed. The anterior margin of the mouth is rounded and projects slightly. The columellar callus completely covers the very narrowly rimate or altogether closed umbilicus.

Measurements of shells (in millimetres).

Specimens A—C are from Persian Baluchistan (*Blanford*), specimens D—F from Magas in S. Persia (also *Blanford*).

	A	B	C	D	E	F
Length	18·3	14·5	15·3	14·4	13·4	10·3
Maximum breadth ..	11	9·1	9·1	8·4	7·5	6·2
Length of aperture ..	14·2	11·4	11·8	11·2	9·3	7·3
Breadth of aperture ..	9·5	8·1	7·3	7·2	6·4	5·1
Length of spire (dorsal) ..	3·6	2·9	3·3	3·4	2·4	2·6
Breadth of base of spire ..	4·2	3·5	3·7	3·5	3·5	2·9

Shells from the two localities only differ in size. Our specimens are those examined by Nevill.

Radula. We have extracted the radula from one of Blanford's specimens in which remains of the animal persisted. It is of the same type as that of *L. bactriana* but differs in several particulars. The base of the central tooth is distinctly bilobed. The three cusps of the inner lateral teeth are long and sharp, but those of the intermediate bicuspid teeth are short and blunt, the inner cusp being broadly truncate. The marginal teeth are somewhat remarkable, having the outer margin coarsely denticulate, one of the denticulations being often of a lobular nature. The dental formula is approximately 12.7.1.7.12.

Type-specimen. No. M11545/2, Zoological Survey of India (Ind Mus.) [Persian Baluchistan].

Localities. The only specimens we have seen are those collected by Dr. Blanford in Persian Baluchistan and at Magas in Southern Persia. There is a good series from each locality.

The position of this species is a little doubtful. The shell is in some respects intermediate between that of *L. peregra* (*ovata*) and that of *L. lagotis*. It resembles somewhat that of *L. intermedia* as figured by Kobelt in the new edition of Rossmässler's "Iconographie" (pl. 488, No. 2602), but the whorls increase more gradually in size and the mouth is broader.

Limnaea bactriana, Hutton.

(Pl. v, figs. 1, 2; pl. vii, fig. 6.)

1850. *Limnaea bactriana*, Hutton, *Journ. As. Soc. Bengal* XVIII (2), p. 656.

The shell is moderately small, thin, fragile, of a pale, dull brownish colour, polished when clean but coated with calcareous algae in most of the specimens examined. The surface is often irregularly decussated and always bears, at any rate on the body-whorl, prominent but narrow longitudinal ridges and corresponding striae set close together. No transverse striae can be detected with a lens. The sculpture is often concealed by the calcareous algal coat. The apex is acuminate but not very acute, the spire prominent, but occupying less than $\frac{1}{3}$ of the total length in dorsal view. The suture is impressed and moderately oblique. There are 4 or $4\frac{1}{2}$ whorls, which are neither swollen nor shouldered; those of the spire increase gradually in size and the penultimate whorl is relatively large. The body-whorl is large and of ovoid form; its inner outline is markedly sinuate and somewhat emarginate towards the anterior extremity, but the antero-internal angle is broadly rounded, the outer outline is evenly and not very strongly curved. The mouth is large but not expanded, extending backwards for more than $\frac{4}{5}$ the length of the body-whorl and being less than twice as long as broad; it is of symmetrical ovoid form, pointed posteriorly and with its main axis parallel to that of the shell. The outer lip is sharp and neither introverted nor expanded; it has a regular and considerable outward curvature and extends forwards considerably beyond the limits of the body-whorl. The peristome is continuous, the callus broad but thin, extending over the narrow but profoundly perforate umbilicus; the columella is distinctly folded.

As in many species of *Limnaea* the shell is dimorphic. We shall call the two forms (*a*) and (*b*) and describe the commoner (*a*) first.

(*a*) In this form the shell has a comparatively long spire, occupying nearly $\frac{1}{4}$ of its length in dorsal view. The first $3\frac{1}{2}$ whorls increase in size gradually, but the basal whorl of the spire is enlarged, the spiral is by no means uniform and the body-whorl comparatively narrow.

(*b*) The shell differs from that of (*a*) mainly on account of the fact that there is a distinct change in the direction of the spiral between the ultimate and penultimate whorls. The base of the spire is therefore concealed in the body-whorl so that its visible part

becomes comparativey short (slightly more than $\frac{1}{5}$) of the total length, while the body-whorl being more transverse appears broader and has a more expanded mouth, the posterior extremity of which is situated at a higher level on the shell.

Measurements of Shells (in millimetres).

	Type (*a*).	Type (*b*).	Young.
Length	18·0	16·0	7·4
Breadth	11·7	11·3	4·6
Length of aperture	11·0	10·8	4·8
Breadth of aperture ..	6·5	6·3	1·7
Length of spire (dorsal view)	5·0	3·4	2·5
Breadth of base of spire (dorsal view)	3·5	3·2	2·0

The soft parts of the living animal have no noteworthy peculiarity. The foot and head are pale greenish yellow with minute whitish specks. The lower part of the mantle is black with large rounded yellowish spots; higher up the yellow predominates and the dark pigmentation is reduced to a delicate network.

The alimentary canal. The jaw is not strongly developed; the central piece is narrow and lunate, only its outer or marginal half is fully cornified and of a brown colour. The side pieces are feeble. The buccal mass is large and powerful, deeply rounded in lateral view. The salivary glands are smaller than in some species; they enter the alimentary canal just behind the buccal mass.

The radula is broad, its dental formula being approximately 18.7.1.7.18. The central tooth, which is comparatively large, has a distinctly tridentate cusp, which is very asymmetrical and is provided at the tip of the central denticulation with a minute thickened spine or tooth. The base of the tooth is elongate and only a little emarginate proximally. The lateral teeth are broad and tridentate; those on either side of the central tooth have the innermost denticulation subequal to the outermost and the central denticulation long and sharp. The outer lateral or intermediate teeth have two rather blunt cusps; the true marginals have from 3 to at least 7 very short and blunt denticulations, the outermost of which is the broadest. These denticulations are arranged in an almost straight transverse line.

The oesophagus is slender and elongate, marked on the surface with lines of dark pigment; it forms a well-defined double loop at about half its length between the buccal mass and the chyle stomach. This structure is short and by no means clearly differentiated externally. The lateral muscular masses of the gizzard are large but quite distinct in the middle line and slightly unequal in size; they extend very little over the true stomach, which is elongate and merges very gradually into the intestine

near the point at which the liver-duct enters the alimentary canal. The proximal part of the stomach is somewhat sacculated. The liver is large and the intestine rather stouter than in some species.

The *genitalia* are very like those of *L. chlamys*,[1] but the upper part of the male duct above the prostate, the lower part of the same duct and also the spermathecal duct are all considerably longer. Other apparent differences (the larger size of the female accessory glands and the more lobate form of the hermaphrodite gland) are probably due to the state of sexual activity in the specimens examined. The ovarian part of the hermaphrodite gland is particularly well developed. The prostate is spindle-shaped, but very small.

Habitat. This species was described from Quetta and was found in considerable abundance in an irrigation-channel leading to the garden of the British Consulate at Nasratabad (Seistan town) and also in pools on the parade-ground at the same place. In the channel the water was usually still, but it was allowed to flow freely every few days. It was always more or less turbid. The bottom was composed of stiff clay and supported a rather scanty growth of Characeae and of a narrow-leafed *Potamogeton*. In the pools, which had a similar bottom but contained a somewhat more luxuriant vegetation consisting chiefly of *Zannichellia palustris*, the water was extremely foul, being frequented by camels, donkeys and mules. The basins had been excavated in obtaining clay for bricks and the water had probably entered by percolation. Shells were also found subfossil in the banks of old water-channels near Nasratabad.

Habits. It is noteworthy that these molluscs, though living in water the surface of which was frequently frozen at the season at which they were observed, were in a state of sexual activity so far as the female organs were concerned. Egg-masses were abundant on the water-weeds. The adults seemed to feed chiefly on minute algae growing on the mud.

No difference was observed between those individuals from the dirty pools and those from the irrigation channel.

Affinities. Until the anatomy of the Asiatic Limnaeidae is better known some doubt must remain as to the affinities of this species. The shell resembles those of the group *L. lagotis*, but is more distinctly perforate. The structure of the spire somewhat resembles that of *L. lagotis* var. *subdisjuncta*,[2] Nevill, but the penultimate whorl is relatively large and the structure of the mouth is quite different. Hutton in his original description compared the shell to that of the young *L. chlamys*, Benson, and curiously enough, before we recognized the identity of our specimens, we did the same so far as the genitalia were concerned. There can be little doubt, therefore, that a relationship with the Indian

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[1] Annandale and Prashad, *Rec. Ind. Mus.*, XVI, p. 143, fig. 4 (1919).

[2] *Sci. Res. Yarkand Miss. Mollusca*, p. 9 (1886). For figures see Weber, *Wiss. Ergeb. Reise. Thian-Schan*, Mollusken, pl. i, figs. *f-h* (*Ab. Bayer. Ak. Wiss. Math.-phys. Klasse*, XXVI, 1913).

species exists, but what precisely that relationship is still remains to be discovered.

We have compared our specimens from Seistan with one named by Hutton from the old collection of the Asiatic Society of Bengal This shell is stated to be from Kandahar, but Hutton records the species only from Quetta, which was in Afghanistan when he wrote. It is very possible that the locality is incorrect. The specimen is not mature and agrees very closely with the young shell figured by us on pl. vii.

Limnaea gedrosiana, sp. nov.

(Pl. vii, figs. 2–4.)

1850. *Limnaea peregra,* Hutton, *Journ As. Soc Bengal* (2) XVIII. p. 655.

This species, so far at any rate as the shell is concerned, closely resembles *L. iranica*, but differs in that the shell is smaller, thinner, paler in colour, smoother, less regular in outline, with a blunter apex, more oblique spiral and slightly more impressed suture. The colour is a faint greenish yellow, the shell is extremely fragile and when fresh quite transparent. There are $3\frac{1}{2}$ or 4 whorls. The spire is twice as long in dorsal as in ventral view, occupying at least $\frac{1}{4}$ of the length of the shell in the former. The curvature of the inner profile of the body-whorl is less convex and not so regular as in *L. iranica,* and this whorl as a whole is much less symmetrical. The mouth of the shell is ovate, pointed but not retroverted posteriorly. It is almost bilaterally symmetrical and narrower than in *L. iranica*; its main axis is parallel to that of the shell. Though relatively as long as in the preceding species, it only extends backwards for about $\frac{7}{9}$ the length of the body-whorl. The curvature of the outer lip is slightly flattened in adult shells. The anterior margin projects considerably beyond the body-whorl.

Measurements of Shells (*in millimetres*).

	Quetta			Lab-i-Baring.		
Length	11	9·1	7·1	7·5	8	7·8
Maximum breadth ..	6·3	5·6	4·6	4·1	4·1	4·6
Length of aperture ..	8·2	6·7	5·7	6·0	6	5·4
Breadth of aperture ..	5·4	4·1	3·6	3·8	3·6	3·3
Length of spire (dorsal) ..	2·3	1·7	1·4	1·3	1·4	1·4
Breadth of base of spire ..	3·1	2·3	1·9	2·1	2·3	2·1

The living animal resembles that of *L. bactriana,* but the foot is perhaps rather smaller, the tentacles longer and more pointed and the colour pale.

The alimentary canal also resembles that of *L. bactriana,* but the muscular gizzard is more uniformly developed and more compact. It can be seen in the living animal through the shell as a globular shining mass.

The jaw and radula are of the same type as those of the species already discussed, and closely resemble those of *L. bactriana* in particular. They exhibit, however, great placticity and individual variability (see figures, p. 42). The marginals never have the peculiar form of those of *L. iranica.*

Genitalia. The genitalia are of the same type as those of *L. bactriana*, but have one important difference, viz. that whereas in that species the male and female parts of the system are approximately equal in length, in *L. gedrosiana* the vas deferens is greatly elongated, while the female ducts are short. This difference is not correlated with any difference in the position of the external sexual apertures, which in both species are situated almost on a level, but in *L. gedrosiana* the male duct is strongly convoluted.

Type-specimens. M. 11533/2, Zoological Survey of India (Ind. Mus.).

Localities. This species is common, as Hutton noted, in the Pishin district (Chaman) and at Kandahar. It also occurs in abundance at Quetta and in the Hamun-i-Helmand in Seistan.

Habits. *L. gedrosiana* can apparently live only amidst dense submerged vegetation. Hutton found it in brick tanks at Kandahar and in a small marsh at Chaman. Our specimens from Quetta were taken among weeds in a pool supplied by water from an underground source in the Residency gardens. The submerged vegetation in this pool was dense and the water, in November and January, perceptibly warmer than the air. In the Hamun this *Limnaea* occurs mainly amidst algae growing on the roots of *Phragmites* and also on *Potamogeton pectinatus* in small pools in the reed-beds.

Affinities. *L. gedrosiana* is apparently related to *L. peregra*, but differs in the blunter spire, more oblique spiral and longer mouth of its shell. We do not feel justified in uniting the two forms, and the shell differs considerably from that of any of the "varieties" from Central Asia ascribed to *L. peregra* by former authors.

Variation and plasticity. There is not much individual variation in shells from the same environment, except that correlated with age. Shells from Quetta, however, are larger and a little broader and have distinctly larger mouths than those from the Hamun. Moreover, their spire is distinctly shorter.

var. **rectilabrum**, nov.

(Pl. vi, figs. 1–6.)

This variety or phase differs from the *forma typica* so far as the shell is concerned mainly in having the outer lip distinctly flattened so that it slopes outwards in a straight line. Its margin is sometimes slightly turned inwards towards the aperture. The precise form of the mouth is, however, subject to considerable individual variation (see pl. vi). The radula does not differ more from that of the *forma typica* than that of the latter varies. The genitalia

are practically identical, but the vas deferens differs slightly in proportions.

This variety exhibits both individual variation and plasticity in a higher degree than *L. gedrosiana, s.s.* The shape of the mouth of the shell and of the whole body-whorl differs considerably in individuals from the same environment, while individuals from one environment differ in having a narrower shell than those from another. The two localities from which we have examined fresh specimens are the Kushdil Khan reservoir, situated at an altitude of 5000 ft. in the hill-country of Baluchistan north of Quetta, and a small pool in the desert some miles south of Nasratabad in Seistan. The Kushdil Khan reservoir is a large body of clear shallow water artificially confined and liable to dry up in summer. In winter it contains at certain places a fairly dense submerged vegetation consisting of *Potamogeton pectinatus*, *Naias major*, etc. The pool near Nasratabad was quite a small one. At the time of our visit it was completely isolated in the desert, but in flood-time is evidently connected with a large backwater of one of the effluent channels of the Helmand. Its vegetation consisted in December of dead reeds and a scanty growth of broad-leaved *Potamogeton.*

Specimens from Kushdil Khan were much larger and as a rule considerably broader than those from Seistan (*cf.* figs. 1–3, 4–6 on pl. vi). All the shells from each locality belonged, though differing considerably, quite definitely to the variety.

At Kushdil Khan dead shells, some with remains of the animal, were collected in flood-drift on the edge of the reservoir, while a few individuals were found adhering to the lower surface of stones near the margins. The molluscs in the desert near Nasratabad were attached in large numbers to dead reed-stems and to the droppings of goats, flocks of which watered at the pool.

Measurements of Shells (in millimetres).

Specimens from A—C are from Kushdil Khan reservoir (Baluchistan), and specimens D—F from a small pool, some miles south of Nasratabad, Seistan.

	A	B	C	D	E	F
Length	15·1	13·4	14·5	12·2	11·1	9·8
Maximum breadth ..	9·6	8·1	8·8	7	6·8	5·4
Length of aperture ..	11·5	10	10·7	9·2	8·9	7·2
Breadth of aperture ..	8·1	6·4	7·6	5·6	5·5	4·4
Length of spire (dorsal) ..	3	2·7	3·4	2·8	2·2	1·8
Breadth of base of spire ..	3·8	3·4	3·5	3·1	2·7	2·8

Type-series. M 11534/2, Zoological Survey of India (Ind. Mus.).

Limnaea truncatula, Gray.

1850. *Limnaea truncatula,* Hutton, *Journ. As. Soc. Bengal* (2) XVIII, p. 656.

We have seen no specimens from Baluchistan or Seistan, but have examined a large series from different parts of the Western

Himalayas. These specimens provide evidence of much local plasticity, some agreeing with European shells, others having the form of the var. *longula* figured by von Martens in the report (in Russian) on the molluscs in Fedtschenko's *Reise in Turkestan* (vol. 1, pl. ii, fig. 26, 1874). Specimens from some Himalayan localities are much larger than those from others.

Hutton states that *L. truncatula* is common in the marshlands bordering the Helmand at Girishk and also in similar situations at the Kogrick Pass and at Quetta. The fact that it was not found at Quetta in winter is, therefore, interesting. The species seems more susceptible to drought and unfavourable conditions than most of the genus [1] and probably conceals itself in cold weather. Had it occurred at all commonly in Seistan, however, dead shells would probably have been recovered from the recent deposits examined at the edge of the Hamun and elsewhere. The presence of a liver-fluke of the genus *Fasciola* in the country does not necessarily imply that this mollusc is the intermediate host of the liver-fluke, for *L. truncatula* does not occur in North America and yet *Fasciola hepatica* is prevalent in some districts [2]; moreover, as Mr. Kemp points out in a note appended to this paper, the Seistan liver-fluke is not identical with the European one.

Limnaea hordeum, Mousson.

(Pl. vii, fig. 5.)

1874. *Limnaea hordeum*, Mousson, *Journ. Conchyl.* XXII, p. 42.

The shell is extremely small and rather thick, narrowly elongate but blunt at the apex. Our single specimen is bleached white and has a somewhat porcellaneous appearance. There are four whorls but the apical one is very small and projects little. The suture is impressed and very oblique, so that the spire is much shorter in the ventral than in the dorsal view. The third whorl is more than 3 times as long as the second and the body-whorl considerably longer than the spire. The mouth is small and rather narrow, almost straight and practically oval, being little contracted and not at all pointed posteriorly. The lip is somewhat expanded and has a thickened appearance due to a blunt ridge running round it a short distance inside the margin. The columella is slightly folded, its callus narrowly expanded over the rimate umbilicus. The callus is joined posteriorly to the outer lip. The surface of the shell is marked with faint longitudinal striae, which are regular and set close together.

We have compared our single specimen with two of Mousson's species from the edge of the river Euphrates and can find no difference. The species was originally described from that river. Our Mesopotamian specimens are from Nasariyeh. We obtained a single dead shell in a drift at the edge of a small pool in the

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[1] Walton, *Parasitology* X, p. 243 (1917)
[2] Ward, *Fresh Water Biol. N. America*, p. 389 (1918).

desert some two miles south of Nasratabad in Seistan. The pool in flood-time is connected with a branch of the Helmand river. The following are the measurements (in millimetres) of our Persian specimen:—

Length	5
Maximum breadth	2·7
Length of aperture	2·2
Breadth of aperture	1·4

Family PLANORBIDAE.

The three species belonging to this family and known from Baluchistan and Seistan are all small and all occur commonly throughout Northern India and the adjacent countries. It is with some reluctance that we feel obliged to recognize the two groups represented by the three species as distinct genera, but they differ so much not only in shell but also in anatomy that no other course seems possible to us. We assign, therefore, two of the species (*Planorbis euphraticus*, Mousson and *P. convexiusculus*, Hutton) to the genus *Gyraulus*, Agassiz, and one (*Planorbis calathus*, Benson) to the still more distinct genus *Segmentina*, Fleming.

Genus **Gyraulus**, Agassiz.

1837. *Gyraulus*, Agassiz, *Nouv. Mem. Soc. Helv.* I (*fide* Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 118, 1915).

In this genus the shell is small, thin, flat, pale, translucent or transparent, without strong transverse ribs, with or without spiral epidermal cilia, with or without peripheral keel, with few whorls, with a simple lip, without teeth or partitions on the internal surface, with a dextral spiral. The radula has the central tooth bicuspid and the laterals bi- or tricuspid, the marginals with several sharp cusps. The edge of the mantle is not thickened. The vas deferens is continued distally into a narrow penis, which projects straight into an elongate bulbous chamber or penis-sheath and is armed at its termination with a well-developed horny stylet.

Type-species. Planorbis albus, Müller (Palaearctic).

There has been much confusion about the two species of this genus that occur in Baluchistan and Seistan, chiefly because conchologists have rarely seen specimens from the original localities. The correct names for these species are in our opinion *G. convexiusculus* (Hutton), of which *G. saigonensis*, Crosse and Fischer, is a synonym, and *G. euphraticus*, Mousson, to which Hutton and later Benson applied the preoccupied name *Planorbis compressus*.

Gyraulus convexiusculus (Hutton).

1850. *Planorbis convexiusculus*, Hutton, *Journ. As. Soc. Bengal* (2), XVIII, p. 657.

1864. *Planorbis saigonensis*, Crosse and Fischer, *Journ. de Conchyl.*, XII, p. 362, pl. xiii, fig. 7.

1876. *Planorbis convexiusculus*, Hanley and Theobald, *Conch. Ind.*, p. 48, pl. xcix, figs. 8–10.
1886. *Planorbis convexiusculus*, Clessin, *Die Fam. Limnaeiden* in Martini and Chemnitz's *Conch. Cab.* (ed. Küster), p. 127, pl. xvii, fig. 9.
1897. *Planorbis compressus*, v. Martens, *Süss-u. Brackw. Moll.* in Weber's, *Zool. Ergebn. Niederl. Ost.-Ind.* IV, p. 13, pl. i, figs. 17–22, pl. xii, figs. 7, 10.
1909. *Planorbis saigonensis*, Germain, *Rec. Ind. Mus.*, III, p. 117.
1918. *Planorbis saigonensis* (?), Annandale, *Rec. Ind. Mus.*, XIV, p. 112, pl. xi, fig. 12.
1919. *Planorbis, convexiusculus*, id., *Rec. Ind. Mus.*, XV, p. 166.

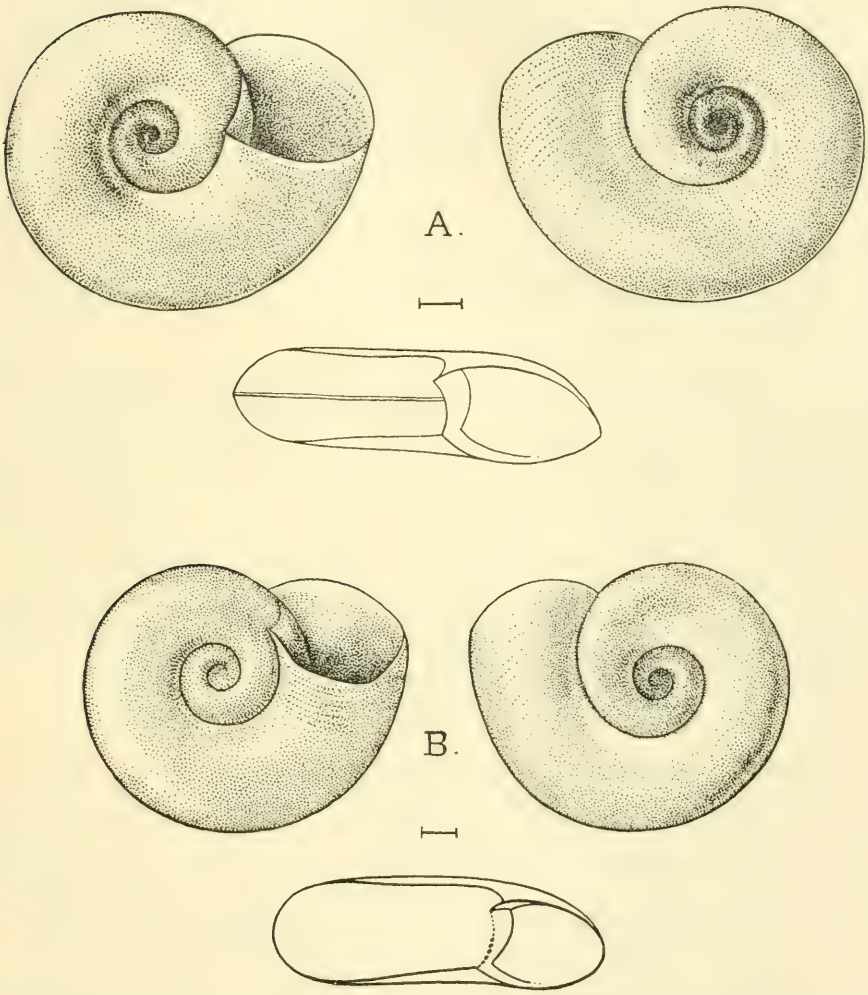

FIG. 7.—Shells of *Gyraulus* from pool in Residency garden, Quetta, Baluchistan.

A. *Gyraulus euphraticus*, Mousson. B. *G. convexiusculus*, Hutton.

This shell is apparently very like that of *G. albus*, the type-species of the genus, but the whorls are deeper. It rarely exceeds

5 mm. in maximum diameter. The figure of the mouth in *Conchologia Indica* is not very good, the upper margin being represented as too much elevated. Some variation, however, exists in this respect.

It is undoubtedly to *G. convexiusculus* and not to Hutton's *P. compressus* that Crosse and Fischer's *P. saigonensis* belongs. Specimens from Tibet identified by Germain (who had probably had access to the collections described by the latter authors) as *P. saigonensis* agree closely with shells from Quetta, one of the type-localities of Hutton's species.

The radula has approximately the dental formula 11.9.1.9.11. The two cusps of the central tooth are well developed and sharply pointed. The inner laterals have two stout, sharply pointed cusps, the outer laterals or transitional teeth three. The marginals have from four to six similar but more slender cusps. Von Martens' figure of the teeth is on too small a scale to show their structure clearly.

The genitalia (fig. 5 E, p. 40) belong to Simroth's [1] Typus III and closely resemble his figure of those of *Planorbis vortex* in general structure. All the ducts are, however, much shorter, the penis-sheath is larger and more elongate and the spermatheca smaller and also more elongate.

Planorbis convexiusculus is common with the succeeding species among weeds in water-channels and in pools in the reed-beds in Seistan, also in ponds near Quetta, where it occasionally occurs in large numbers on the muddy bottom of open water-channels. It is almost invariably found with *P. saigonensis*. Its geographical range extends from Lower Mesopotamia through Eastern Persia, Afghanistan and Northern India to Upper Burma, French Indo-China, China, Japan, and the Malay Archipelago.

Like many aquatic Pulmonates this species rises to the surface of the water in the evening and crawls shell-downwards on the surface film. It is, however, apparently unable to swim actively in this position as *G. euphraticus* does (*post.*, p. 56).

Gyraulus euphraticus, Mousson.

1834. *Planorbis compressus*, Hutton (*nec* Michaud), *Journ. As. Soc. Bengal* (2) III, p. 93.
1850. *Planorbis compressus. id., ibid.*, XVIII, p. 117.
1874. *Planorbis* (*Gyraulus*) *devians* var. *euphratica*, Mousson, *Journ. de Conchyl.* (3) XIV, p. 44.
1918. *Planorbis saigonensis*, Annandale, *Rec. Ind. Mus*, XV, p. 166.
1918. *Planorbis saigonensis, id., Mem. As. Soc., Bengal* VI, p. 304.

The shell of this species is so like that of *G. convexiusculus*, and the two are so frequently found together, that we would have felt inclined to regard them merely as dimorphic forms had it

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[1] Simroth, "Mollusca (Weichtiere)" III, p. 502, fig. 165, pl. xxvi, figs. 4, 6 in Bronn's *Tier-Reich* (1912).

not been for certain differences in the radula and for the fact that the habits are to some extent distinct. The shell, as one of us has pointed out (*op. cit.*, 1918), differs from that of *G. convexiusculus* not only, as Hutton noted, in being more compressed and more strongly carinate, and having the lip and whorls of a slightly different shape, but also in being larger, more opaque and more coarsely and irregularly sculptured. The last whorl moreover as a rule deviates from the spiral of the upper whorls. These characters are to some extent variable, but the radula differs in having all the teeth narrower, all the laterals tricuspid and the marginals with smaller cusps. The genitalia have all the ducts longer than those of *L. convexiusculus* and the spermatheca much larger. Otherwise they are very similar.

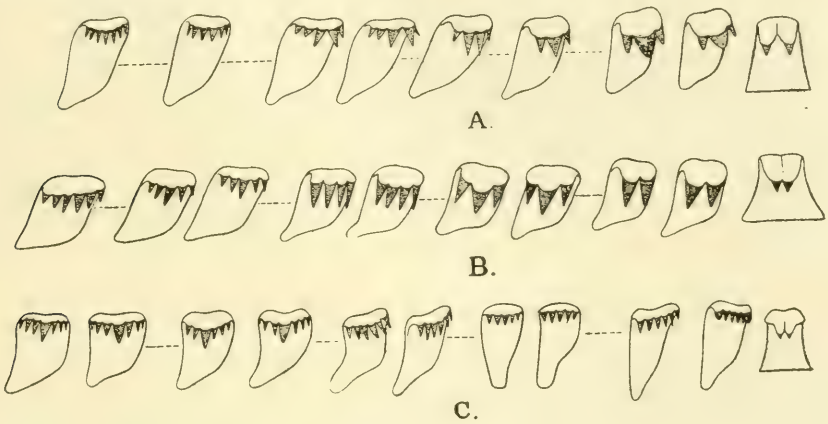

FIG. 8.—Radular teeth of Planorbidae.

A. Teeth of *Gyraulus euphraticus*, Mousson, from Quetta (× 708).
B. Teeth of *G. convexiusculus*, Hutton, from the same locality (× 900).
C. Teeth of *Segmentina calathus* (Benson) from swamp near Gurdaspur, Punjab (very highly magnified).

Germain[1] regards Hutton's *Planorbis compressus* as synonymous with *P. saigonensis*, Crosse and Fischer, but specimens from Northern India have the sculpture coarser and more irregular, the last whorl more oblique, the mouth larger and more oblique and the inner whorls more concave on the lower surface than is shown of *G. saigonensis* in Crosse and Fischer's[2] original figure, with which specimens agree. Specimens of the carinate form from Quetta, however, agree closely with shells of Mousson's *G. devians* var. *euphratica* recently collected by Captain C. L. Boulenger in Mesopotamia. The species would, therefore, appear to be essentially a Palaearctic one, but there has been much confusion as to

[1] *Rec. Ind. Mus.*, III, p. 117.
[2] Crosse and Fischer, *Journ. de Conchyliologie*, XI, p. 362, pl. xiii, fig. 7.

its real distribution. It certainly extends from Mesopotamia to the Kiangsu Province of China.

The habits differ from those of *G. convexiusculus* in that the animal swims actively on the surface in the evening. This we recently observed at Chakradharpur in Chota Nagpur, and we have been able to confirm the observation in Calcutta. While floating shell-downwards like other species of the family with its foot applied to the surface film, it moves forward rapidly in a jerky manner by repeated strokes of its shell in the water. The sole of the foot adheres to the surface-film and the shell is raised almost to a horizontal position with its major axis parallel to but well below the film. It is then rapidly depressed, so that momentarily the axis forms almost a right angle with the surface. After this downward stroke it is rapidly raised again to a horizontal position, and the animal is propelled forwards a little obliquely. The manoeuvre is frequently repeated, each time with a jerk, leverage being provided by the friction between the sole of the foot and the surface-film. Doubtless the flattened, carinate form of the shell is of advantage in its use as an oar, and probably all species with this character behave in the same way. The bacterial "velum", noted in the Burmese species *G. velifer*,[1] is commonly present in *G. euphraticus* also.

Genus **Segmentina**, Fleming.

1828. *Segmentina*, Fleming, *Hist. Brit. Anim.*, p. 270.

This genus consists like *Gyraulus* of small or minute, thin-shelled species, but the whorls are as a rule of a different form, convex above and flattened below and the shell is characterized by the production at intervals on the inner surface of the main whorl of curious opaque, white, transverse teeth or ridges of an enamel-like substance Correlated doubtless with the presence of these is the fact that the edge of the mantle is thickened. The radula differs from that of *Gyraulus* in having the teeth narrower and with smaller cusps and all the lateral multicuspid. The genitalia are also of a different type in that the penis, though produced into the penis-sheath, is directed into it from one side and is not provided wfth a horny stylet.

Type-species. *Planorbis nitidus*, Müller (Palaearctic).

Segmentina calathus (Benson).

1850. *Planorbis calathus*, Benson, *Ann. Mag. Nat. Hist.* (2) V, p. 348.
1876. *Planorbis calathus*, Hanley and Theobald, *op. cit.*, pl. xxix, figs. 4-6.
1918. *Planorbis calathus*, Annandale, *Rec. Ind. Mus.* XIV, p. 113.

The shell is very much like that of the type-species of the genus (*Planorbis nitidus*, Müller), to which it apparently bears

[1] Annandale, *Rec. Ind. Mus.*, XIV, p. 112, pl. xi, figs. 7-11.

much the same relation as *Gyraulus convexiusculus* does to *G. albus*. The radula has approximately the formula 13.10.1.10.13. The teeth are rather small. The terminal part of the central tooth is distinctly bilobed. The inner laterals have six small, sharp cusps, the other teeth of the same series five. The inner marginals have six cusps very similar to those of the inner laterals, while the outer marginals have seven cusps, the central cusp being considerably larger than the others.

Our material is not well preserved for anatomical investigations, but in a specimen from the Punjab the terminal part of the male duct belongs to Simroth's Typus II. The blind sac-like appendages shown in his diagram (*op. cit.*, p. 502, fig. 165) are, however, very poorly developed.

The species is common in swamps in Northern India, but somewhat local in its distribution. It is recorded from several places in the Himalayas, Bengal, Assam, Burma, Ceylon and Siam. One of us recently found it to be common in a swamp near Peshawar on the North-West Frontier of India and also obtained a specimen in a similar situation at Gurdaspur in the Punjab. Two dead and whitened shells were found at the edge of a pool in the desert near Nasratabad, Seistan. The shells are very small, but otherwise fairly typical.

CLASS **LAMELLIBRANCHIA** (=PELECYPODA).

This class is represented in our collections from Seistan and Baluchistan by large series of specimens of two species, *Corbicula fluminalis* (Müller) and *Lamellidens marginalis* (Lamarck). Hutton (*Journ. As. Soc. Bengal*, XVIII, p. 659: 1850) has described under the name *Pisidium paludosum* a third species from Chaman, now on the Afghan frontier of Northern Afghanistan, but we have seen no shells of this form. It may be a young *Corbicula*.

Corbicula fluminalis, which also occurs in ponds and streams at Quetta, and the *Unio* are both so abundant in Seistan, both recent and subfossil, that their shells are a feature of the country. They are found lying on the surface, wherever the land is occasionally flooded, in thousands and the banks of ancient streams and lakes are full of the shells of *Corbicula*. This is the case at many places now completely desert. Though the shells are frequently bleached and sometimes wind-worn and sand-eroded, they are usually in a remarkably perfect condition.

Family CYRENIDAE.

Genus **Corbicula**, Megerb.

This genus provides many difficult problems in taxonomy, increased by the fact that there is no recent, well-illustrated monograph. Undoubtedly many of the so called species now generally accepted will have to retire into the synonymy of others.

Corbicula fluminalis (Müller).

(Pl. viii, figs. 1–6.)

1774. *Tellina fluminalis*, Müller, *Verm. terr. et fluv. Hist.* II, p. 205.
1818. *Cyrena cor*, Lamarck, *Anim. sans. Vert.* V, p. 552.
1854. *Cyrena crassula*, Mousson, Bellardi's *Cat.*, p. 54
1864. *Corbicula cor*, Prime, *Ann. Lyc. Nat. Hist. N. York*, VIII, p 7, fig. 8.
1866. *Corbicula crassula, id., ibid.*, p. 216, figs. 44, 45.
1883. *Corbicula fluminalis*+*C. crassula*, Locard, *Arch. Mus. Hist. Nat. Lyon* III, pp. 222, 256, 258, pl. xxii, figs. 17, 18, 25, 26.
1913. *Corbicula fluminalis*, with var. *cor*, Germain, *Bull. Mus. Hist. Nat.* (Paris), p. 472.

The species is a very variable and plastic one and has a very wide geographical range in Africa and Asia. It was originally described from the Euphrates. We have examined a large series of fresh and subfossil shells from Seistan, the Afghan desert and Northern Baluchistan. Those from the Afghan desert were collected by the Seistan Boundary Commission of 1902–1903. Several small shells were also obtained in a spring of distinctly brackish water at Saindak in the west of the Baluchistan desert. In most of the series comprised in this collection, including those of fresh shells from the Hamun-i-Helmand, the specimens can be separated easily enough into two groups, one agreeing well enough with the majority of shells from the Euphrates, the other with the breadth proportionately narrower and the umbonal region more prominent. The former form is undoubtedly the true *Tellina fluminalis* of Müller, while the latter agrees closely with Prime's figures of *Corbicula cor* (Lamarck). In one large series from the desert on the banks of the Helmand in Afghan territory some of the shells are still narrower and come very near the same author's figures of *Corbicula crassula*, Mousson; while in several series shells intermediate between *C. fluminalis* and *C. cor*, *C. cor* and *C. crassula* are readily selected. *C. cor* and *C. crassula* may, therefore, be recognized at most as varieties, if this be convenient, but not as distinct species.

All the shells we have examined from Mesopotamia, Seistan or Persia are small, and the species in Asia Minor (in which also, however, it is (*fide* Locard) plastic in size) apparently attains larger dimensions in favourable circumstances. The largest fresh specimens we obtained in Seistan is a single valve 27·5 mm. broad by 24·5 mm. high. It exhibits an interesting abnormality in the hinge, in which only one, the central, cardinal tooth is developed. The colour of the periostracum varies from bright green to black; that of the inner surface is violet. Mesopotamian shells are often decorated with broad, whitish, transverse bars externally.

The species commonly hides itself in mud or sand in winter. We found very few living examples in Seistan, in spite of the abundance of fresh shells everywhere. Several living individuals were, however, dug from mud at the bottom of small pools in the Randa stream near Jellalabad, about 12 miles north of Nasratabad, in November.

Family UNIONIDAE.

Genus **Lamellidens**, Simpson.

1900. *Lamellidens*, Simpson, *Proc. Nat. Mus.* (*Washington*), XXII, p. 854.
1911. *Lamellidens*, Ortmann, *Nautilus*, XXIV, p. 106
1918. *Lamellidens*, Prashad, *Rec. Ind. Mus.* XV, p. 145.
1919. *Lamellidens*, *id.*, *ibid.*, XVI, p. 293, fig. 4.

The occurrence of this genus in Seistan proves the existence of a distinct Indian element in the fauna.

Lamellidens marginalis, Lamarck.

Subsp. **rhadinaeus**, nov.

(Pl. iii, figs. 9, 10; pl. viii, figs. 7-11.)

Shells from Seistan only differ from those of the *forma typica* from Bengal in a few particulars, but the differences are constant in a large series. In shape the shell is somewhat variable, but is close to that of the var. *corrianus*, Lea, being more transverse and having the upper margin straighter than that of the *forma typica*. In this respect it is intermediate between the two varieties. It is slightly more tumid than either and in old shells one or other of the valves is as a rule bent outwards slightly at the point at which the foot emerges, causing the shell to gape at this point. The sculpture of the young shells is finer and sharper than in the common Indian varieties. The teeth of the hinge are more prominent than in either form, the pseudocardinals stouter and the laterals more bent. In their stoutness the teeth approach those of the species or variety *L. jenkinsonianus* (Benson) of Bengal and Assam.

The older part of the shell is pale cream-colour or silver-grey externally. This usually deepens, as the shell grows, to chestnut, and sometimes even to black. Some shells, however, are pale greenish; there is usually at least one pale yellowish zone on the darker region, and the margin is sometimes pale. The nacre is bluish white and has a china-like lustre with very little iridescence.

Two phases can be distinguished, the difference being visible even in very young shells.

Phase A.—The shell is of considerable size and thickness, with the growth-lines strongly developed, the epidermis of the lower part dark and the hinge-teeth unusually stout and prominent, approaching those of some species of *Unio* in development.

Phase B.—The shell is smaller, thinner, less inflated and paler in colour and the hinge-teeth are less stout and not so prominent.

The young shell seems to be slightly more elongate in phase B than in phase A and is distinctly smoother in the former. It does not differ in essential characters from that of the typical form of the species, but has the sculpture less well developed; it is rather shorter in proportion than that of the var. *corrianus*. Its sculpture is very well preserved even in old shells, the glochidial shell often remaining as a minute tubercle. When about 25 mm. long the shell has a fairly prominent dorsal "wing" and is thin, almost translucent and of a greyish colour.

Measurements of Shells (in millimetres).

Specimens A—C belong to phase A : specimens D—F to phase B.

	A	B	C	D	E	F
Length	97·8	90	90·2	71·3	73·6	51·6
Height	55·5	49·9	47·8	38·4	39·1	28·3
Thickness	37·4	33·4	33·3	25	25·3	16·1

Lamellidens marginalis subsp. *rhadinaeus* is common all over

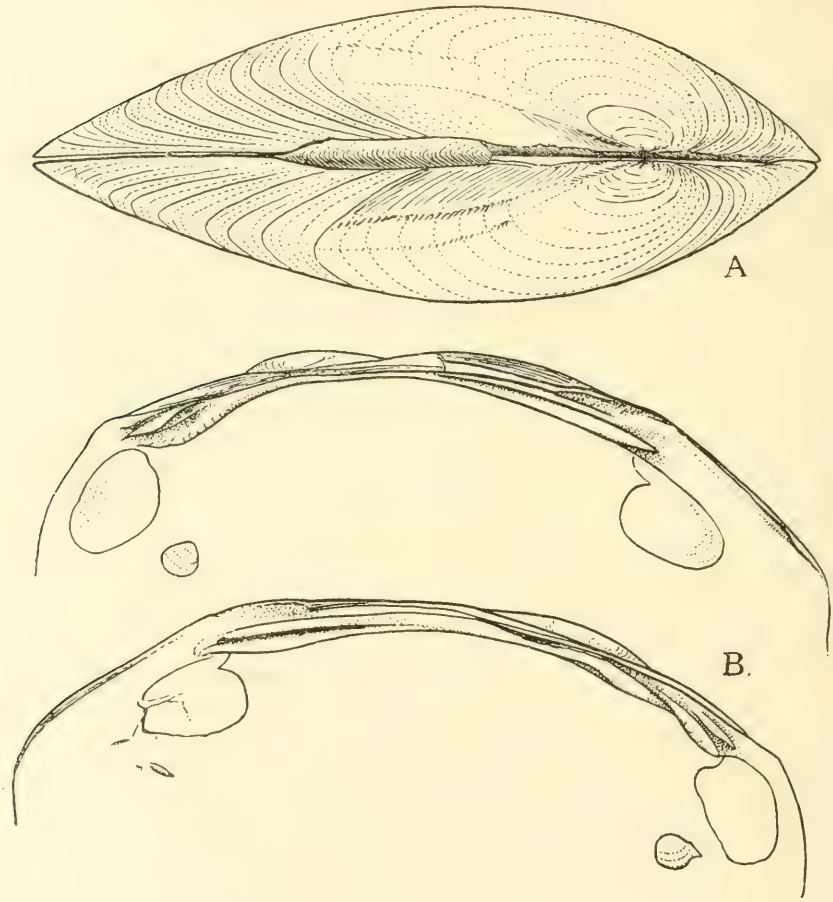

FIG. 9.—Shells *Lamellidens marginalis rhadinaeus*, subsp. nov. (natural size).

A. Dorsal view of type-specimen from a backwater of an effluent of the Helmand near Nasratabad, Seistan.

B. Hinges and scars of the same specimen.

Seistan and broken shells from the Afghan desert evidently belong to the same form. It appears to be quite distinct from the var. *candaharica*, with specimens of which we have compared our series. The range of the species, which is a very plastic one, is more

extensive than Simpson (*op. cit.*, p. 855) stated, extending from the mountains of Afghanistan to Ceylon and from Seistan to Burma, possibly even to Java and South China.

Dead shells were found in very large numbers at the following places in Seistan:—at the edge of the Hamun near Lab-i-Baring, in pools in the desert near Nasratabad, in the bed of Randa stream near Jellalabad about twelve miles to the north and in a large backwater of an effluent of the Helmand some miles to the south-east of the capital. They were also observed on the surface and buried in the stiff clay of open plains near Jellalabad which are periodically flooded. Specimens from still water, including the Hamun, belong to phase B, those from water directly connected with larger streams to phase A.

All these shells were in a remarkably good state of preservation, and their surface was not at all eroded. In many instances the valves adhered tightly together and the molluscs had every appearance of being alive. Indeed, many of them were brought us as containing the animal by herdsmen at Lab-i-Baring, and the people were evidently surprised when we opened them and found only mud inside. It is probable that the animal burrows deep into the mud at the approach of winter and in this connection the gape in the lower margin of the shell of many old individuals is of considerable interest, indicating that the foot is particularly large and powerful.

The shells give an indication of the age which the form habitually reaches, but this indication is open to two interpretations. On all the larger shells examined three very distinct regions can be distinguished. Round the umbo there is a region about 25 mm. wide by 13 mm. high in a large shell. The sculpture of this region, though clear-cut, is almost microscopic. It includes the nodulose and sloping ridges characteristic of the species, and also numerous (about 16) concentric longitudinal striae, each of which is compound. This region has a smooth appearance as a whole and is always of a pale colour. The next region is a broad band about 60 mm. broad by 24 mm. high in a large shell. Its general appearance is similar to the first region, but the epidermis becomes darker towards the lower margin, and it bears about the same number of compound striae. The third or outer region is about 30 mm. deep and occupies the full width of the shell. It has a much rougher appearance than the other two and bears four to six bands or groups of compound striae separated by smooth grooves. We are able to state definitely that the first region represents the growth of more than a year From the situations in which fresh shells are found in winter, where we may confidently believe they occur living in the flood-season, it is clear that the animal commonly undergoes a fairly prolonged period of hibernation, and in all probability it breeds when the floods are at their height in April or May. We found several shells in November that correspond precisely with the first region in the adult shells, and one of them still contained remains of the soft parts. Allowing for the period of free larval

and parasitic life, it is improbable that the shell would grow 25 mm. in one season, and we take it that these young shells represent the growth of something more than a year, probably about eighteen months. The second region probably represents that of one year more, but does the third region correspond to the growth of one year or of six? Probably of one, to judge from the striae on a large series of shells. If this be so, *Lamellidens marginalis rhadinaeus* probably lives as a rule for a little over three years and then dies directly or indirectly of old age. The great majority of the shells collected must, if our surmises are correct, have been of this age, and the animals through weakness or for some other reason, have failed to burrow down to the subsoil water through the very stiff clay on the bottom of the basins in which they lived, when the water began to dry up with the retreat of the floods.

NOTE ON THE LIVER-FLUKE OF SHEEP IN SEISTAN.

By STANLEY KEMP, B.A.

When in Seistan we were informed that both sheep and cattle are frequently infected by a liver-fluke which causes a heavy mortality at certain places in the early summer of each year. On enquiry we learnt that the Seistanis associated this parasite with the fact that when the annual floods recede the flocks are grazed on the peculiar vegetation that springs up on recently inundated land.

I was able (in December) to examine the livers of three sheep, the bile-ducts of two of which contained flukes of the genus *Fasciola*, *s.s.* In one of the livers the worms were unfortunately dead and in a putrefying condition. The other contained eleven specimens, all of which were alive.

Unfortunately the literature on this genus is poorly represented in our Calcutta libraries and several important American memoirs on the subject are lacking. Notwithstanding this fact, however, there appears to be little doubt as to the specific identity of the Seistan form, for most of our specimens agree in every particular except size with the excellent figures of Cobbold's *Fasciola gigantea*, reproduced from Looss by Stevens in "*The Animal Parasites of Man* (London, 1916).

The chief characters by which this species is distinguished from *Fasciola hepatica* are the following :—

(i) The form is generally much more elongate and band-like instead of leaf-shaped, the tapering of the posterior extremity being confined to a very small area.

(ii) The cephalic cone is considerably shorter in proportion to the length of the whole organism.

(iii) The posterior sucker is larger and more prominent and is situated on a line with the junction of the cephalic cone and body, instead of well behind the cone.

(iv) The main lateral diverticula of the gut are considerably more numerous.
(v) The posterior testis does not extend to the posterior third of the body.
(vi) The eggs are larger.

In all these characters except the first our Persian specimens are constant. In eight of the specimens the length varies from 38 to 43 mm. and the breadth from 9 to 11 mm., the proportion of length to breadth being from 3·5 to 4·4. Two specimens are damaged. The remaining individual is abnormal in form; its length is 28 mm., its breadth 12 mm. and it is leaf-shaped in outline. In structural characters, however, it is identical with other individuals from the same sheep.

The eggs are approximately 156 to 173 μ in length and 86 to 95 μ in breadth.

The small size of the specimens may possibly be due to the fact that they were examined before they had attained their full dimensions, though they were sexually mature. We were, indeed, informed by the sergeant in charge of the slaughtering of sheep for the troops at Nasratabad that he had noticed very much larger individuals later in the year.

In my examination of freshwater snails in Seistan I found no cercariae that could be associated with *Fasciola*, probably because the incidence of the parasite in the molluscan host is seasonal. Judging, however, from the abundance of shells in the soil of inundated land at the edge of the Hamun, the intermediate host is probably *Limnaea gedrosiana*, Annandale and Prashad. As this mollusc is also common in the hill-country of Baluchistan it would be interesting to know whether the fluke occurs there also.

So far as we are aware *F. gigantea* has not hitherto been recorded from Asia. Looss cites *F. angusta* (Railliet) and *F. aegyptiaca*, Looss, as synonyms[1] and states that the species is widely distributed in Northern Africa, including Egypt. It is said to have occurred accidentally in man in South America.

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[1] Looss, *Zool. Jahrb., Syst.*, XVI, p. 783 (1902).

EXPLANATION OF PLATE III.

FRESHWATER MOLLUSCA OF BALUCHISTAN AND SEISTAN.

The natural size of the shells is indicated by vertical or transverse lines.

Amnicola (Alocinma) sistanica, subgen. et sp. nov.

FIGS. 1–4.—Shells from Seistan, illustrating variations in form.

FIG. 5.—Operculum as seen from within (× about 10).

Melanoides pyramis var. **flavida** (Nevill).

FIG. 6.—Animal removed from shell (× 2).

Melanoides scabra var. **elegans** (Hutton).

FIG. 7.—Shell from Sunderbans, Bengal.

Melanopsis deserticola, sp. nov.

FIG. 8.—Type-specimen from Kaindak, Persian Baluchistan.

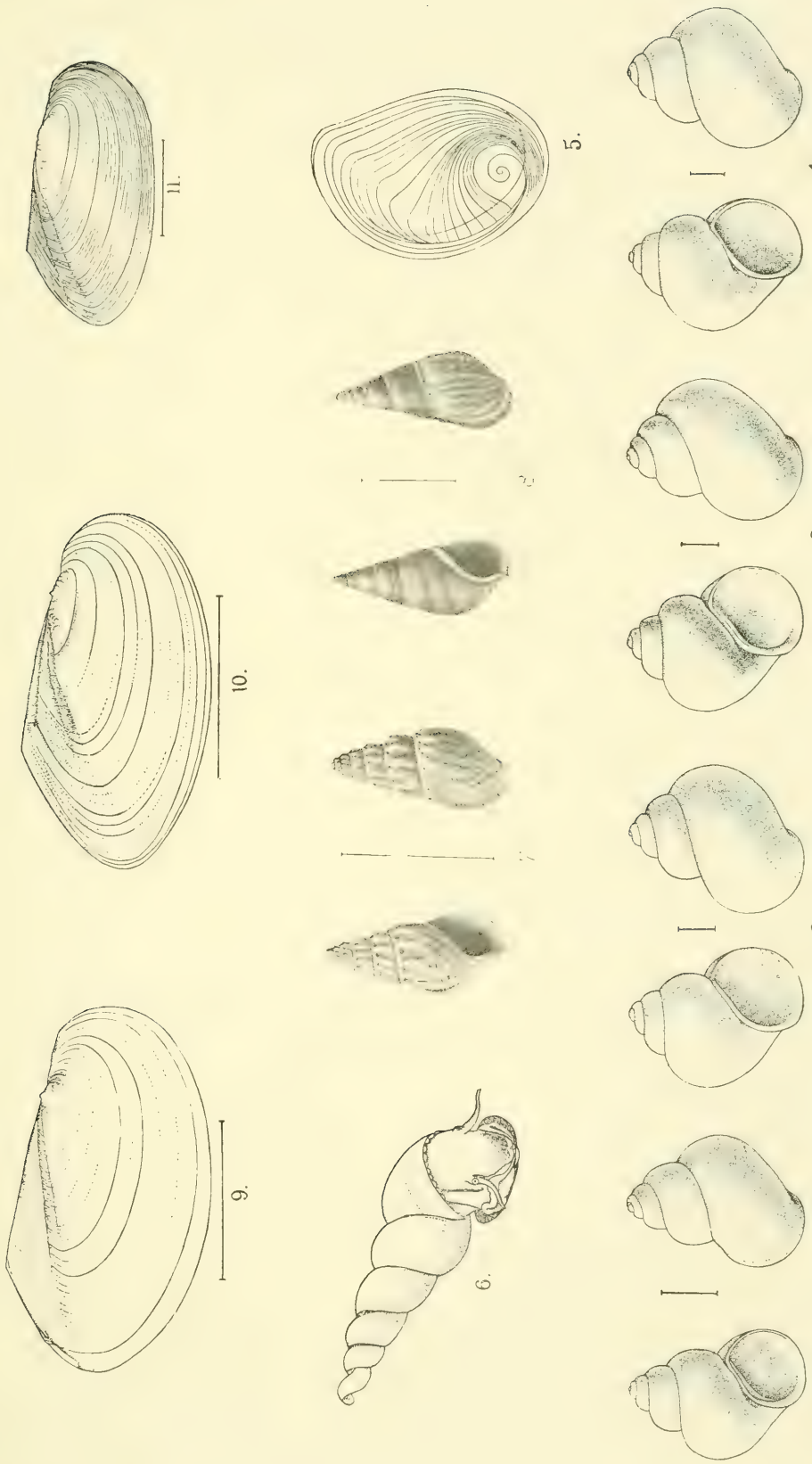
Lamellidens marginalis, subsp. **rhadinaeus**, subsp. nov.

FIG. 9.—Young shell of phase B from a pool in the desert near Nasratabad, Seistan.

,, 10.—Young shell of phase A from the Hamun-i-Helmand near Lab-i-Baring, Seistan.

Lamellidens marginalis var. **corrianus** (Lea).

FIG. 11.—Young shell from a pond on the Calcutta Maidan.



MOLLUSCA OF BALUCHISTAN & SEISTAN.

D. Bagchi & A. Chowdhary del.

EXPLANATION OF PLATE IV.

MELANOIDES TUBERCULATA (MÜLLER), M. PYRAMIS (HUTTON) AND M. TIGRINA (HUTTON).

The natural length of shells is indicated by vertical lines.

Melanoides tuberculata (Müller).

FIG. 1.—Shell from the Hosansagar tank, Secunderabad, Deccan.

Melanoides tigrina (Hutton).

FIG. 2.—Shell from Quetta, Baluchistan.

Melanoides pyramis (Hutton).

FIG. 3.—Dead shell from Quetta, Baluchistan.

Melanoides pyramis var. **leopardina**, var. nov.

FIG. 4.—Shell from Poona, Bombay Presidency.

Melanoides pyramis var. **luteomarginata** (Nevill).

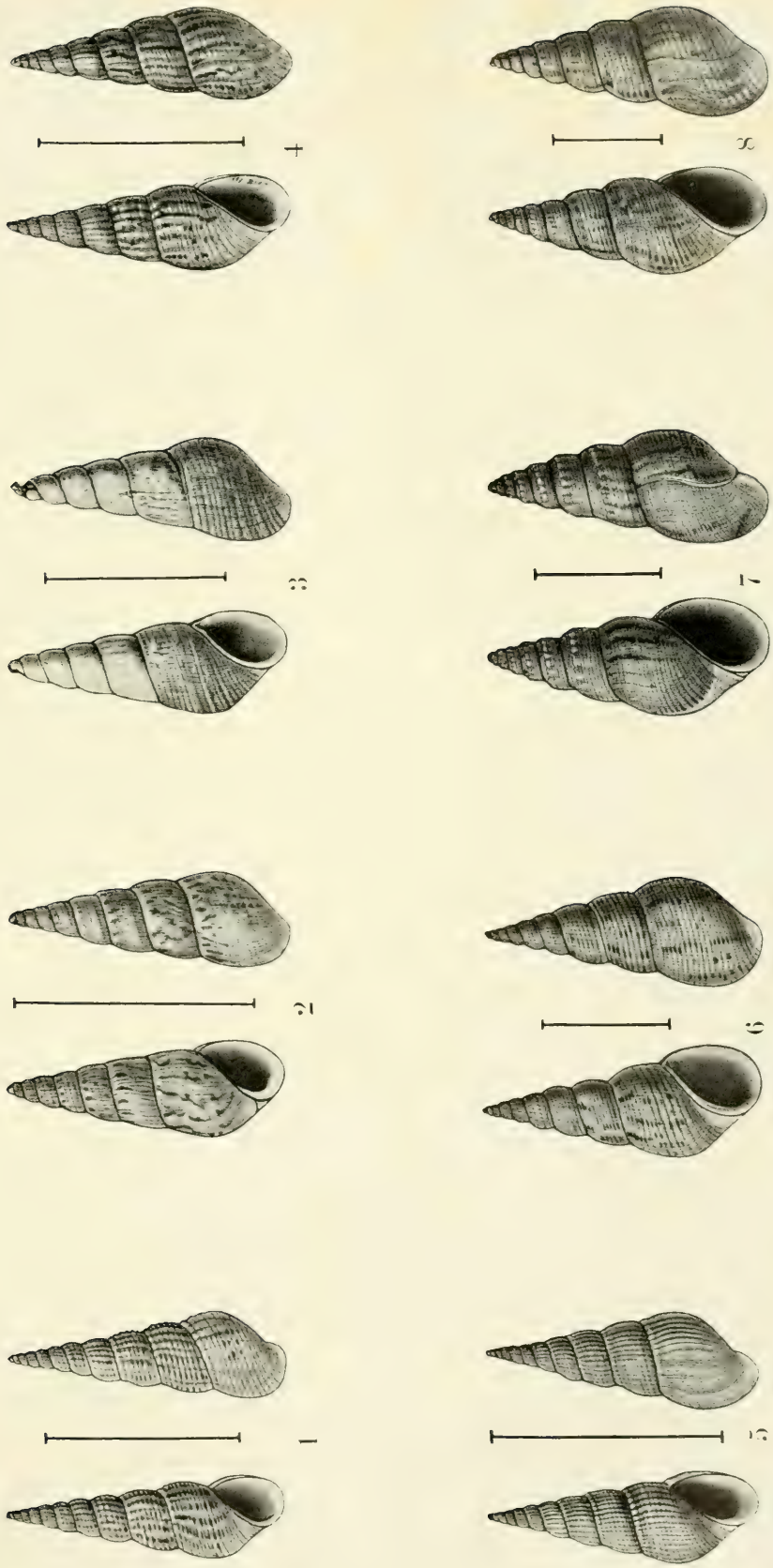
FIG. 5.—Shell from type-series; Persian Baluchistan.

Melanoides pyramis var. **flavida** (Nevill).

FIG. 6.—Shell from a spring at Hurmuk on the Perso-Afghan-Baluch frontier.

Melanoides pyramis var. **puteicola**, var. nov.

FIGS. 7, 8.—Shell from type-series from a well at Ferozepore, Punjab.



INDIAN AND PERSIAN SPECIES OF *MELANOIDES*.

A. C. Chowdhury, *del.*

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1919.

EXPLANATION OF PLATE V.

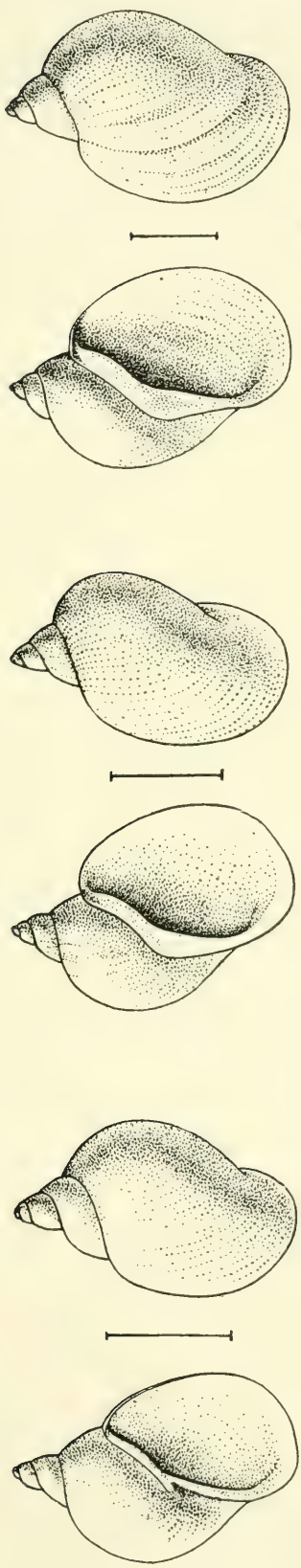
LIMNAEAE OF BALUCHISTAN AND SEISTAN.

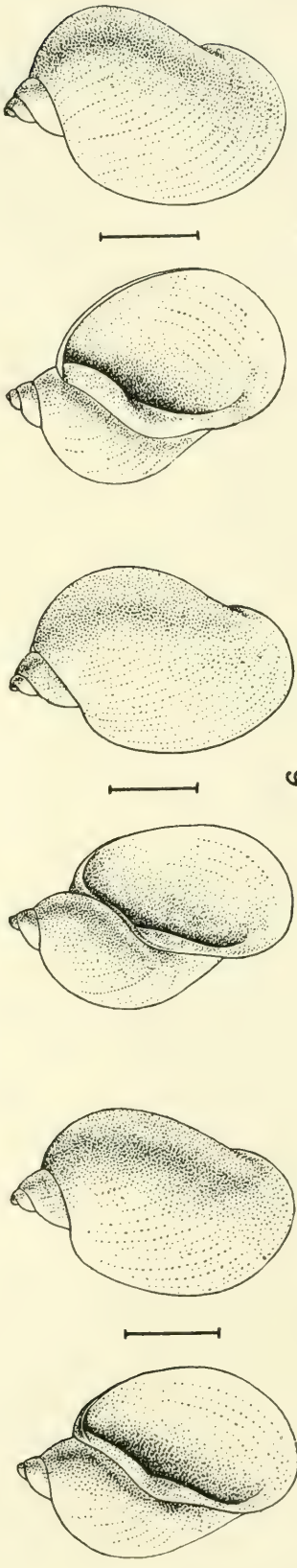
Limnaea bactriana, Hutton.

FIGS. 1, 2.—Shells from a water-channel, Nasratabad, Seistan.

Limnaea persica, Issel.

FIGS. 3, 4.—Shells from near Kerman, Eastern Persia.
,, 5, 6.—Shells from the Zanginawar Lakes in the Baluchistan desert near Nushki.





LIMNAEIDAE OF SEISTAN AND BALUCHISTAN.

A. Chowdhary del.

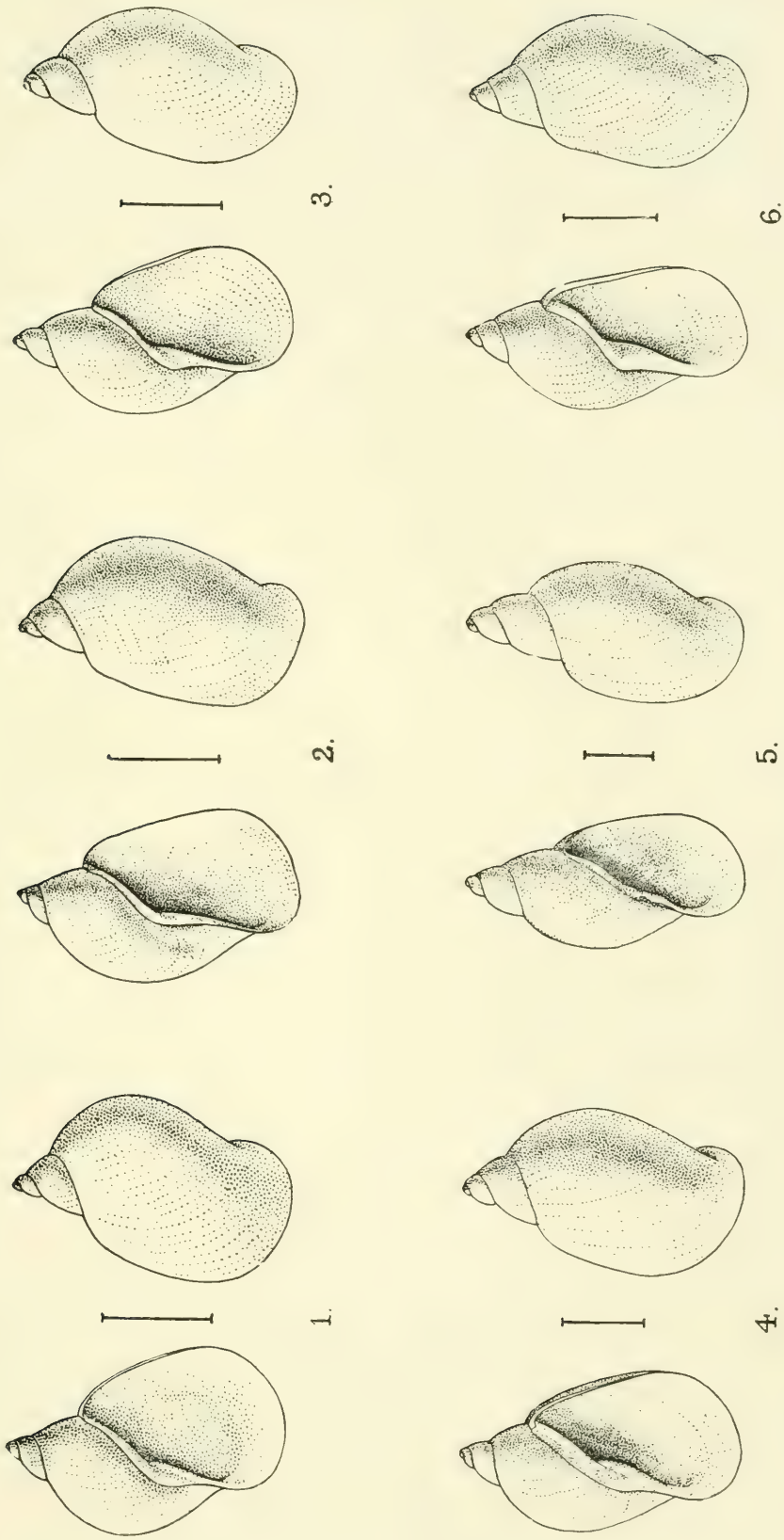
EXPLANATION OF PLATE VI.

Limnaea gedrosiana var. **rectilabrum**, var. nov.

FIGS. 1–3.—Shells from the Kushdil Khan reservoir, Pishin District, Northern Baluchistan.

,, 4, 6.—Shells from a pool in the desert near Nasratabad, Seistan.

FIG. 5.—Young shell from the edge of a backwater of a large water-channel in the same district.



LIMNAEIDAE OF SEISTAN AND BALUCHISTAN.

A. Chowdhary del.

EXPLANATION OF PLATE VII.

LIMNAEAE OF BALUCHISTAN AND SEISTAN.

Limnaea iranica, sp. nov.

FIG. 1.—Type-specimen from Persian Baluchistan.

Limnaea gedrosiana, sp. nov.

FIG. 2.—Shell (type-series) from a pond in the Residency garden, Quetta, Baluchistan.

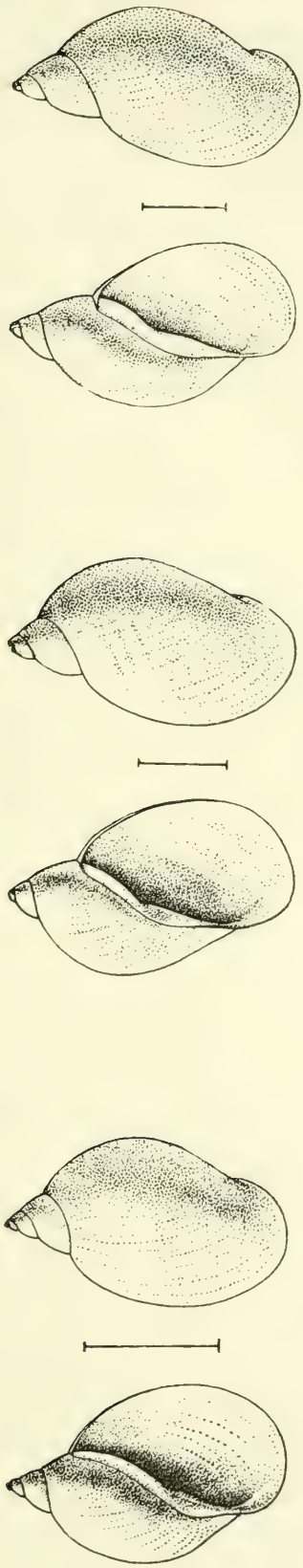
FIGS. 3, 4.—Shells from the reed-beds of the Hamun-i-Helmand near Lab-i-Baring.

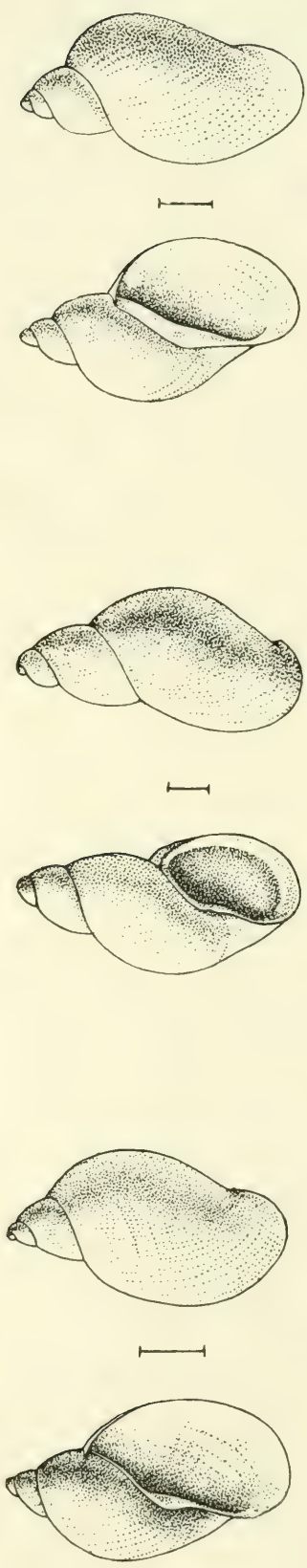
Limnaea hordeum, Mousson.

FIG. 5.—Shell (? subfossil) from the desert near Nasratabad, Seistan.

Limnaea bactriana, Hutton.

FIG. 6.—Young shell from the desert near Nasratabad.





LIMNAEIDAE OF SEISTAN AND BALUCHISTAN.

A. Chowdhary del.

EXPLANATION OF PLATE VIII.

LAMELLIBRANCH MOLLUSCS OF SEISTAN AND THE AFGHAN DESERT.

Corbicula fluminalis (Müller).

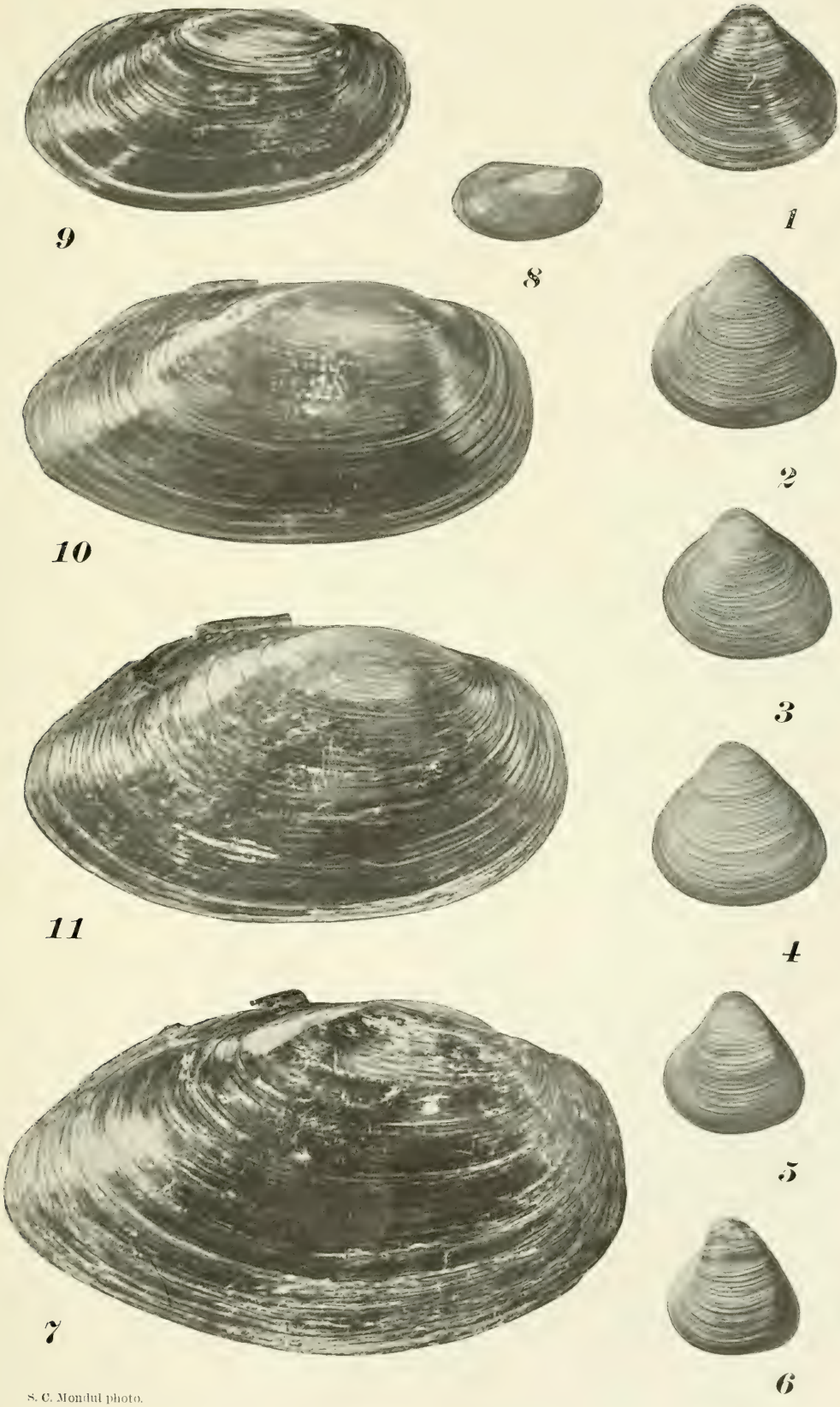
FIGS. 1–6.—A series of shells from the edge of the Helmand in the Afghan desert, illustrating variation in form and size.

Lamellidens marginalis, subsp. **rhadinaeus**, subsp. nov.

FIG. 7.—Type-specimen (phase A) from the desert near Nasratabad, Seistan.

FIGS. 8–11.—A series of shells of different ages from the Hamun-i-Helmand near Lab-i-Baring.

All the shells are shown of the natural size.



S. C. Mondul photo.

Mollusca of the Helmand.

NOTES ON FISH OF THE GENUS *DISCOGNATHUS* FROM INDIA AND PERSIA.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India.*

(With Plates IX—XI.)

Although it is only a few months since I published notes on the Indian species of this genus,[1] a large amount of additional material is already available and I have been able to examine living specimens in districts so far apart as Seistan in Eastern Persia and the Nilgiri Hills in Southern India. The latter district is particularly important as it is the type locality for several of the forms described by Jerdon and Day. It is not yet possible to clear up all the difficulties concerning the Indian species and much more material is still necessary before the Assamese and Burmese forms can be adequately discussed, but I hope that these notes may lead to further investigation of the genus, which is a particularly interesting one from a biological point of view.

In my former notes I neglected to mention the species described by Tate Regan from the North Western Frontier of India under the name *Discognathus wanae*,[2] and I gave no reference to the Persian form described by Berg as *Garra persica*.[3] The latter is probably a local race of *D. lamta*, but the former seems to be a very distinct species.

Two species from South India have been brought to my notice too late to be discussed in this paper. They will be described shortly by Mr. C. R. Narayan Rao under the names *D. platycephalus* and *D. bicornutus*. These species must be attributed to Mr. Narayan Rao, but I have noted some of their more salient characters in the key to the species printed here. These characters he has demonstrated to me.

The genus as a whole falls into two sections, distinguished by the degree of differentiation of the adhesive disk behind the mouth on the ventral surface. Both these sections are found in Africa as well as in Asia and both extend into the Palaearctic part of the latter continent, but the most highly differentiated forms occur mainly in India and Malaysia, in which countries those with the simpler type of disk are practically absent. Among those in which the disk is best developed, a secondary differentiation occurs in

[1] Annandale, *Rec. Ind. Mus.* XVI, pp. 113, 129 (1919).
[2] Tate Regan, *Ann. Mag. Nat. Hist.* (8) XIII, p. 263, fig. A (1914).
[3] Berg, *Ann. Mus. Zool. St. Petersbourg* XVIII, p. lxi (1913).

certain species in the naked chest and the specialization of the muscles of the thorax. In the following key I have made use of the first of these characters in my primary division and of the second in the first secondary division. It is possible that the two primary groups will have to be regarded ultimately as distinct genera.

Key to the Indian and Persian species of Discognathus.

I. Mental disk small, less than half as broad as head, without a specialized posterior border; margins of opercula meeting in the middle line well behind the disk.
  A. Disk very imperfectly differentiated, without free posterior border; barbels 4; chest covered with scales ... *D. adiscus.*
  B. Disk with posterior border free but lateral borders not so; barbels 4; chest covered with scales ... ... *D. wanae.*
  C. Disk with both lateral and posterior margins free; 2 barbels; the whole of the ventral surface naked ... *D. phryne.*

II. Disk large, more than half as broad as head, with a free lateral and posterior granular border, entirely or almost separating the opercular margins.
  A. Chest covered with scales, not much flattened; its muscles not highly differentiated.
    1. No barbels. *l.l.* 44 ... ... *D. imberbis.*
    2. 4 barbels. *l.l.* 36-41.
      a. Pupil of eye in middle or anterior half of head: eye usually visible from below; snout tuberculate in male but not forming a very distinct process.
        i. Opercular borders approaching one another at an obtuse angle on the ventral surface, widely separated by mental disk ... ... *D. lamta.*
        ii. Opercular borders approaching one another closely at an acute angle behind the mental disk; disk subcircular ... ... *D. gotyla.*
      b. Pupil of eye distinctly in posterior half of head; eye (except in *D. gravelyi*) invisible from below.
        i. Snout moderately rounded, more or less produced and tuberculate, at any rate in adult male, immediately in front of or outside nostrils.
          a. Snout forming a single free conical process in front of nostrils in all individuals; opercular borders approaching one another at an acute angle on the ventral surface; length of head nearly 5 times in total length ... ... *D. stenorhynchus.*
          β. Snout produced into a pair of conical processes, one outside each pair of nostrils ... ... *D. bicornutus.*
          γ. Snout produced in male only; its process single, usually shorter than in *α*; opercular margins nearly transverse and widely separated on ventral surface; length of head at least $5\frac{1}{2}$ times in total length ... *D. jerdoni.*
        ii. Snout bluntly pointed, never produced in front of or outside nostril; slightly retroverted at tip.
          α. Dorsal profile from tip of snout to behind dorsal fin forming an even rather high curve; depth of body 5 times in total length ... ... *D. gravelyi.*
          β. Dorsal profile nearly straight; that of head sinuous; depth of body (in adult) nearly 7 times in total length ... ... *D. elegans.*
          γ. Top of head obliquely flattened; profile of head and anterior part of body a slanting straight line ... *D. platycephalus.*
  B. Chest naked, flattened, with specialized muscles.

1. Pectoral fins hardly longer than head, not nearly reaching ventrals ... ... *D. nasutus.*
2. Pectorals distinctly longer than head, nearly reaching ventrals ... ... *D. macrochir.*

SECTION I.—*Group of* Discognathus variabilis.

1863. *Discognathus* (*s.s.*), Bleeker, *Atl. Ichth.* III, p. 24.

In this group the adhesive apparatus on the ventral surface of the head is comparatively little differentiated, the snout projects little beyond it, and the general facies of the fish is less peculiar, the ventral surface being less flattened and the caudal peduncle more distinct. As Boulenger has pointed out in discussing an African species (*D. quadrimaculatus* [1]) belonging to the group, it has a close resemblance to the eastern Asiatic genus *Crossochilus*, a genus which, according to most recent authors, is not found west or north of the Malay Peninsula; but there is a distinct difference in the structure of the mouth and in particular of the lower lip.[2] In this section of *Discognathus*, as also in the other species, the jaws are much less sharp than in *Crossochilus* and are never horny or bony, but always cartilaginous and covered with a thin epithelium. The upper lip is joined to the lower lip directly by a frenulum, but the lower lip itself is vestigial, disappearing entirely in most species in the middle of the jaw, though in some, as in *D. phryne*, it is represented by a delicate fold of integument that may be extended over the whole jaw. The transverse band of tissue which stretches in many species across the anterior margin of the mental disk just behind the lower jaw appears to be quite distinct, as is shown by the condition in *D. phryne*, from the lower lip. It is this band of tissue, however, which is labelled *l.l.* in my figure on p. 114, *Rec. Ind. Mus.*, Vol. XVI. The snout does not appear to be produced or tuberculate in any of these species.

It is possible that *Discognathus* is derived from *Crossochilus* and that the species of the first section are closely related genetically to that genus. The geographical difficulty is not so great as might appear at first sight, for the species *Cirrhina latia* is closely related to *Crossochilus*, in which indeed it is placed by Günther [3] and Vinciguerra,[4] and the range of *Cirrhina latia* extends from Upper Burma to Baluchistan.

The eponymous species of this group is found in Palestine and Mesopotamia. The three discussed here occur in the extreme east of Persia or on the North West Frontier of India, while *D. quadrimaculatus* is recorded from various lakes and rivers in the upper watershed of the Nile and *D. vinciguerrae* (which, so far as I can judge from Boulenger's figure,[5] also belongs to the group) from the White Nile and the Upper Nile.

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[1] Boulenger, *The Fishes of the Nile*, p. 180 (1907).

[2] For an excellent figure of the mouth of *Crossochilus*, see Weber and Beaufort, *Fishes of the Indo-Australian Archipelago* III, p. 232, fig. 96 (1916).

[3] Günther, *Cat. Fish. Brit. Mus.* VII, p. 71 (1868).

[4] Vinciguerra, *Ann. Mus. Stor. Nat. Genova.* (2) IX (XXIX), p. 280 (1889–90).

[5] Boulenger, *Fish. Nile*, p. 185, pl. xxxi, fig. 4 (1907), and *Cat. Fresh-w. Fish. Africa* I, p. 347, fig. 261 (1909).

Discognathus adiscus, sp. nov.

(Pl. x, fig. 2; pl. xi, fig. 1.)

L. l. 36—38. D. 3/8. V. 2/5.

This is a small species of slender habit. The dorsal profile from the tip of the snout to behind the dorsal fin is strongly and evenly arched; that of the caudal peduncle slightly concave. The ventral profile as far as the base of the caudal peduncle is convex. The head is of moderate size, its length contained about 5 to 5½ times in the actual total length. It is somewhat flattened above. The snout is rounded and smooth. It is shorter than the part of the head behind the eye. The nostril is situated nearer the tip of the snout than the eye. The eye is large and rather prominent; its length contained about 3½ times in the length of the head, and a little less than twice in the interorbital breadth; it is not visible from below. The pupil is situated near the middle of the head, and the upper margin of the eye near the dorsal profile. The mouth is large and almost straight. It is situated only a short distance behind the tip of the snout. The upper lip is well developed, covering the upper jaw, fringed at the margin and minutely granular. There are 4 short barbels. The lower lip properly so called is only developed at the sides and there is no transverse band of specialized structure behind the lower jaw, which is fully exposed. The mental disk is very imperfectly developed. It consists of a granular pad truncate or subtruncate in front, free at the sides, and more or less emarginate, but not free, posteriorly. The margins of the opercula meet at an acute angle on the mid-ventral line some distance behind it and the branchial openings extend well on to the ventral surface. The dorsal fin is nearly as high as the body. Its last undivided ray is cartilaginous and articulated. The pectorals, which do not nearly reach the ventrals, are rather narrow, pointed and distinctly shorter than the head. The caudal is long, distinctly lobed and with the lobes pointed. The scales are well developed but somewhat deciduous. They cover the whole of the body. There are 5½ scales between the lateral line and the dorsal, and 4 between the former and the ventral.

The pharyngeal bones and their teeth closely resemble those of *D. phryne* (*v. postea*), but the teeth are more slender.

The dorsal margin is pale bluish grey; there is a more or less distinct bluish mid-lateral streak, running from behind the head to the base of the caudal fin. The lower part of the head and sides and the ventral surface are yellowish-white.

Type-specimen, No. $\frac{9763}{1}$ F, *Z.S.I.* (*Ind. Mus.*).

Distribution.—This fish is extremely abundant in small water-courses and pools in the plains of Seistan. We obtained specimens from the following localities:—Nasratabad, irrigation channel in Consulate garden; pool in the desert 5 miles south of Nasratabad; pools in stream-bed 12 miles north of Nasratabad; channels in the reed-beds of the Hamun-i-Helmand near Lab-i-

Baring, and channel leading out of the Hamun 12 miles east of Lab-i-Baring ; small watercourse, Lutak, southern Seistan.

Habits.—D. adiscus is gregarious and always lives in large shoals. In the day-time it stays at the bottom, feeding apparently on algae, but in the evening I have seen shoals swimming on the surface. All the individuals we found in the Hamun, which were not numerous, were dead or dying, and we found enormous numbers in a moribund condition, in which they floated on the surface, in pools of very foul water in a stream-bed north of Nasratabad. We did not find the fish in any but still or slow-running water.

I have placed this species in the genus *Discognathus* with some doubt, but I do not know where else to place it. The mouth differs distinctly from that of both *Cirrhina* and *Crossochilus*, though the structure of the gill-openings resembles that found in these genera. Moreover, the mental disk, though poorly developed and differing in shape from that of other species, is present, and the general facies is not unlike that of *D. quadrimaculatus*. On the whole I think that the species must be accepted as an extremely primitive representative of *Discognathus*. If this be so, its *provenance*, together with that of the other primitive species *D. variabilis*, *D. phryne* and D. *wanae*, would suggest that the genus perhaps originated in South Western Asia. It is noteworthy that it does not occur in Central Asia, and possibly the African species that are apparently allied, may be degenerate rather than primitive. Without examininig specimens I cannot express an opinion on this point.

Discognathus wanae, Regan.[1]

" Depth of body 4 in the length, length of head $4\frac{1}{2}$ to $4\frac{2}{3}$. Snout rounded, nearly as long as postorbital part of head; diameter of eye 5 in length of head; interorbital region flat, its width nearly $\frac{1}{2}$ length of head. Width of mouth $\frac{1}{3}$ length of head; two barbels on each side, shorter than diameter of eye. Upper lip with minute papillae near the margin; lower very narrow; behind it a circular disc divided into a papillose anterior and a smooth posterior portion, and with only the posterior edge free. Dorsal III 7; origin equidistant from tip of snout and base of caudal; first or second branched ray longest, nearly as long as head. Anal II 5. Pectoral extending $\frac{3}{5}$ of distance from its base to pelvics, which nearly or quite reach vent. Caudal deeply emarginate. Greyish, mottled with darker.

" Five specimens, the largest 80 mm. in total length." (Tate Regan). Mr. Regan has kindly informed me that there are about 36 scales in the lateral line and that both back and belly are covered with scales smaller than those on the sides.

I have not seen this species, the description of which I quote in full. It was described from Waziristan in the hills of the

[1] Tate Regan, *Ann. Mag. Nat. Hist.* (8) XIII, p. 263, fig. A (1914).

North West Frontier of India and comes from the same geographical district as the species (*D. phryne*) next to be described.

Discognathus phryne, sp. nov.

(Pl. x, fig. 3; pl. xi, fig. 2.)

D. 3/7. A. 2/5. L. l.36-39. L. t.5/5-6.

This species is apparently allied to *D. variablis*, Heckel, from which it differs in proportions and in its naked chest and back. Like *D. variabilis* it has only two barbels.

The size is small and the habit rather stout. The length of the head, the greatest depth of the body and the length of the caudal fin are approximately equal and are contained from $4\frac{3}{4}$ to $5\frac{1}{4}$ times in the complete total length. The dorsal profile is sinuous but nowhere strongly arched, rising in an almost even low curve from the tip of the snout to the anterior margin of the dorsal fin. The abdomen is convex. The snout is blunt and rounded and projects slightly beyond the mouth. Secondary sexual characters were not observed on the heads of specimens captured in winter. The nostrils are large and situated nearer the eye than the tip of the snout. The eye is small, its length being contained 3 to 5 times in the length of the head; it is lateral in position, its upper margin approaching the upper profile, and is situated near the middle of the length of the head. The upper lip is comparatively narrow and indistinctly fringed. The mouth is large and broadly arched. The lower lip is represented by a narrow, linear flap of tissue; posterior to this there is a transverse, minutely tuberculate band, obliquely truncate at either end and much narrower than the anterior flap; it is about as long as the upper lip. Posterior to this again lies the true mental disk, which is smooth and by no means highly developed. It is somewhat lozenge-shaped in the adult fish and considerably broader than long; its posterior and lateral margins are free. In shape and proportions it is somewhat variable. There is a small, blunt barbel at each angle of the mouth; its size is variable and it is sometimes reduced to a mere tubercle. There is no trace of anterior barbels. The dorsal fin starts considerably nearer the base of the caudal than the tip of the snout and slightly in front of the ventrals. Its undivided rays are soft and slender and the last, which is almost as long as the head, is articulated in its distal third. The pectorals are a little shorter than the head and do not nearly reach the ventrals when adpressed; they are set obliquely on the side of the body. The caudal peduncle is not clearly marked off. The caudal fin is large, distinctly cleft and with the two halves subequal or equal and bluntly pointed.

The scales are rather small. There is a relatively broad middorsal streak which is entirely bare and so also are the chest and abdomen. The muscles of the chest, however, are not highly specialized. The lateral scales are deciduous. In the young those

beneath the lateral line are poorly developed. The lateral line is conspicuous.

The pharyngeal bones are broad and very convex. They each bear twelve teeth, but the second tooth of the outer row is very short, though broad, and almost hidden by the others. The formula appears to be 6.3.3/3.3.6, but the teeth are very closely congregated and the rows difficult to distinguish. The teeth are fairly long and slender but shorter than those of *D. adiscus*, sharply pointed (except the second of the outer row) and slightly retroverted at the tip, which is obliquely truncate.

The colouration varies with the environment, but the scales, the upper part of the cheeks, the operculum and the dorsal surface of the head and body are always minutely speckled with black, and the specks are always more numerous on the back and on the top of the head than elsewhere. In individuals from very clear water they are so numerous as to give these regions a blackish colour. Larger black spots are sometimes present on the upper part of the sides, and a narrow blackish vertical bar can usually be distinguished on the distal end of the caudal peduncle. The ventral surface and the lower part of the head are white. The iris is speckled like the scales. The fins are colourless. In the young there is a bluish mid-lateral streak running along the body.

Type-specimen, No $\frac{9787}{1}$ F., *Z.S.I.* (*Ind. Mus*) (from Seistan).

Distribution.—This species is very abundant in the hill country of Baluchistan at altitudes between 5,000 and 6,000 feet. A single specimen was taken by Mr. S. W. Kemp and myself, with many of *D. adiscus*, in an irrigation channel at Nasratabad, Seistan.

Habits.—*D. adiscus* is gregarious and lives as a rule among algae on the bottom of slow-running water-channels and pools. In the outflow of the Kushdil Khan reservoir in the Pishin district north of Quetta large numbers were observed opposite the places where water flowed in from underground sources. The weather was very cold at the time and this water was warmer than that which came from the reservoir. The fish were feeding on a green filamentous alga.

The species seems, as already stated, to be closely related to *D. variabilis*, Heckel, and is doubtless the one referred to by Zugmayer[1] as intermediate between that form and *D. lamta*. It is almost certainly identical with the *D. variabilis* mentioned in the editorial note prefixed to Tate Regan's account of fish from Seistan in *Journ. As. Soc. Bengal*, (n.s.) II, p. 8 (1906).

SECTION II.—*Group of* Discognathus lamta.

1838. *Platycara*, McClelland, *Journ. As. Soc. Bengal*, VII, (2), p. 944.

This group is certainly more highly developed than that of *D. variabilis*. The mental disk is always relatively large and is a

[1] Zugmayer, *Abh. Bayerisch. Ak. Wiss. Math.-phys. Klasse* XXVI (6), p. 24 (1913). These specimens were from the Pishin River in northern Baluchistan. There are two Pishins in Baluchistan, the one north of Quetta and one, referred

highly specialized structure consisting essentially of three parts—an anterior transverse band of soft tissue covered with minute tubercles, a central almost cartilaginous disk with a smooth surface, and a posterior and lateral free border of soft tuberculated integument. It is therefore a much more efficient organ of adhesion. In all the Indian forms with which I am acquainted the disk completely separates the antero-ventral margins of the opercula, but Gray and Hardwicke in their "*Illustrations of Indian Zoology*" figure these borders in *D. gotyla* as meeting behind the disk (Vol. I, pl. lxxxviii, fig. 3) and this also appears to be the case in certain African forms. In specimens I assign to *D. gotyla* the borders nearly meet. In the Indian forms the snout, either in the adult male or in both sexes, is tuberculate and often produced between or outside the nostrils.

In the Indian species the number of rays in the dorsal fin and of scales in the lateral line as a rule affords little or no assistance in specific diagnosis.

The fish of this group are mostly tropical, but a local race of *D. lamta* is found as far north as Palestine, while either *D. jerdoni kangrae* or a closely allied form inhabits mountain streams in the Aden hinterland. In Africa species are found in the Nile valley, in the great African lakes and in the eastern waters of Abyssinia. In Asia the range of the group extends from Palestine to Yunnan, Southern India and Borneo. It seems to have its headquarters in the hill country of Southern India and Assam, but the Assamese species or races have not been investigated since the time of McClelland. In streams at the base of the Nilgiris I found four distinct species.

Discognathus lamta, Day [1].

1919. *Discognathus lamta,* Annandale, *Rec. Ind. Mus.* XVI p. 114, text-fig. 1 and p. 131, pl. ii, figs. 1, 1*a*.

Dr. Chaudhuri has recently taken specimens of this species near Seringapatam in Mysore. They differ slightly from North Indian specimens, but I have not sufficient material to establish their racial identity.

Discognathus persicus (Berg.).

"*Garra persica*, Berg, sp. n.[2]

"*Discognathus lamta* (*non* Ham. Buch.) Nikolsky, *Ann. Mus. Zool. St. Petersbourg*, IV, 1899, p. 411 (No. 11706,11707).

D II 7, A II 5, 11.35 $\frac{+}{3\frac{1}{2}+4}$37.

11707. River Bampur in Eastern Persia. N. Zarundy 1898, 15–27. VII (6).

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to by W. T. Blanford in his "*Zoology and Geology of Eastern Persia*," in Persian Baluchistan some little distance inland from the Arabian Sea.

[1] Buchanan's *Cyprinus* (*Garra*) *lamta* was probably, from its habitat, identical with McClelland's *Platycara nasuta* (1838) rather than with the *D. lamta* of authors. It is, however, impossible to establish this with absolute certainty.

[2] Berg, *Ann. Mus. Zool. St. Pétersbourg* XVIII, p. lxi (1913).

11706. Kiabad in Zirkuh (Eastern Khorassan). N. Zarundy 1898, 3.V (1).

" Near *Garra lamta* (Ham. Buch.), from which differs in having 7 branched rays in dorsal (in *lamta* Ham. Buch. 8, as much in *crenulata* Heck., *rufa* Heck., *obtusa* Heck.). Lower lobe of caudal shorter than head. Total length 75 mm.

" Barbels 4, very short, uppers $\frac{1}{2}$ diameter of eye, lowers $\frac{2}{5}$. Pupil in the second half of the head. Ventrals below anterior $\frac{1}{3}$ of dorsal. Snout projecting strongly beyond mouth. Upper lip well developed, not fringed. Width of the mouth less than $\frac{1}{2}$ length of head, rather equals the interorbital width. Caudal peduncle $1\frac{1}{2}-1\frac{2}{3}$ times as long as deep. Eye supero-lateral, not visible from below. Depth of body 5·0–4·6 in its length (without caudal), head 4·5–4·3. Diameter of eye 4·1–4·0 in the length of head, 1·8 in the interorbital width. Pectorals 5·0–4·8 in the length of body (without caudal). Belly covered with scales. 4–5 round black spots on the dorsal near its base. A dark vertical bar on the caudal peduncle near the base of the caudal. Snout of breeding males with numerous conical horny tubercles.

" Eastern Persia." (Berg).

Discognathus jerdoni (Day).

(Pl. ix, figs. 1, 2; pl. xi, fig. 3).

1849. *Gonorhynchus Gotyla*, Jerdon (*nec* Gray), *Madras Journ. Lit. Sci.* XV, p. 309.
1867. *Garra Jerdoni*, Day, *Proc. Zool. Soc. London*, p. 288.
1878. *Discognathus Jerdoni*, Day, *Fish. Ind.* II, p. 528, pl. cxxii, fig. 6.
1889. *Discognathus jerdoni*, Day, *Faun. Brit. Ind. Fish.* I, p. 247.

This species is remarkable for its stout facies and very short, broad head, which differs considerably so far as the shape of the snout is concerned in the two sexes. The dorsal profile behind the snout is very nearly straight in the male and only slightly arched in the region of the dorsal fin in the female.[1] The snout is rounded and much longer, especially in the male, than the part of the head behind the eye. The nostril is very much nearer the eye than the tip of the snout. The eye is relatively large, especially in the male, in which its length is contained in the length of the head about 5 times and in the interorbital breadth twice. In the female the length of the eye is contained at least $5\frac{1}{2}$ times in the length of the head and from $2\frac{1}{4}$–3 times in the interorbital breadth. The branchial openings extend on to the ventral surface, but on the sides do not reach much more than half way up the head In the female the snout is smooth and very slightly concave in lateral profile. In the male it is traversed by two semicircular grooves The first of these, which is deep and undercut though narrow, lies a short distance in front of the nostril, while the second is about equidistant from the first and from the tip of the snout. The short projection

[1] Day's figure (*Fish. Ind.*, pl. cxxii, fig. 6) is taken from a badly preserved specimen.

caused by the first groove bears several spiny tubercles and there is a short row of smaller horny tubercles on each margin of the second groove. The upper lip is broad, concealing the upper jaw, granular and minutely fringed. There is a narrow semicircular transverse granular band in front of the disk, which is transverse and more strongly arched anteriorly than posteriorly. Behind the disk there is a broader semicircular free border. There are four short tentacles. The opercular margins are almost transverse on the ventral surface. The chest is flattened but scaly and without specialized muscles. The dorsal fin is not so high as the body. Its last undivided ray is moderately stout and it has nine or ten rays in all. The pectorals are broad and expanded and have the outer ray flattened. They are shorter than the head and their base is oblique. The scales are large. There are 3 or 3½ above the lateral line and the same number between it and the ventral. The colour varies with the environment. Specimens from the Bhavani River at the base of the Nilgiris are very dark olivaceous on the sides and back and white on the ventral surface. All the fins are greyish but the pectoral fins have white borders. The rays of the caudal are white but the middle third of the membrane is blackish. In a specimen from a small muddy stream running into the Bhavani the colours are much paler, but there is no dark mid-lateral streak and no spot behind the operculum.

The largest specimen I have seen, an adult male from near Mettapolaiyam, is 184 mm. long.

The species is common in the Bhavani River near the base of the Nilgiris both before and after the stream leaves its gorge. It lives in places where the stream-bed is rocky and the current strong. Jerdon found it in the Manantoddi as well as the Bhavani and Day records it also from the Wynaad. I have seen a small and probably immature specimen which seems to belong to the species from the Nasik district of the Bombay Presidency.

Subsp. **kangrae**, Prashad.

1878. *Discognathus lamta*, Day, *Fish India* II, p. 528 (in part), pl. cxxiii, figs. 1, 1*a*.

1919. *Discognathus kangrae*, Prashad, *Rec. Ind. Mus.* XVI, p. 163, figs. 1, 1*a*.

This form seems to be no more than a local race of *D. jerdoni*, distinguished by its longer head and smaller eye.

Capt. Donald, Warden of Fisheries in the Punjab, has recently presented to the Indian Museum through Dr. Baini Prashad a series of specimens from hill-streams in the Kangra valley. They establish the fact that the fully developed adult male is identical with the form figured by Day in the plate cited.

Discognathus stenorhynchus (Jerdon).

(Pl. ix, fig. 3; pl. xi. fig. 4).

1848. *Gonorhynchus stenorhynchus*, Jerdon, *Madras Journ. Lit. Sci.* XVI, p. 310.

This species is closely related to *D. jerdoni*, but can be distinguished at once by the structure of the snout and by its relatively longer head. The snout, *in both sexes and at all ages*, is greatly produced in front of the nostrils, forming a regular conical forwardly-directed process, which however does not extend as far forward as the actual tip. As in *D. jerdoni*, this process is formed by a semicircular groove which passes below it. It bears at its free extremity two rows of spiny tubercles. There is a second groove some distance in front of the first which transforms the actual tip of the snout into a second process, which is directed forwards and slightly upwards and bears a number of small spiny tubercles on its posterior surface. The dorsal fin is rather less high than in *D. jerdoni* and the two larger unbranched rays are thicker and stouter. A third (anterior) unbranched ray may be present or absent. The pectoral fins are relatively short and narrow, rounded at the tip and oblique. The chest is not so flat as in *D. jerdoni*. The scales are rather smaller, though of the same number in the lateral line. There are $3\frac{1}{2}$ between the lateral line and the dorsal fin and $2\frac{1}{2}$ or 3 between the former and the ventral.

The colour of fresh specimens is as follows:—the sides and back pale yellowish above changing to pink below. All the fin-rays are somewhat infuscated and there is a row of dark spots along the base of the dorsal fin. An obscure dark mid-lateral line extends from behind the head on to the caudal fin. The iris is golden yellow. The colours have faded considerably in specimens in spirit.

I have examined thirteen specimens, the largest of which is 90 mm. long. The snout is produced in individuals less than two inches long.

Distribution.—This fish is only known from the base of the Nilgiri Hills. My specimens were taken in a small muddy stream (the Nierolay) which runs into the gorge of the Bhavani River some 12 miles above Mattapolaiyam in August.

Discognathus gotyla (Gray and Hardwicke).

(Pl. x, fig. 1; pl. xi, fig. 6).

1832. *Cyprinus gotyla*, Gray & Hardwicke, *Ill. Ind. Zool.* I, pl. lxxxviii, figs. 3, 3*a*.
1867. *Garra gotyla*, Day, *Proc. Zool. Soc. London*, p. 288.

This little species is also closely related to *D. jerdoni*, but the eyes are in the middle of the head, the head is large and the structure of the snout is different. The three specimens I have examined are perhaps not fully adult, but the secondary sexual characters are fairly well developed. The length of the head is contained in the total length a little more than five times. The eye is very large, its length being contained a little more than four times in the length of the head. The dorsal profile of the head is convex in the female. In the male there is a short process between the nostrils, bearing several relatively large spiny tubercles. The

anterior semicircular groove on the snout is not strongly developed. The mental disk is subcircular and of very large size. It is completely surrounded by a granular border. The opercular and preopercular margins are adherent on the ventral surface. The former approach one another at an acute angle and almost meet behind the disk. The dorsal fin is higher than the depth of the body. The pectorals are large and pointed and have the outer ray somewhat expanded. They are nearly as long as the head.

The colour is dark olivaceous with traces of several paler longitudinal streaks on the caudal peduncle. There is a dark spot behind the operculum and a dark median streak on the caudal fin. The ventral surface is pale.

Day states that the species grows as long as $5\frac{2}{5}$ inches. My specimens are about 50 mm. long.

Distribution.—Day states that the species is abundant at the base of the hills in the Bhavani River but rarer in the Sigur. I took two males and a female in the Nierolay stream at the base of the Nilgiris in August, with a number of specimens of *D. stenorhynchus* and one of *D. jerdoni*.

Discognathus elegans, sp. nov.

(Pl. ix, fig. 4; pl. xi, fig. 5).

This species is distinguished by its elongate form and by the structure of the snout, which bears numerous patches of horny tubercles but is not produced between or outside the nostrils.

The dorsal and ventral profiles of the body and the tail are nearly parallel and the depth of the body is contained more than six times in the total length. The head is short and rather narrrow, its length being contained nearly six times in the total length. The snout is more than twice as long as the part of the head behind the eye. Its dorsal profile is concave, the posterior transverse groove found in certain other species between the nostrils being represented by a broad depression. There is a narrow anterior transverse groove, which extends backwards on the sides of the head nearly as far as the anterior margin of the eye. There are about seven groups of horny tubercles on the snout, but some of them may coalesce or be subdivided. The nostril is very much nearer the eye than the tip of the snout. The eye is of moderate size, invisible from below. The snout is rounded in ventral view. The upper lip, which is fringed and granular, is relatively small, exposing both jaws. There are four very small barbels, those at the angle of the mouth being almost vestigial. The mental disk is transverse and lens-shaped. There is a narrow band of granular tissue in front of it and it is surrounded on three sides by a broad granular free border, which is slightly emarginate near the angle of the jaw on each side. The opercular borders are practically transverse on the ventral surface and are widely separated. The chest, and indeed the whole ventral surface, is flat but scaly and without specialized muscles. The dorsal fin is higher than the depth of the body; its

undivided rays are weak. The pectorals are as long or very nearly as long as the head, pointed and not much expanded. The ventrals, the anal and the two lobes of the caudal are also elongate and pointed. The scales are rather small. There are $4\frac{1}{2}$ between the lateral line and the dorsal and $3\frac{1}{2}$ between the former and the ventral. The number in the lateral line is the same as in other Indian species of the group.

The colour is dark olivaceous without definite markings. The ventral surface is yellowish-white The fins are infuscated, but the paired ones have a pale border.

This is the largest species of the genus with which I am acquainted. The type-specimen is 216 mm. long and the local fishermen state that individuals one cubit long are sometimes captured.

Type-specimen, No. $\frac{9798}{1}$ F, *Z.S.I.* (*Ind. Mus.*).

Distribution.—I have seen this species only from the gorge of the Bhavani River at the base of the Nilgiris, where it was taken with *D. jerdoni* in August. I have examined six specimens.

D. elegans is related to *D. gravelyi* from Burma, but the form is more elongate, the snout is tuberculate and there are considerable differences in the structure of the mental disk. From *D. platycephalus*, Rao it is distinguished by its more elongate form and more convex head. *D. ceylonensis* (Bleeker)[1] seems to be an allied species.

ADDENDUM.

The True Cyprinus lamta *of Buchanan.*

Dr. B. L. Chaudhuri has kindly drawn my attention to a quotation from Buchanan's manuscript notes which casts some light, in conjunction with the same author's original figure of "Cyprinus godiyari," on the identity of his *Cyprinus lamta.*

This quotation will be found on page 81 of Day's volume on the fisheries and botany of Bengal in Hunter's *Statistical Account of Bengal* (1876). He says, quoting Buchanan, "the *Godiyári* is another small Cyprinus found in the same places," *i.e.* in small streams among rocks in the Bhagalpur district; while in a footnote to the name *Godiyári* he adds, apparently on his own authority, "*Cyprinus lamta*, Ham. Buch. Fish. Ganges, p. 343, and MS. drawings No. 105, as *Cyprinus godiyari.*"

Buchanan's MS. drawing No. 105 is still in the possession of the Asiatic Society of Bengal. It comprises three figures, one a finished coloured drawing[2] of the whole fish, the others outlines of the dorsal view and of the ventral surface of the head. These figures represent a species unknown to me but apparently allied to

[1] *Garra* (*Garra*) *ceylonensis*, Bleeker, *Versl. en Meded. Afd. Natuurk.* XV, p. 239 (1863).

[2] McClelland gives a rather poor reproduction (sufficiently accurate in essentials) of this drawing in *Asiatic Researches* XIX, pl. xliii, fig. 2 (1839).

D. nasutus. Possibly it is *D. macrochir* (McClelland), but the figure of the head is unfinished and shows very little detail. The figure is labelled "Cyprinus godyari" in Buchanan's handwriting. The species figured is *not* the *D. lamta* of Day's *Fishes of India* and of subsequent authors. If we are to accept Day's identification on this occasion, the *D. lamta* of his later works will have to receive some other name; but the only point in favour of this is the fact that Buchanan himself was of the opinion that the Lamtá of the Gorakhpur district was identical with the Godiyári of the Bhagalpur district (*op. cit.*, p. 103). Considering the universal confusion of species that has followed, it is by no means improbable that Buchanan himself did not distinguish them clearly and that his *Cyprinus lamta* was, as I have suggested elsewhere, a composite group rather than a single species. It must be remembered that Day, who had himself collected different forms of *Discognathus* in the Bhavani River (where at least four quite distinct species occur), failed in the end to recognize their diversity. The only way in which the point can be settled is by a thorough ichthyological survey of the small streams of the Bhagalpur and Gorakhpur districts.

July 21st, 1919.

EXPLANATION OF PLATE IX.

Species of *Discognathus* from South India.

Discognathus jerdoni (Day).

FIG. 1.—Adult male from the Bhavani River near Mattapolaiyam, Coimbatore District. Actual length 184 mm.

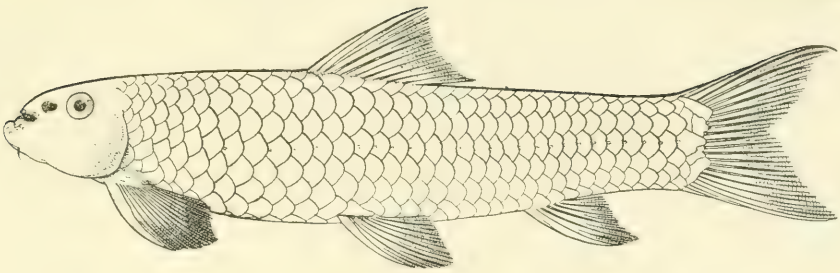
,, 2.—Adult female from the same locality. Slightly smaller than male.

Discognathus stenorhynchus (Jerdon).

FIG. 3.—Adult male from small stream running into the Bhavani gorge at the base of the Nilgiris. Actual length 90 mm.

Discognathus elegans, sp. nov.

FIG. 4.—Type-specimen (adult male) from the Bhavani gorge Actual length 216 mm.



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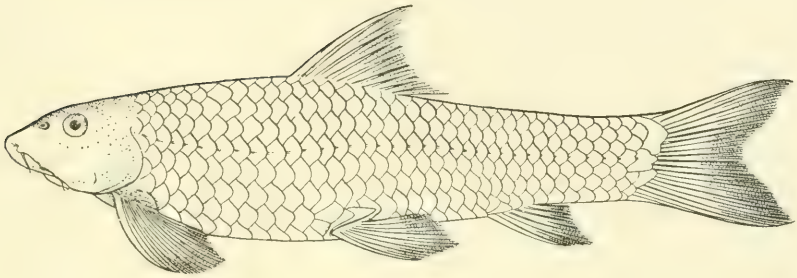

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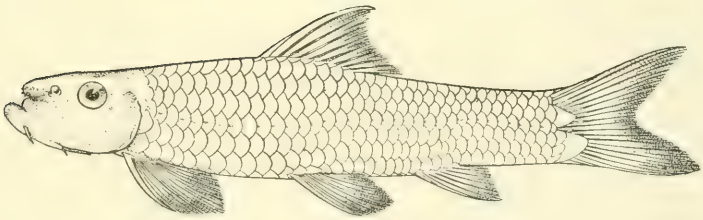

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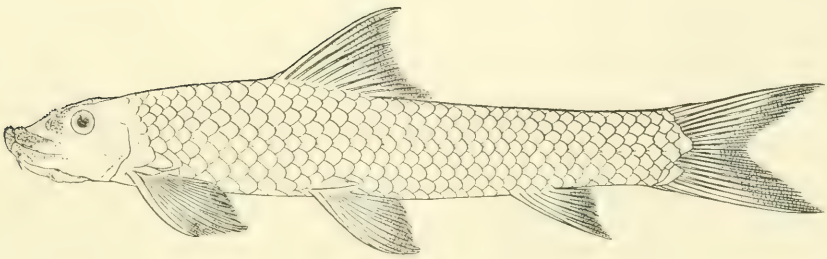

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A. Chowdhary del.

DISCOGNATHUS FROM SOUTH INDIA.

EXPLANATION OF PLATE X.

Species of *Discognathus* from South India and Eastern Persia.

Discognathus gotyla (Gray and Hardwicke).

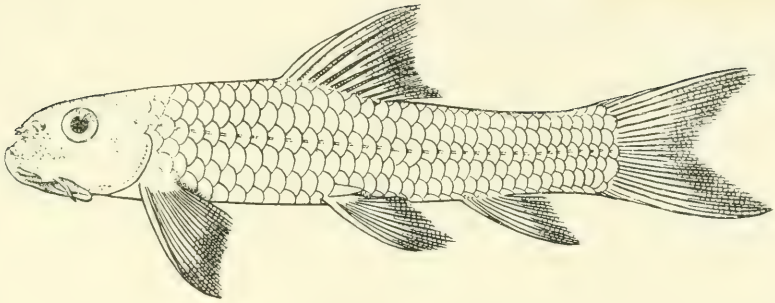
FIG. 1.—Young male from small stream running into the Bhavani gorge at the base of the Nilgiris. Actual length 50 mm.

Discognathus adiscus, sp. nov.

FIG. 2.—One of the type-specimens from Seistan (× 1½).

Discognathus phryne, sp. nov.

FIG. 3.—Type-specimen from Seistan (× 1½).



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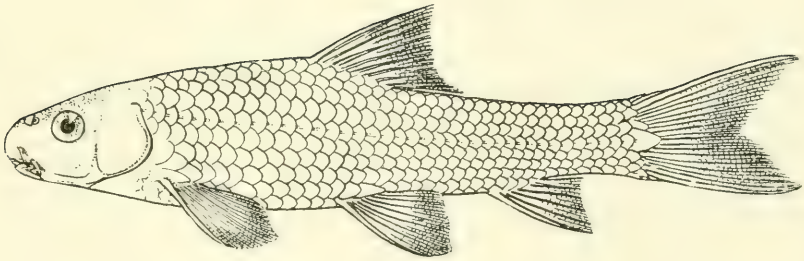

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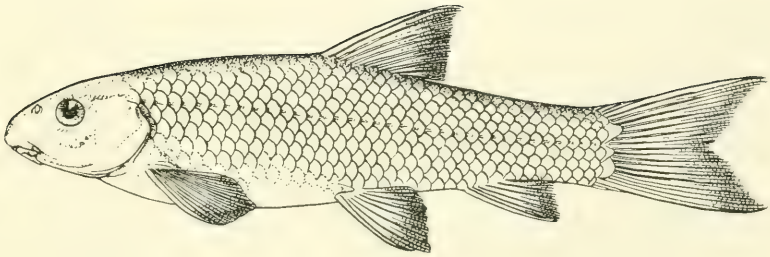


3.

A. Chowdhary del.

DISCOGNATHUS FROM INDIA & PERSIA.

EXPLANATION OF PLATE XI.

Mental disk and pectoral fins of Indian and Persian species of *Discognathus*.

FIG. 1.—*D. adiscus*, sp. nov.

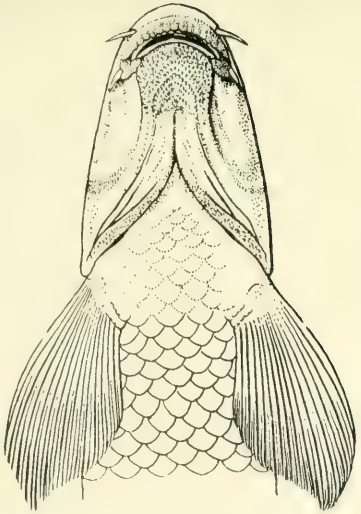
,, 2.—*D. phryne*, sp. nov.

,, 3.—*D. jerdoni* (Day). Adult male.

,, 4.—*D. stenorhynchus* (Jerdon). Adult male.

,, 5.—*D. elegans*, sp. nov. Adult male.

,, 6.—*D. gotyla* (Gray & Hardwicke). Young male.



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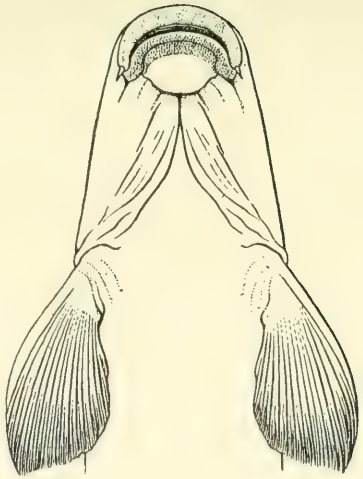

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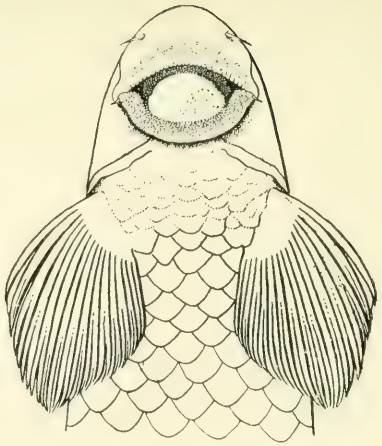

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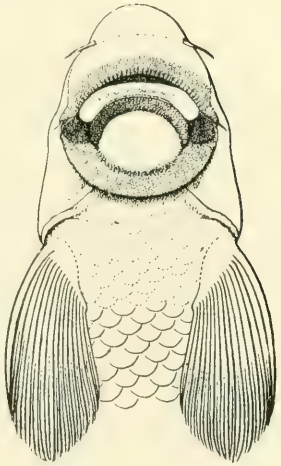

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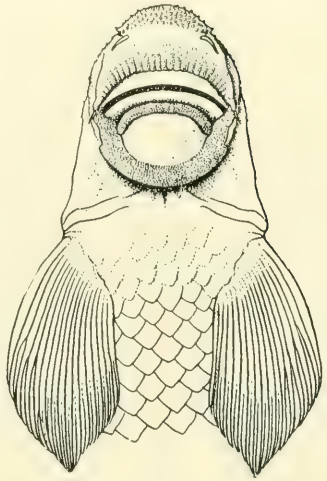

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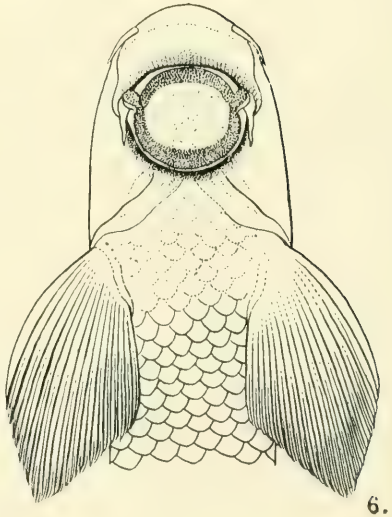


6.

A. Chowdhary del.

DISCOGNATHUS FROM SOUTH INDIA & PERSIA.

NOTES ON ODONATA COLLECTED IN SEISTAN AND BALUCHISTAN IN WINTER.

By MAJOR F. C. FRASER, *I.M.S.*

LIBELLULINAE.

Genus **Orthetrum.**

O. taeniolatum, Kirby.

Two males taken at Saindak near the Persian frontier, W. Baluchistan, 17-11-18. $\frac{8749}{HI}$. [Dragon-flies I believe to have belonged to this species were also seen near the Hamun-i-Helmand in December. *N. A.*].

One specimen is normal, the other departs from the type by having only one row of cells between *Rs* and *Rspl* in all wings. Both specimens are fully adult and pruinosed.

In the collection are two specimens of Libelluline larvae, taken in the Residency garden, Quetta, 10-11-18. These belong to the genus *Orthetrum* and are probably *taeniolatum*. They closely resemble larvae of the latter taken in the Deccan, where they are common in shallow streams, concealed beneath curtains of *Spirogyra* and other water-weeds. The eyes are prominent and strongly angulated outwards; the body is depressed and squat and the dorsal carina of each segment, except the 10th, ends with a sharp, robust spine. The whole body is hairy, this coat serving to pick up debris and flocculent detritus during life, which serves both for concealment from its foes and as an ambush for its prey.

[The larvae were taken among dense weeds in a pond fed by an underground source of water distinctly warmer than the air at the time. *N. A.*].

AESCHNINAE.

Genus **Hemianax.**

Three *Aeschnid* larvae from Hanna Stream, *ca.* 6,000 ft., near Quetta, Baluchistan, 10-11-18. $\frac{8748}{HI}$. None are fully grown so that it is impossible to tell to what the insects belong by a study of the tracheation, but I think that there is no doubt that these are the larvae of *Hemianax ephippiger*, Selys, a common insect around Quetta. [These larvae are from a small stream with a luxuriant growth of Characeae, amongst which they were concealed. *N. A.*]

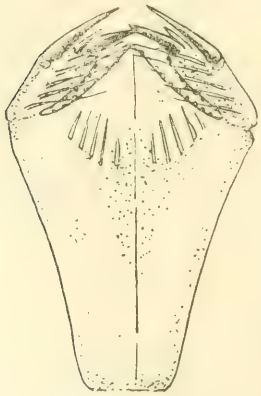
AGRIONINAE.

Genus **Ischnura.**

I. elegans, Van der Lind.

$\frac{8746}{HI}$, $\frac{8747}{HI}$, $\frac{8749}{HI}$. Three females, all differing in their colour scheme; this due partly to a teneral condition and partly due to the polychroism customary in this species. I have compared these with a series from Mesopotamia where the insect is very common and find that teneral forms are usually of a bright orange colour, especially as to the thorax. The orange pigment is soon absorbed and replaced by a greenish-yellow. Progressively with the absorbtion of the yellow pigment, blue is laid down, so that a series of forms is met with, passing from orange and yellow, through green to blue. Pari-passu with this, black pigment is deposited until it largely obscures the ground colour. Thus the eye-spots are often absent in the very early stage, being replaced by a broad orange fascia which soon changes through yellow and green, to blue, the change beginning from the front and extending backwards. At the same time, the black fascia which crosses the vertex, extends backwards and gradually laps round the area which is eventually to form the eye-spot. Evidence of this may actually be seen in the specimens quoted. The humeral fascia, usually found in this species, is unenclosed in all three specimens, but two small, black spots on the sides indicate the genesis of a posthumeral stripe.

In one specimen, the second abdominal segment bears a somewhat quadrate, black spot on the dorsum which is absent in the other two. This specimen is a bright orange colour and has the eye-spots fully developed. There is no doubt that some specimens retain the original orange colouring throughout imaginal life. The other two specimens are orange and blue respectively but have no eye-spots nor the quadrate spot on the second abdominal segment. All other markings are the same as the first specimen. In my Mesopotamian specimens, a regular series graduating from the one to the other may be seen so that there is no doubt that the insects are identical.



1.

FIG. 1.—Mask of larva of *Ischnura elegans*?

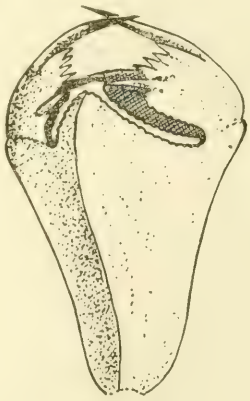
It is possible to divide up a number of Agrionine larvae in this small collection into two species. (The age of the larvae varies somewhat widely). One of these forms closely resembles the larvae of *Ischnura senegalensis* but it is probably the larvae of *I. elegans*. The mask (fig. 1) is long

and flat; the anterior border projects well forward between the palps and is furnished along its free border with minute teeth. The opposed borders of the palps are similarly armed and each is furnished with a strong movable hook and five long, stout setae, directed inward. In addition, each has a robust spine at its end and a smaller one between this and the movable hook. The caudal lamellae are more or less lanceolate and acuminated at the distal end. The tracheal ramification is pigmented and the lateral borders of the lamellae spined, the spines being robust on a little less than the basal half, and rather minute for rather more than the distal half. At the junction of these two different kinds of spines can be seen, in some specimens at least, a very faint suggestion of a transverse line, the only sign of the nodate character of the lamellae. The ends of the tibiae are richly tufted with spinous hairs and spines.

These larvae were taken along with the two Libelluline larvae mentioned above, in the Residency garden, Quetta. One imago was taken at Lab-i-Baring, Seistan, "lying on the surface of the water in channel in reed-beds in the Hamun," 10-12-18, and the other two at Kirtaka, W. Baluchistan, near Afghanistan frontier, "among coarse grass growing on sand round a small spring." The females of *Ischnura* commonly lie up among coarse herbage, in the neighbourhood of water, whilst the males rarely stray far from the neighbourhood of water.

INDETERMINATE LARVAE.

The other larvae (from the rice-beds of the Hamun-i-Helmand near Lab-i-Baring) combine some of the features of an Agrionine larva with those of a Lestine. The middle-lobe (fig. 2) is typically Agrionine; there is no suggestion of a middle notch as seen in the other family but the palps are highly differentiated and the movable hook is of great length.



2.

FIG. 2.—Mask of indeterminate larva from the Hamun-i-Helmand.

There is a stout hook on both sides of the movable one and the space between the outer hook and this is deeply serrated. The border of the inner hook is lamellated, its edge being furnished with a row of closely-set, teeth-like processes, similar to rows on the border of the middle lobe and outer border of the palp. The palps appear to be more or less cupped by the lamellated extension.

The anal appendages are also of unusual character and obscurely nodate. They are lanceolate in shape and doubled on themselves like a half-opened leaf. The outer border and midrib are spined for about two-thirds of the proximal end and the distal portion is deeply pigmented in its outer half, in fact almost black in some specimens. The specimens are young so that nothing is learnt from the tracheation.

The larvae of dragonflies usually hibernate during the winter, and it is surprising to find that so many were taken in an active condition during two of the coldest months of the year. [The temperature was as a rule well below freezing-point at night at the time they were captured. The water of the streams and pools at Quetta in which the larvae were found was, however, distinctly warmer than the air, while the channels and pools in the Hamun-i-Helmand were protected from wind and frost by the reeds. *N. A.*].

SPONGES, HYDROZOA AND POLYZOA OF SEISTAN.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India.*

(Plate XII).

Specimens of eight species of the groups discussed in this paper were collected in Seistan—three sponges, one Hydrozoon, and four Polyzoa. While the sponges and the Hydrozoon are widely-distributed species, all of which also occur within the limits of the Indian Empire, two of the four Polyzoa are new to science, though related to Indian species; one of the other two is characteristically Indian and Eastern Asiatic, the other cosmopolitan as a species.

The three sponges are *Spongilla alba, Spongilla carteri* and *Ephydatia fluviatilis.* The range of the first extends from Egypt to Bengal, of the second from Hungary to Mauritius and the Malay Archipelago, while the third is cosmopolitan in non-tropical countries. The specimens of *S. alba* are sufficiently distinct to be made the types of a new variety; of *S. carteri* only gemmules, which do not differ from those of Indian sponges, were obtained; but the *Ephydatia*, while differing in certain respects from European forms, is not definitely enough different for nominal distinction. It is, however, quite distinct from the two Indian varieties or races, *himalayensis* from the Western Himalayas (which should perhaps be united with *syriaca*, Topsent) and *intha* from the Shan States of Burma.

The Hydrozoon is *Hydra vulgaris*, a cosmopolitan species not uncommon in India.

The four Polyzoa are somewhat remarkable forms. They are *Fredericella sultana* var. *jordanica, Plumatella* (*Afrindella*) *persica*, sp. nov., *Plumatella* (*Hyalinella*) *bigemmis*, sp. nov. and *Lophopodella carteri.* The *Fredericella* is a race of a cosmopolitan species the known range of which includes the Volga and Jordan systems; one *Plumatella* is closely related to a Gangetic species (*P. testudinicola*) associated, unlike its Persian relative, with fresh-water tortoises; the other differs from the cosmopolitan *P. punctata* in one important structural and physiological character, while the *Lophopodella* is a characteristic Indian species with a local race in China and Japan and related to Tropical African forms.

The representatives in Seistan of the three groups have, therefore, mixed geographical relationships, partly Indian, partly

southern Palaearctic, partly cosmopolitan. The Indian element is strongest, or at any rate most conspicuous, in the Polyzoa.

It is remarkable to find these groups (or at any rate the sponges and Polyzoa) so well represented in a country that seems in almost every respect unsuitable for them. In the Inlé lake-system in the Shan States,[1] a district apparently in all respects favourable to such organisms, only three sponges and two Polyzoa, both of which belonged to the same genus, were found; whereas in the Hamun system, in which the water is of extremely variable composition and amount, in which extremes of climate occur in regular succession, the same number of sponges and twice as many Polyzoa (which belonged, moreover, to three genera) were obtained. It might seem at first sight that it was necessary for gemmules and statoblasts to undergo desiccation, of which there is the greatest possible chance in Seistan, just as it is necessary for the eggs of many "Phyllopod" Crustacea; but against this theory must be placed the richness of the fauna of these groups in the comparatively equable conditions of Lower Bengal. We are still far from understanding the factors that encourage growth and reproduction in the lower aquatic invertebrates, and the only possible way to gain light is to keep careful records of the modes of occurrence of the living animals and of the *provenance* of specimens. The Hamun is the seventh large Asiatic lake that I have had an opportunity of examining in the last seven years (as well as innumerable smaller bodies of water), and in each place I have paid particular attention to the sponges and Polyzoa; but I must confess myself still as far as ever from understanding many of the fundamental factors in the biology of these groups. The lakes have been of diverse kinds and situated in diverse countries—Lake Biwa in Japan, the Tai Hu in China, the Talé Sap in Siam, the Inlé Lake in Burma, the Chilka Lake in India, the Hamun in Persia and the Lake of Tiberias in Palestine. But they are not sufficient.

PORIFERA.

Of three sponges collected in Seistan in winter, one (*Ephydatia fluviatilis*) was found in an active state; of one of the others only dried specimens were found, and of the third only gemmules. The *Ephydatia* is interesting because it occurred in the Hamun-i-Helmand in two phases each correlated with a different type of environment.

I take this opportunity to describe a new variety of *Spongilla lacustris* from Mesopotamia.

Spongilla alba, Carter.

1915. *Spongilla alba*, Annandale, *Mem. Ind. Mus.* V, pp. 25-32, figs. 1, 2 pl. iii; pl. iv, figs. 1, 2; pl. v, fig. 1.

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[1] Annandale, *Rec. Ind. Mus.* XIV, p. 75 (1918).

var. **rhadinaea**, nov.

The chief diagnostic character of this variety lies in the shape of the skeleton-spicules, a large proportion of which are bluntly pointed. This I have not seen in any Indian specimen. The flesh-spicules, which are scattered singly among the interstices of the skeleton, are very thin and vary in length; they taper to the extremities and have their spines, which are extremely minute, congregated in the central region. The gemmule-spicules have all their spines straight. The sponge is compact but friable, containing little chitinoid substance. The external membrane

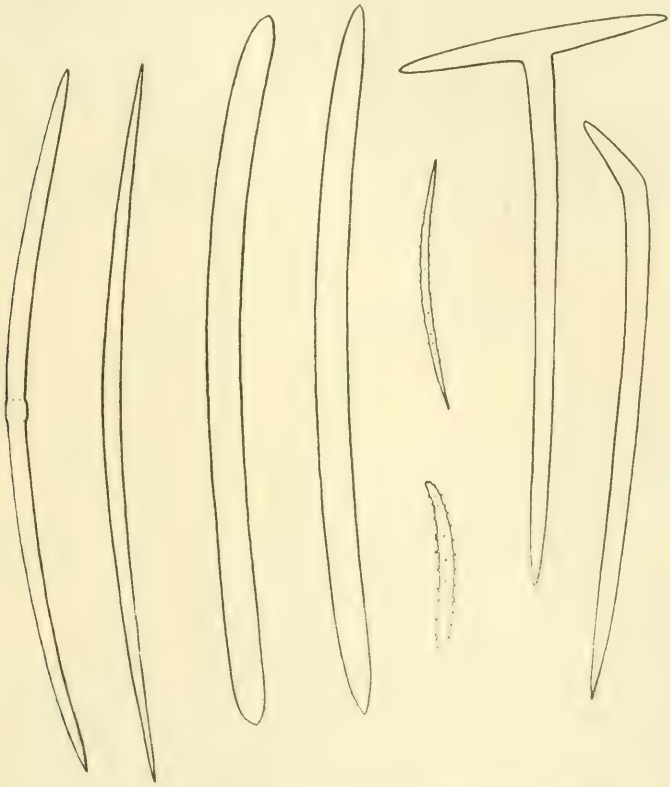


FIG. 1.—Spicules of *Spongilla alba* var. *rhadinaea*, nov., × 250.

has disappeared from my specimens, which coated the stems of reeds in a layer not more than 1 cm. thick. They contain abundant gemmules of a perfectly normal character, but rather small and bleached white.

Measurements of spicules, etc.

Length of skeleton-spicules ..	0·402-0·414	mm.
Greatest diameter of skeleton-spicules	0·0123-0·025	mm.
Length of flesh-spicules	0·0826-0·135	mm.
Length of gemmule-spicules ..	0·082-0·094	mm.
Diameter of gemmules	0·425-0·51	mm.

Type-specimen.—P. $\frac{94}{1}$, Z.S.I. (*Ind. Mus.*).

Locality, etc.—This sponge was found in abundance in the dry Naizar or reed-country round the Hamun-i-Helmand in December, 1918. Gemmules were also observed in drift near Nasratabad with those of *S. carteri.* The sponge grows on the stems and roots of reeds in country desiccated for a considerable part of each year. No living examples were observed in winter.

[Spongilla lacustris var. ineptorum, nov.]

Fragments of sponge from the edge of a creek running into the Tigris at Baghdad must be assigned, on account of their yellowish colour in a dry condition, to *S. lacustris* rather than *S. alba,* but they represent a very distinct new variety, for which I propose the name *ineptorum.* When fresh they were evidently green. Their skeletal support is fragile and all the elements in the skeleton feebly developed. The skeleton-spicules are very thin, resembling those of the var. *montana,* Potts,[1] a variety which

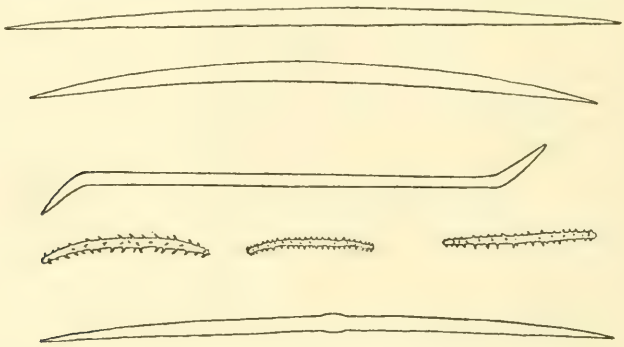


FIG. 2.—Spicules of *Spongilla lacustris* var. *ineptorum,* nov. × 250.

lives at high altitudes. At the nodes of the skeleton, however, there are dense masses of microscleres, most of which are covered somewhat sparsely with rather stout spines. The spines at the extremities are retroverted. These microscleres are indistinguishable from those of the gemmules. Others also occur, however, more sparingly in which the spines are all quite straight and the ends more pointed. The two types of flesh-spicules are found together. The gemmules are normal, with the pneumatic wall well developed and the spicules abundant and arranged in the usual manner.

Measurements of spicules, etc.

Length of skeleton-spicules ..	0·348-0·373	mm.
Greatest diameter of skeleton-spicules	0·0082-0·0123	mm.
Length of flesh and gemmule-spicules	0·082-0·095	mm.
Diameter of gemmules ..	0·394-0·476	mm.

[1] Potts, *Proc. Nat. Sci. Philadelphia,* 1887, p. 192, pl. 6.

Type-specimen. P. $\frac{93}{1}$ Z.S.I. (*Ind. Mus.*).

These specimens were collected in December, 1918 by Bombadier R. Hodgart of the Anglo-Indian Battery (Zoological Collector in the Z.S.I.) and presented by him to the Zoological Survey of India.

Spongilla (Eunapius) carteri, Carter.

1911. *Spongilla carteri*, Annandale, *Faun. Brit. Ind., Freshw. Sponges*, etc., p. 87, fig. 14.

Gemmules, which do not differ from those of Indian specimens, were found among drift at the edge of a pool in the desert near Nasratabad, Seistan, in December, 1918. The pool in flood-time is connected with an effluent of the Helmand.

This sponge is by far the commonest species in the plains of India. It has also been found in Hungary, Mauritius and several of the Malay islands. Its occurrence so far west in Asia as Eastern Persia is interesting in view of the fact that it has been found in Eastern Europe. Specimens from Lake Balaton in Hungary differ somewhat in structure from any Indian form, but their gemmules are closely similar.

Ephydatia fluviatilis, auct.

1911. *Ephydatia fluviatilis*, Weltner, *Trans. Soc. Nat. St. Pétersbourg* XLII, p. 59, pl. i.

1916. *Ephydatia fluviatilis*, Annandale, *Journ. As. Soc. Bengal* (n.s.) XI, p. 445.

Sponges of this species were found in the Hamun-i-Helmand in two different types of environment, on the lower surface of blocks of hard clay at the edge of the lake and on the stems of bulrushes in the reed-beds. Specimens from these two habitats differ considerably, but neither affords any very definite diagnostic character whereby it might be distinguished nominally from the *forma typica* of the species. Both phases differ from the Himalayan var. *himalayensis* (which is so near the Syrian var. *syriaca* that it is hardly worth while to distinguish them) in the almost complete absence of spines or tubercles, however minute, on the skeleton-spicules.

Sponges on the stems of bulrushes form a layer 2 to 3, rarely 5 mm. thick. The outline of each mass is oval, following the long axis of the reed, which it rarely, if ever, completely encircles. Few are more than about 70 mm. long. Their colour is dirty white. The external surface is smooth and rounded with but moderately conspicuous exhalent orifices and radiating superficial channels. The consistency is very soft and friable. The skeleton contains little binding substance and is not particularly regular in structure. There are no bubble-cells. The skeleton-spicules are short and slender, sharply but abruptly pointed, often a little irregular in outline and sometimes bearing a few widely scattered extremely minute tubercles, as a rule gently curved but sometimes bent in the middle or elsewhere almost abruptly. In some parts of the sponge there are groups of very small and slender spicules. Measurements of these are not included in the table given below. The gemmule-

spicules are well-developed and normal in appearance. A few are scattered in the parenchyma. The shafts are stout and as a rule considerably longer than a single rotule, with the spines upon them by no means strongly developed. The rotules are deeply but irregularly divided, their denticulations having the form of flattened spines more or less welded together at the base but without any trace of webbing. The gemmules are small and somewhat depressed. Their pneumatic layer is thin and they bear a single layer of spicules. These specimens are from station 21 of our expedition. I give with their measurements those of specimens from station 20, which I will describe, for comparison.

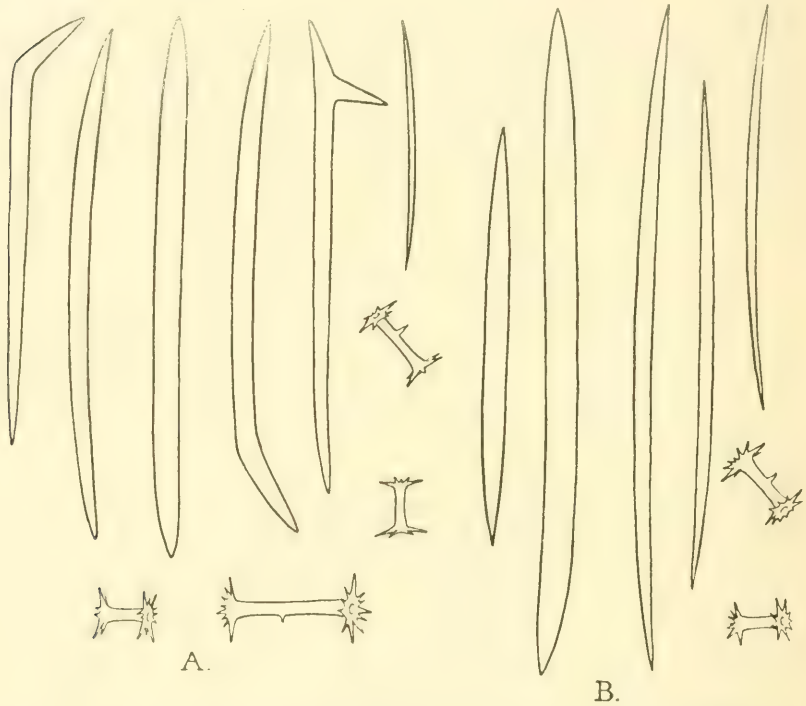
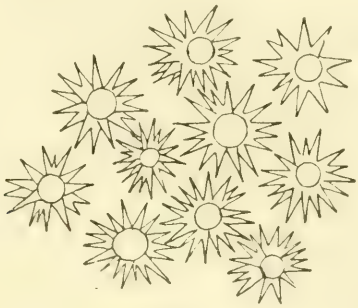


FIG. 3.—Spicules of *Ephydatia fluviatilis* from the Hamun-i-Helmand, × 250. A = spicules of specimens from the lower surface of a block of clay at the edge of the lake. B = spicules of a specimen from the stem of a bulrush in a reed-bed.

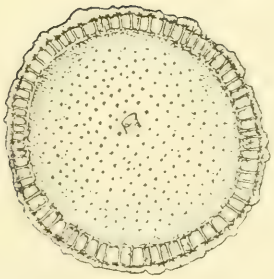
Measurements of spicules, etc.

	Sta. 20.	Sta. 21.
Length of normal skeleton-spicules ..	0·246-0·328 mm.	0·2624-3075 mm.
Maximum breadth of normal skeleton-spicules ..	0·006-0·025 ,,	0·0123-0·01435 ,,
Length of normal gemmule-spicule ..	0·020-0·0369 ,,	0·0287-0·0369 ,,
Diameter of rotule	0·016-0·0246 ,,	0·0246-0·0328 ,,
Diameter of gemmule	0·340-0·375 ,,	0·345-0·359 ,,

The specimens from sta. 20 are from the lower surface of blocks of hard clay which had fallen into the lake from cliffs of that substance. Their skeleton-spicules exhibit less variation and are as a rule shorter and relatively stouter than those from the stems of bulrushes. Their normal gemmule-spicules are also usually stouter and shorter with relatively larger rotules, but very long spicules of the same type occur occasionally. The whole sponge is so full of particles of clay that it is almost impossible to study the structure of the skeleton in detail, but it is certainly (doubtless for this



A.



B.

FIG. 4.—Gemmules and gemmule-spicules of *Ephydatia fluviatilis* from the Hamun-i-Helmand. A = outer rotules of a specimen from a block of clay at the edge of the lake: highly magnified. B = a gemmule of a specimen from the stem of a bulrush as seen from above: × 20.

reason) very lax and amorphous and the groups of small spicules characteristic of the other phase seem to be absent, though small amphioxi occur scattered in the parenchyma. The colour is that of the clay. The gemmules are normal except that in some single birotulate spicules are, as it were, plastered on outside the normal single row in a vertical or slanting position. They are held in position by an extension of the outer horny coat, which covers them completely.

It is probable that there was a difference in the chemical composition of the water from which these two sets of sponges came

(see p. 97 *antea*), and they were growing in very different types of environment, though in the same lake at a distance of less than five miles apart. The sponges from sta. 21 were living in most unfavourable conditions on the lower surface of blocks of clay partly embedded in soft mud, which permeated their whole substance, and in a situation liable to desiccation with a change of wind, and also to the effects of nightly frost. Those from sta. 20 on the other hand were living in much deeper water, protected from frost and wind and not in any danger of being choked by mud (*v.* p. 91). The sponges from the blocks of clay were in a somewhat similar situation to those of the var. *syriaca* I collected in the Lake of Tiberias,[1] except that the latter were attached to solid stone. In the other instance the method of growth is similar to that of *Spongilla fragilis* in Japan.[2]

The specimens from the edge of the Persian lake are so enveloped in and permeated by mud that their whole structure is distorted, whereas those of the Lake of Tiberias were normal in structure but small. Moreover, there is no trace of green corpuscles in the Persian specimens, though minute extracellular algae of various kinds are found in their parenchyma.

The specimens from both types of environment in the Hamun-i-Helmand were in an active vegetative condition in December, but both contained numerous gemmules. I can find no trace of embryos.

No specimens of *E. fluviatilis* from the Hamun bear any particular resemblance to those of the same species described from lakes in Central Asia by Weltner (*op. cit.*), except that the skeleton-spicules of those growing on reeds have a somewhat similar outline to those from Issyk Kul figured by him in figs. 8-14 on p. 65 of the work cited. In the occurrence in the sponges from the margin of the lake of occasional abnormally large birotulate spicules they resemble the Australian *E. multiformis*,[3] but that species (? or variety of *E. mülleri*) possesses bubble-cells in its parenchyma. I have examined a cotype or schizotype sent me before the war by Dr. Weltner and have found in it a spicule of this type, but neither in Persian nor in Australian specimens have I discovered such spicules *in situ* on the gemmule. I see no reason to regard them as adventitious but believe that they are produced free in the parenchyma, perhaps as a result of abnormal environment.

HYDROZOA.

Hydra vulgaris, Pallas.

1911. *Hydra vulgaris*, Annandale, *Faun. Brit. Ind., Freshw. Sponges, etc.*, p. 148, fig. 29, p. 131, fig. 27A.

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[1] Annandale, *Journ. As. Soc. Bengal* (n. s.) IX, p. 59 (1913) and XI. p. 455 (1916).

[2] Annandale and Kawamura, *Journ. Coll. Sci. Univ. Tokyo* XXXIX, p. 13 (1916).

[3] Weltner in Michaelsen and Hartmeyer's *Faun. Südw. Australiens* III, p. 138 (1910).

A single small specimen of a pale brownish colour and without buds or reproductive organs was taken amongst green filamentous alga in an irrigation-channel at Nasratabad, Seistan, in December.

POLYZOA.

The four species of Polyzoa collected in Seistan all belong to the Phylactolaemata and all but one are sessile, branching species. Otherwise they have little in common. The two Plumatellinae are remarkable for the differentiation exhibited between the zooecia that produce free and those that produce fixed statoblasts. All the species were found in full activity in December, except the *Afrindella*, which was taken in foul water and was in a degenerate condition, densely packed with statoblasts of both kinds. *Lophopodella carteri*, which elsewhere has been found associated with algae,[1] was only observed in an active state in Seistan attached to tubes inhabited by a small Oligochaete worm, but perhaps stolen by the worm from a Dipterous larva.

Fredericella sultana subsp. **jordanica**, Annand.

1913. *Fredericella sultana jordanica*, Annandale, *Journ. As. Soc. Bengal* (n.s.), p. 223, pl. vii, figs. 1, 1*a*, 1*b*, 1*c*.
1915. *Fredericella sultana* subsp. *jordanica*, *id.*, *Trav. Sta. Biol. Volga* (Saratow) V, p. 74.

Specimens that may be assigned to this race were abundant in December both on the stems of bulrushes in the reed-beds of the Hamun-i-Helmand near Lab-i-Baring and on the lower surface of blocks of clay at the edge of the lake near the same place. It was also found on empty Unionid shells in the open lake. Though many of the colonies were degenerate they contained few statoblasts and the peculiar thickening of the ectocyst noted in association with the formation of gemmules in the Lake of Tiberias was not observed. The zooecia were narrow and still more strongly keeled and emarginate than in specimens from Palestine or the Volga.

F. sultana is apparently cosmopolitan as a species. The Palestinian race has hitherto been found only in and near the Lake of Tiberias and in the lower Volga system in eastern European Russia. In the plains of India it is replaced by the race *indica*, while the typical form occurs in the lakes of Kumaon in the Western Himalayas.

Fam. PLUMATELLIDAE.

Genus **Plumatella**, Lamarck.

Subgenus **Afrindella**, Annandale.

1912. *Afrindella*, Annandale, *Rec. Ind. Mus.* VII, p. 140.

This subgenus has hitherto been found only in tropical Africa, India, Siam[2] and the Philippines. Its occurrence in Seistan is,

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[1] West and Annandale, *Journ. As. Soc. Bengal* (n.s.) VII, p. 83 (1911).

[2] *Plumatella* (*Afrindella*) *tanganyikae* occurs in the inner lake of the Talé Sap in the Siamese province of Singgora or Sunkla.

therefore, evidence for the existence of a tropical element in the aquatic invertebrate fauna of that country.

Key to the species of the subgenus Afrindella.

A. Zoaria forming a single layer.
  1. Ectocyst smooth; zooecia regular in growth, with a strong continuous keel; statoblasts (free) elongate .. *Plumatella philippinensis.*
  2. Ectocyst obscurely annulate, densely covered with minute sand-grains; zooecia without keel; statoblasts (fixed) broad, variable in shape ... ... *P. testudinicola.*
  3. Ectocyst rough, irregularly annulate on the distal region; proximal region of zooecium strongly keeled; statoblasts (free and fixed) moderately elongate ... *P. tanganyikae.*

B. Zoarium in two layers, in the lower of which fixed, in the upper free statoblasts are produced.
  Ectocyst more or less irregular; zooecia without keel; statoblasts (free and fixed) elongate ... ... *P. persica.*

Plumatella (Afrindella) persica, sp. nov.

This species closely resembles the Gangetic *Plumatella testudinicola*[1] in structure, but is differentiated (apart from the method of growth) by the possession of free as well as fixed statoblasts and by the more elongate form of the latter.

The specimens examined consist of rather dense growths on the woody roots and stems of water-plants which were in a condition of rest in winter. Each growth is separated quite definitely into two layers. Most of the zooecia of the outer layer are degenerate but some still contain polypides, while all except the youngest are packed with free gemmules. Those of the lower layer are filled with fixed statoblasts arranged in single longitudinal rows. The zoarium is everywhere too congested to reveal its precise method of growth, but even round the margins of the colony, where the youngest zooecia occur, the two layers are distinct and the lower zooecia contain fixed statoblasts. In this part of the zoarium the zooecia are arranged roughly in parallel lines and it is clear that the system of budding was that of a terminal and a latero-terminal bud being given off almost simultaneously by each terminal zooecium, and that owing to the congested state of the colony the latero-terminal buds have been closly adpressed to the terminal ones. The zooecia lie practically flat, all orientated in one direction and each with its orifice opening almost horizontally. The base of the buds being somewhat flattened and issuing from the lower part of the parent zooecium permits the latter to open in this way. When the polypides expand they doubtless bend upwards, which the softness and laxness of the distal part of the zooecia would readily permit them to do. The zooecia are nearly cylindrical but flattened on the attached surface. They are about

[1] Annandale, *Rec. Ind. Mus.* VII, p. 148, pl. xiii (1912).

0·7 mm. in diameter and not longer than 2·5 mm. In the denser parts of the colony they are often bent or twisted in their long axis. The proximal region of each zooecium is brownish, smooth or irregularly annulated and translucent, the softer distal region colourless, transversely wrinkled when the polypide is retracted and transparent in fresh specimens. In degenerate colonies this region disappears with the polypides, but in living areas it is of relatively large extent.

The polypides are nearly colourless throughout. I have not been able to detect any distinctive feature in their anatomy.

The statoblasts are of the elongate type. Those of the free kind are from 1½ times to over twice as long as broad. They have the sides nearly parallel and the ends broadly rounded. The ring of air cells is narrow and not much broader at the ends than at the sides. It encroaches little on either surface. These statoblasts are somewhat curved in their long axis. The fixed statoblasts resemble the free ones in shape, but are larger and usually broader and more variable in outline. They are very flat but slightly convex on the dorsal surface, black, smooth and polished. Each is surrounded by a delicate peripheral crenulate carina separated from the body of the statoblast by a deep but narrow groove. Both kinds of statoblast are large compared with the calibre of the zooecium.

Measurements of statoblasts (in millimetres).

	Free.	Fixed.
Length	0·289-0·374	0·34-0·544
Breadth	0·17-0·204	0·255-0·272

Type-specimen. P. $\frac{91}{1}$ Z.S.I. (*Ind. Mus.*).

Locality, etc.—Our specimens were found at the bottom of a pool of very foul water in the nearly dry bed of the Randa stream near Jellalabad, Seistan. They coated the peculiar nodular roots and the stems of some plant which grew in the mud but had died down completely in winter.

Subgenus **Hyalinella**, Jullien.

1885. *Hyalinella*, Jullien, *Bull. Soc. zool. France* V, p. 133.
1910. *Hyalinella*, Loppens, *Ann. Biol. Lacustre*, IV, p. 147.
1911. *Australella*, Annandale, *Faun. Brit. Ind., Freshw. Sponges, etc.*, p. 212.
1911. *Plumatella* (in part), *id., ibid.*, p.212.
1914. *Australella*, Kraepelin in Michaelsen's, *Land-u. Süsswass. Fauna Deutsch-Sudwestafrikas*, XI, p. 61.
1916. *Australella*, Annandale, *Rec. Ind. Mus.* XI, p. 163.

The one diagnostic feature of this subgenus is that the true ectocyst is transformed into a gelatinous layer, which may be so thick as to produce a synoecium analogous to that of the Lophopodinae. The growth, however, is always dendritic, and the tentacles never of great length. Until now no fixed statoblasts have

been observed, but they are highly developed and specialized in the species to be described here. Some species of the genus bear a close external resemblance to those of the group of *Plumatellae* that has been named *Alcyonella*, but in *Alcyonella* a horny ectocyst is present as well as the gummy substance by means of which the zooecia are agglutinated together. In preserved specimens of *Hyalinella* the ectocyst is apt to shrink and lose its gelatinous character, but in the natural condition its structure and appearance are most characteristic. It is usually much harder than the zooecium of the Lophopodinae. Six species may now be assigned to the subgenus:—*Plumatella punctata*, Hancock, the type-species; *P. bigemmis*, sp. nov.; *P. indica*, and *P. longigemmis* (Annandale); *P. jheringi* (Meissner), and *P. lendenfeldi* (Ridley). The first of these is widely distributed in Europe and North America and occurs also in tropical Africa and in India; the second is here described from E. Persia; *P. indica* and *P. longigemmis* are Indian; *P. jheringi* comes from Brazil, and *P. lendenfeldi* from Australia.

These species may be distinguished by the following key:—

I. Ectocyst not greatly swollen, fairly soft, not concealing the identity of the zooecia.
  A. Statoblasts of one type only, all free.
    1. Statoblasts not much longer than broad, very variable ... ... *P. punctata.*
    2. Statoblasts nearly $1\frac{1}{2}$ times as long as broad, not particularly variable ... ... *P. longigemmis.*
  B. Fixed statoblasts present as well as free ... *P. bigemmis.*

II. Ectocyst stiff, not greatly swollen but compacting the zooecia together into a solid mass.
  Statoblasts oval, rounded at the ends ... *P. indica.*

III. Ectocyst very copious, soft; the distinction between zooecia entirely obliterated.
  A. Statoblasts oval, subtruncate at the ends ... *H. lendenfeldi.*
  B. Statoblasts subcircular or polygonal ... *H. jheringi.*

As is shown in this key the distinction between my *Australella* and Jullien's *Hyalinella* is merely a matter of degree. Some specimens of the species now to be described might be assigned with equal propriety to either. Nor does the one differential character, considered in this light, seem sufficient for generic separation from *Plumatella*.

Plumatella (Hyalinella) bigemmis, sp. nov.

The zoaria grow prone on the stems of plants and have much the appearance of those of *H. punctata*, except that the ectocyst is still more transparent and swollen and quite smooth on the external surface. Young zoaria have an almost linear growth, slightly zig-zag owing to the subterminal buds being produced on opposite sides of alternate zooecia. Though these buds are lateral in origin they are directed almost straight ahead, so that the deviation from a straight line is not great. As the colony develops, the zooecia are pressed together into a compact layer. This is brought about by the production of lateral branches which form an acute angle with the main axis of the colony. A radiating

zoarium may also be produced and in the mature colony the orientation of the zooecia is often radial, mainly in four directions. In any case a large number of the zooecia always point in the same direction. The colony as a whole is quite flat, the gelatinous ectocyst filling in the interstices between the zooecia.

The individual zooecia maintain their identity distinct, but their ectocyst is so thick that their openings have in more congested parts of the colony a honeycomb-like appearance. The ectocyst is, as already stated, usually quite hyaline and colourless, but it is sometimes darkened towards the distal extremity of the zooecia It is hard and almost cartilaginous for the greater part of its length, but the harder region ends abruptly near the aperture, which is surrounded by a thin, soft, mainly retractile membrane. The margin of the former region is well-defined, of an oval form and somewhat oblique in its long axis, which is mainly vertical in direction. Sometimes the external surface is covered with minute algae. The zooecia are long, but somewhat variable in length, sometimes bent or curved in their long axis. They are distinctly flattened. Their transverse diameter (internal) is about 0·5 mm. and even when quite young they are of almost equal calibre throughout their length. Their long axis is parallel to the surface to which they are attached.

This description applies to the normal zooecia which constitute the greater part of the colony, but in old zoaria zooecia of another type are produced at or near the terminal points of the branches. These are variable in shape and sometimes shorter, occasionally longer, than the normal zooecia. Zooecia of this type (which are only produced when the vegetative period of growth nears its end) never contain a fully developed polypide but only one or more statoblasts partly embedded in a strand of undifferentiated tissue, which broadens out towards the distal extremity of the zooecium.

The polypide is much like that of *H. punctata* and offers no particular diagnostic characters. The tentacles are moderately short and not very numerous and the whole body is almost colourless.

The free statoblasts are very like those of *H. punctata*, but not so variable in shape, a little more rhomboidal, and with a broader ring of air-cells at the extremities. The fixed statoblasts are large, broadly oval, of a dark brown colour and densely punctured on the surface. Each is, however, surrounded by an amorphous mass of dark horny material that obscures its true shape and ornamentation. The statoblasts are not very numerous.

Measurements of statoblasts (in millimetres).

	Free.	Fixed.
Length	0·357–0·374	0·459–0·561
Breadth ..	0·255–0·272	0·425–0·459

Type-specimen. P. $\frac{92}{1}$, Z.S.I. (*Ind. Mus.*).

Locality.—Our specimens were found on the stems of bulrushes in the reed-beds of the Hamun-i-Helmand near Lab-i-Baring in December, 1918, with *Fredericella sultana* and *Ephydatia fluviatilis.*

Genus **Lophopodella**, Rousselet.

1904. *Lophopodella*, Rousselet, *Journ. Quek. Micr. Club* (2) IX, p. 45.
1911. *Lophopodella*, Annandale, *Faun. Brit. Ind., Freshw. Sponges*, etc., p. 231.
1914. *Lophopodella*, Kraepelin in Michaelsen's *Land-u. Süsswasserfauna Deutsch-Sudwestafrikas* I, p. 64.

Kraepelin gives in the work cited a useful key to the species and figures the statoblasts. He points out that the African species hitherto confused with *L. carteri* is distinct, and describes it under the name *L. stuhlmanni.* He also describes a new variety of *L. capensis* (Sollas) under the name var. *michaelseni.* The forms that must now be referred to the genus are *L. carteri* (Hyatt), *L carteri* subsp. *davenporti* (Oka), *L. thomasi*, Rousselet, *L. capensis* (Sollas), *L. capensis* var. *michaelseni*, Kraepelin and *L. stuhlmanni*, Kraepelin. The range of the genus extends from Eastern Persia to Japan, Brazil and South Africa, but is mainly tropical. The following key, though not actually based on Kraepelin's, owes much to it.

Key to the species of Lophopodella.

1. Each extremity of the statoblast produced into a long slender process bearing books along each margin ... *L. capensis.*
2. Extremities of statoblast truncate or subtruncate, with a single row of hooked processes.
   - A. Extremities of statoblast broadly truncate, little narrower than the greatest transverse diameter ... *L. stuhlmanni.*
   - B. Extremities of the statoblast broadly rounded, much narrower than the greatest transverse diameter ... *L. carteri.*
   - C. Extremities of the statoblast very narrow, concave *L. thomasi.*

All of these species except *L. carteri* are African.

Lophopodella carteri (Hyatt).

1911. *Lophopodella carteri*, Annandale, *Faun. Brit. Ind. Freshw. Sponges*, etc., p. 233, fig. 46, pl. iii, figs. 4, 4*a*.
1912. *Lophopodella carteri, id., Rec. Ind. Mus.* VII, p. 143.

Specimens from an irrigation channel in the Consulate garden at Nasratabad, Seistan agree well with Indian specimens. Statoblasts were also taken, with gemmules of *Spongilla carteri* and *S. alba*, amongst drift at the edge of a pool in the desert in the same district. The statoblasts did not differ in any respect from those of Indian colonies.

Statoblasts were found in active colonies in all stages of development in December. The animal was living among green filamentous algae. The most interesting feature of these colonies was, however, that each was attached to a fine mucilaginous tube and that each tube was inhabited by a small Oligochaete worm

identified by Lt.-Col. J. Stephenson, I.M.S., as *Nais communis* var. *punjabensis*. This worm does not ordinarily construct tubes, and was found free in the reed-beds of the Hamun, but Col. Stephenson has seen it in tubes made by insect larvae (probably those of Diptera) in the Punjab. It is possible that in Seistan also it occupied the dwellings of larvae which it had dispossessed or succeeded after their departure, but as to the association between it and *Lophopodella* there can be no doubt, for it was noted repeatedly on more than one occasion. *L. carteri* has been observed in association with certain algae,[1] and it is not uncommon for Chironomid larvae to construct their tubes at the base of its colonies; but I have not hitherto found it associated with Oligochaete worms.

The known geographical range of *L. carteri* now extends from Eastern Persia to Japan. The Japanese and Chinese race (*davenporti*, Oka [2]) is distinguished from the *forma typica* by the greater development of the terminal processes of the gemmule, but nothing is known of the species in the countries intermediate between India and China.[3] A form (var *himalayana*, mihi) with the process of the gemmules absent or imperfectly developed occurs occasionally in the Kumaon Lakes in the Western Himalayas, but normal colonies have been found at the same places at other times. In the plains of India the distribution is apparently sporadic, but the species is common in parts of the Bombay Presidency and the Central Provinces. I have never found it in the Punjab, Bengal or Madras.

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[1] See Annandale and West, *Journ. As. Soc. Bengal* (n. s.) VII, p. 81, pl. iii (1911).

[2] *Pectinatella davenporti*, Oka, *Zool. Anz.* XXXI, pp. 7, 6 and *Annot. Zool. Japan.* VI, p. 117 (1907).

[3] The Rev. Gist Gee has recently sent me specimens of the Japanese race from Soochow in the Kiangsu province of China.

EXPLANATION OF PLATE XII.

Polyzoa of Seistan.

Plumatella (Hyalinella) bigemmis, sp. nov.

Fig. 1.—A part of the peripheral region of a mature but growing colony on the stem of a bulrush, showing the resting statoblasts, × $5\frac{2}{3}$.

,, 2.—A part of the peripheral region of a more compact and vigorous colony, × $5\frac{2}{3}$.

The white substance in the interstices between the zooecia is composed of microscopic algae.

Fig. 3.—Three zooecia containing statoblasts, × 40.

On the right a zooecium in which the polypide has completely degenerated and a single free statoblast has been produced, is shown growing over a terminal zooecium in which a single fixed statoblast has been formed. The degenerated polypide of the latter is also shown. Its roof has largely disappeared. On the left a zooecium with a single statoblast is figured.

Plumatella (Afrindella) persica, sp. nov.

Fig. 4.—Fixed statoblasts, × 40.

,, 5.—A part of a still vigorous colony growing on a rootlet, × $5\frac{2}{3}$.

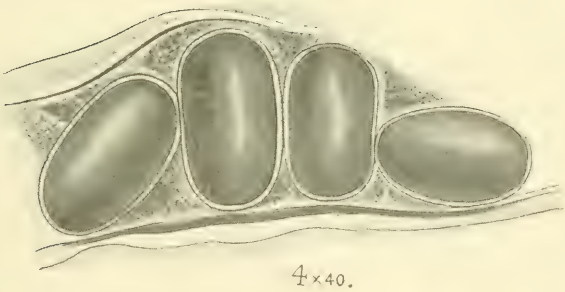
,, 6.—A part of a colony in which most of the zooecia of the upper layer have degenerated and disappeared, leaving those of the lower layer exposed. The roof of the latter has also degenerated, exposing the fixed statoblasts, × $5\frac{2}{3}$.

,, 7.—Free statoblasts, × 40.

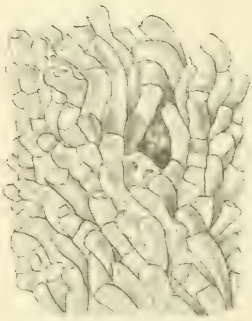
1×5⅔.

2×5⅔

3×40

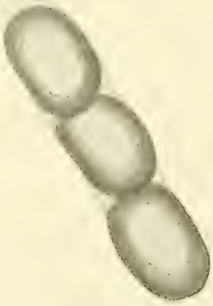


4×40.



5×5⅔.

6×5⅔.



7×40

A. C. Chowdhary del.

POLYZOA OF SEISTAN.

CARABIDAE FROM SEISTAN.

By H. E. ANDREWES.

[The Carabid beetles on which Mr. Andrewes has been kind enough to report were collected, mostly by Mr. S. W. Kemp, in the depth of winter. With the exception of *Metabletus fuscomaculatus* and *Microlestes corticalis*, which come from the desert, they were found at the edge of water-channels, streams or pools, or at that of Hamun-i-Helmand or lake of Seistan. On the shore of this lake there is in winter a drift-line, marking flood-level and consisting mainly of fragments of reeds. Under these fragments a fairly large fauna (consisting mainly of beetles and Heteroptera, but also including earwigs, a toad, etc.) finds shelter, and here we took no less than seven of the sixteen Carabidae found in Seistan.—*N. Annandale.*]

The species of Carabidae taken in Seistan number sixteen only. These show little relationship to the Indian fauna, though there are two species of which I have records from Karachi and the United Provinces respectively. A third species has not yet been recorded as coming from India, but I have examples of it in my collection from the Himalayas as mentioned below. Seistan—judging by the Carabidae—seems to be near the boundary (in so far as it exists) separating the fauna of Central Asia from that of the long sandy tract which stretches from Morocco to Sind. I have been able to determine most of the species, but have had to leave one or two unidentified.

Distichus planus, Bon.

1 Ex. No. 8782. Lab-i-Baring, Seistan, 7-xii-18, under drift at edge of Hamun.

Common in S.E. Europe, S.W. Asia, Egypt, etc.

Dyschirius sp.

3 Ex. No. 8795. Edge of stream of saline water near Lab-i-Baring, Seistan, 11-xii-18.

I have not been able at present to identify this species.

Pogonus micans, Chaud.

11 Ex. No. 8791-3. Lab-i-Baring, Seistan, 7-xii-18, under drift at edge of Hamun.

N. Persia: Astrabad. Kopet-Dagh: Germab.

Bembidium sp.

1 Ex. No. 8779. Nasratabad, Seistan, *ca.* 2,000 ft., 26-xi-18.

I cannot identify this species, but a large number have been described from Central Asia, and this may be among them.

Bembidium niloticum, Dej.

1 Ex. No. 8799. Water-channels near Nasratabad, Seistan, xi-18.

Described by Dejean from Egypt, whence it extends eastwards as far as Japan, and south to the Malay Peninsula; I have seen Indian specimens from the Himalayas, but not further south.

Bembidium varium, Oliv.

11 Ex. Nos. 8798-9, 8802. Near Jellalabad, Seistan, 2-xii-18. Channel 8 miles E. of Lab-i-Baring, Seistan, 16-xii-18.

Extends apparently over the whole of Europe, and the greater part of temperate Asia.

Bembidium latiplaga, Chaud.

5 Ex. Nos. 8794, 8797, and 8800. Channel 8 miles E. of Lab-i-Baring, Seistan, 16-xii-18. Water channels near Nasratabad, Seistan, xi-18. Edge of stream of saline water near Lab-i-Baring, Seistan, 11-xii-18.

Mediterranean basin and S. Russia. I am not aware that the species has been recorded yet from a locality so far east as Seistan.

Siagona europaea, Dej.

1 Ex. No. 8789. Lab-i-Baring, Seistan, 7-xii-18, under drift at edge of Hamun.

This is the furthest point east from which I have seen an example of this species, which is commonly found in the Mediterranean basin. I have quite recently (*Ann. and Mag. Nat. Hist.*, (9) iii, 1919, p. 470) given my reasons for considering it distinct from the Indian *S. depressa*, F.

Chlaenius semicyaneus, Solsky ?

1 Ex. No. 8777. Hurmuk, Perso-Baluch-Afghan frontier, *ca.* 3,000 ft., 22-xi-18.

A single ♀ example agreeing fairly well with Solsky's description, but I have no specimen available for comparison.

Chlaenius spoliatus, Rossi.

3 Ex. Nos. 8780, 8783-4. Lab-i-Baring, Seistan, 7-xii-18, under drift at edge of Hamun.

This species has a very wide range, from S. Europe and N. Africa to Japan; it does not extend to Southern Asia.

Diplocheila transcaspica, Sem.

2 Ex Nos. 8781 and 8785. Lab-i-Baring, Seistan, 7-xii-18, under drift at edge of Hamun.

Hitherto known only from the transcaspian provinces of Russia.

Pterostichus sp.

3 Ex. ♀ ♀. Nos. 8786-8. Lab-i-Baring, Seistan, 7-xii-18, under drift at edge of Hamun.

Possibly one of the numerous species described from Central Asia.

Brachinus sp.

1 Ex. No. 8790. Lab-i-Baring, Seistan, 7-xii-18, under drift at edge of Hamun.

Unknown to me. Chaudoir's Monograph of this genus unfortunately does not embrace the palaearctic species.

Glycia ornata, Klug.

1 Ex. No. 8778. Nasratabad, Seistan, *ca.* 2,000 ft., 26-xi-18.

Ranges from the Mediterranean basin through the desert regions of Egypt and Arabia as far as Sind.

Metabletus fuscomaculatus, Motch.

1 Ex. No. 8796. Lab-i-Baring, Seistan, 15-xii-18, at base of desert plants.

South Russia, Mongolia, Caucasus, Syria; I have specimens in my collection from Chamba, Himalayas, but the species has not previously been recorded from the Indian region.

Microlestes corticalis, Dufour.

2 Ex. ♂ ♂ No. 1401. Lab-i-Baring, Seistan, 15-xii-18, at base of desert plants.

Extends from the Mediterranean basin to Central Asia.

REPORT ON THE FRESHWATER GASTROPOD MOLLUSCS OF LOWER MESOPOTAMIA.

PART I. THE GENUS *LIMNAEA*.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India, and* BAINI PRASHAD, *D.Sc., Offg. Director of Fisheries, Bengal, Bihar and Orissa.*

(With Plates XIII, XIV.)

In the report of which the first part is now published we propose to discuss the freshwater Gastropod molluscs of the delta of the Tigris and Euphrates and of the lower reaches of the two rivers. Stress of other work and official duties have already greatly delayed its preparation, and as the medical authorities are anxious for any information about the freshwater molluscs as soon as possible, we have decided to issue it in parts dealing with separate genera or larger groups. It will be convenient to include this report in the same volume as that on the molluscs of Seistan, as the two faunas are related.

The material from Mesopotamia that we now have in our hands consists of three collections, all presented by the generosity of their collectors to the Zoological Survey of India. Two of these have already been discussed.[1] They were made by Lt. Col. W. H. Lane and Bombadier R. Hodgart and consist of empty shells, most of which were probably subfossil. The third collection, made by Capt. C. L. Boulenger, adds greatly to our knowledge as it includes specimens preserved in spirit. It has been possible with its aid to correct and expand the results based on shells previously examined.

We have, so far as possible, consulted the literature on the Persian, Central and Western Asiatic molluscs, as well as that on those of India and Europe, but it is possible that some Russian works, or memoirs published in Europe during the war, may have escaped our notice. The only paper dealing specifically with Lower Mesopotamia that we have found is Mousson's, "Coquilles ters. et fluv. rec. Dr. A. Schlæfli en Orient" in the *Journ. de Conchyl.* XXII (1874). The descriptions in this paper are fairly full and it has not been difficult with specimens before us to discriminate the species. The paper, however, is not illustrated, and without figures or specimens verbal descriptions of freshwater molluscs have little value. We are strongly of the opinion that

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[1] Annandale, *Rec. Ind. Mus.* XV, pp. 159-170, pl. xx (1918).

among the Pulmonata at any rate no description unaccompanied by a recognizable figure should be considered valid.

Genus **Limnaea**, Lamarck.

The species that occur in Lower Mesopotamia are of considerable interest. They fall into two of the main groups of the genus, namely those that may be called, in quite a general sense, those of *L. auricularia* and *L. truncatula*. Most of them we assign to the former group. These species are all variable and at first sight it might seem that most of those of southern Persia and the lower valley of the Tigris and Euphrates were conspecific, merely separable into numerous races and varieties. A careful study of a large amount of material has, however, convinced us that this is not the case, and that a number of species actually exist which can be separated by anatomical as well as merely conchological characters. The examination of young shells is most important for this reason, and we find that adults which resemble one another rather closely can often be traced back to young forms that differ considerably. In conditions such as those found in Lower Mesopotamia, and also in most parts of Persia, convergence seems to have taken place between different species of the genus on a fairly extensive scale, and forms which are perhaps not closely related genetically have come to resemble one another owing to the plastic influence of environment.

In Seistan we know of two species of the *L. auricularia* group (*L. gedrosiana* and *L. bactriana*) which at first sight appear almost identical, but on a detailed investigation have proved quite distinct. We are of the opinion that these species each had a different line of ancestry, but have thought it best in the present state of our knowledge not to discuss these lines of ancestry in detail.

Similarly in collections from Lower Mesopotamia we have found five forms that seemed to us on a superficial examination to grade the one into the other. Two of these (*L. gedrosiana* and *L. bactriana*) are the same as the two Seistan species. The others are *L. peregra canalifera*, *L. tenera euphratica* and *L. cor*.

It is important, therefore, to consider what common features are to be found in the forms of each country, and to what extent these features can be correlated with peculiarities of environment. Both Lower Mesopotamia and Seistan are countries that have a prolonged dry season, when the temperature is high, and are nevertheless liable to floods. In Seistan the water always contains a high percentage of mineral salts, while the delta of the Tigris and Euphrates is an estuarine tract in which even water that is practically fresh is probably liable to be contaminated with water of comparatively high salinity. Moreover, this tract has been gradually extending southwards and receding from the north for a considerable period, and many of our specimens are from old deposits that must have been laid down in conditions far more estuarine than

those that now prevail in the districts where the specimens were collected.

Both the species of *Limnaea* from Seistan and those from Mesopotamia have in most instances small and very thin and fragile shells, which are sculptured with more or less prominent longitudinal ribs, but the ribs on those from Mesopotamia are much more pronounced than on Seistan shells. This is so even in identical species. The shape of the shell in most forms exhibits slightly different modifications in the two countries. The two Seistan species are both rather narrow but have relatively large and patent mouths and short, pointed spires. The three distinct Mesopotamian forms exhibit a tendency, on the other hand, to grow broad in proportion to their height, while their spires are still shorter. Their mouths, in the broader forms, are relatively narrow but on the whole resemble those of *L. gedrosiana* and *L. bactriana.* An entirely new character appears in Mesopotamia in the canalization of the suture above the body-whorl found in all the endemic species and well-defined races.

How far can these differences and resemblances be correlated with similar peculiarities of the shell from different or identical types of environment in other countries? Baker,[1] in his fine monograph of the North American Limnaeidae, states that shells from saline districts in that country are prominently ribbed, but whether this ribbing is associated with the presence of any particular salt we are not informed. We know in a general way what salts are present in the waters of Seistan,[2] but no information is available about the composition of those of the Euphratic delta.

Thinness, fragility and paleness of shell in *Limnaea* are usually associated with unfavourable conditions of life, but more precise information is needed on the point. The reduction of the spire and enlargement of the body-whorl and mouth provide additional space for the branchial chamber and allow a larger portion of the animal to be extended from the shell. This character, moreover, seems to be definitely correlated with difficulty in obtaining the necessary oxygen, and we find different forms of the same species[3] (living in different types of environment in the same localities) in which it is more developed in those that live in still water than in those that inhabit streams. Both in Seistan and in Mesopotamia the *Limnaeae* live mainly in flooded country, perishing in large numbers when the floods subside. The few individuals that survive to perpetuate the species from year to year retire to shallow pools, backwaters or lakes. In the course of such an existence conditions must be encountered in which life is difficult and water lacking in free oxygen.

The *Limnaeae* of Mesopotamia are, except *L. peregra canalifera*, clearly depauperated forms, and the considerably larger size attained

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[1] Baker, *Spec. Pub. Chicago Ac. Sci.* III (1911).
[2] Annandale, *Rec. Ind. Mus.* XVIII, pp. 10, 15 (1919).
[3] Annandale, *Rec. Ind. Mus.* XIV, p. 149, fig. 4 (1918).

by this race is in itself evidence of a different origin from that of the others associated with it—evidence which is greatly strengthened by an examination of the young shell.

In this discussion we have left *L. hordeum* out of account. It is so different from the other species of the fauna that there can be no doubt of its different origin; there can be little doubt of its relationship to *L. truncatula*. It has, however, a larger mouth to the shell than that species and more tumid whorls, especially of the spire. It has, therefore, followed a line of evolution in some respects parallel to, in others divergent from, that which has resulted in such forms as *L. cor*.

Key to shells of Limnaea *from S. Persia and Lower Mesopotamia.*

A. Height of mouth less than $\frac{2}{3}$ that of shell.[1]
  1. Whorls of spire tumid; suture oblique ... ... *L. hordeum.*
  2. Whorls of spire not tumid; suture much less oblique ... *L. truncatula.*
B. Length of mouth more than $\frac{2}{3}$ that of shell.
  1. Upper surface of body-whorl not flattened; suture above it not canalized. (Height less than 20 mm.)
    a. Mouth of shell projecting strongly in ventral view; arc of lip practically a semicircle ... ... *L. persica.*
    b. Mouth less expanded, projecting less; arc of lip less than a semicircle.
      i. Whorls of spire somewhat tumid[2]; suture impressed; main axis of mouth forming an acute angle with that of shell. ... ... *L. bactriana.*
      ii. Whorls of spire not at all tumid; suture little or not at all impressed; main axis of mouth parallel to that of shell.
        α Arc of lip quite regular; apex sharply pointed ... ... *L. iranica.*
        β Arc of lip irregular; apex bluntly pointed.
          † Arc of lip never more than slightly flattened ... ... *L. gedrosiana.*
          * Arc of lip so flattened as to form a slanting straight line ... ... *L. gedrosiana* var. *rectilabrum.*
  2. Upper surface of body-whorl distinctly flattened and deeply depressed round suture.
    a. Shell over 15 mm. high, not very fragile, with the spire usually about $\frac{1}{5}$ as long as the body-whorl and the latter much narrower than high .. *L. peregra canali-* [*fera.*
    b. Shell not higher than 15 mm., fragile, with the spire always less than $\frac{1}{5}$ the height of the body-whorl, which is as broad or nearly as broad as high.
      i Spire very small; upper surface of body-whorl transverse, almost at right angles to the main axis; deeply depressed round suture ... *L. cor.*
      ii Spire small; upper margin of body-whorl cutting main axis obliquely, less depressed round suture. *L. tenera euphratica.*

The key applies only to adult shells; for young shells our figures in the plates issued with this paper and our former one

[1] *Cf.* p. 41, *Rec. Ind. Mus.* XVIII. The specimens now before us show that the mouth may be, and probably always is in the adult, more than $\frac{1}{2}$ as long as the shell.

[2] On p. 45, line 19 of this volume, the word "greatly" has slipped out between "not" and "swollen."

on the molluscs of Seistan may be consulted (see plates vi, vii, xiii, xiv of this volume).

Limnaea gedrosiana, Annand. and Prashad.

1918. *Limnaea subpersica*, Annandale, *Rec. Ind. Mus.* XV, p. 146, pl. xx, fig. 5.
1919. *Limnaea gedrosiana*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 48, pl. vii, figs. 2-4.

There is in Captain Boulenger's collection a fairly good series of specimens in spirit which we cannot separate from our recently described species. The shells, however, though not thicker or less fragile, possess much stronger longitudinal ridges on the body-whorl than specimens from Seistan or Baluchistan. There is no spiral sculpture. The mouth of the shell is also as a rule a little narrower, but this difference is hardly beyond the limits of normal variation and is not so great as that observed between shells from Baluchistan and those from Seistan. The largest shell is 10 mm. high and its maximum diameter is 7 mm. The specimen recently figured by one of us provisionally as *L. subpersica*, Locard, is a very young shell of this species.

The radula is so variable in *L. gedrosiana* that it cannot be regarded in this species as possessing sound diagnostic characters. In a specimen from Mesopotamia it is very like that of some individuals from Baluchistan.

The genitalia resemble those of the Seistan form figured and described by us in the original description of the species. Some differences exist, but these are due to the fact that the Seistan specimen we figured was abnormal in certain respects, as is borne out by dissection of another specimen from the same country. This specimen was found to have the genitalia quite similar to those of specimens in the present collection. The abnormality in the individual figured consisted in the large development of the accessory gland and in the poorer development of the hermaphrodite gland, its duct and the uterine duct; all these latter structures are much better developed in normal specimens, while the accessory gland is usually a small structure. The proximal part of the vas deferens also is rather thicker in normal specimens.

It is clear, therefore, that individual differences must be looked for in the genitalia as well as in the shell and radula of species belonging to this group of *Limnaea*.

The precise locality of Capt. Boulenger's specimens is given by him as "higher reaches of Khandag Creek, Basra, Mesopotamia." The species is not uncommon in swamp-deposits in the delta of the Euphrates.

Limnaea bactriana, Hutton.

(Pl. XIV, fig. 3.)

1919. *Limnaea bactriana*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 45, pl. v, figs. 1, 2; pl. vii, fig. 6.

Three specimens in spirit collected by Capt. Boulenger in ponds connected with the Khandag Creek in a palm-grove near Basra seem to belong to this species. The shells are, however, thicker and are sculptured with curious flattened opaque ribs on the body-whorl. The form is also narrower, perhaps because the specimens had not reached their full growth, and the basal whorl of the spire is smaller and not so distinctly separated from the body-whorl. Otherwise the spire has the characteristic features of Hutton's species. A shell is 10·5 mm. long, and its maximum diameter is 6 mm.

The three shells are all more or less broken. With more abundant material racial differences might perhaps be found between shells from the eastern parts of the range of the species and those from Mesopotamia.

The radula of a specimen has the approximate formula 18.8.1. 8.18. The asymmetry of the cusps of the central tooth is very distinctly marked, as also is its tridentate character. The inner cusp of the lateral tooth though situated at a higher level than the outer is not much larger; all the cusps of the laterals, however, are pointed, differing in this respect from those of the Seistan specimens. The marginals have four to seven blunt cusps, all situated in the same straight line, and one or two small pointed cusps situated on the outer margins of the teeth near the base.

The genitalia. Owing to paucity of material and to the specimens being very much contracted we are not able to add much to our previous account. The genitalia of a Mesopotamian specimen resemble those of specimens from Seistan except that the uterine duct is much thicker at its commencement, the prostate is better developed and lies a little higher up on the male duct, which also is much thicker in its proximal part. These differences may be due at any rate in part to the state of sexual activity in which the molluscs were killed.

Limnaea peregra race **canalifera**, Mousson.

(Pl. XIV, figs. 1, 2.)

1874. *Limnaea canalifera*, Mousson, *Journ. de Conchyl.* XXI, p. 41.
1918. *Limnaea peregriformis*, Annandale, *Rec. Ind. Mus.* XV, p. 165, pl. xx, fig. 4.

This is much the largest form of *Limnaea* known to us from Mesopotamia, and the only one in which the shell grows more than 20 mm. long. The shell is also stouter and more coarsely sculptured than that of other species from the lower Euphrates. It has as a rule—though the fact is not mentioned in the original description—one more whorl, *i.e.* five whorls instead of four.

In dorsal view the shell is very asymmetrical bilaterally. The spire is acuminate, conical, vertical, exserted but short, but not so short as that of other shells of the same group from Mesopotamia, being at least (in adult shells) $\frac{1}{5}$ as long as the body-whorl. Its whorls increase rapidly and evenly in size and the spiral between them is oblique, linear and somewhat impressed.

Each whorl is nearer the inner than the outer margin of the one that succeeds it. They are slightly swollen and slightly flattened above. The apex is small and rounded. The body-whorl is long but rather narrow and not very convex. Its upper surface is flattened and oblique but not angulate. The inner margin is Z-shaped, the upper half of the outline consisting of a somewhat flat curve. It then slopes in fairly abruptly and finally forms a broad projecting lobe, which corresponds with the inner anterior angle of the mouth. This lobe does not project so far sideways as the outline of the upper part of the whorl. The outer margin of the whorl forms an arc of wide diameter and less than a semicircle. The surface is not highly polished. It is ornamented with rather coarse and irregular longitudinal ridges, some of which may be called low costae, and striae. Minute spiral striae are also present. The first three whorls are, however, almost smooth.

In ventral view the shell is ovoid. The body-whorl is swollen above and transverse at its upper margin. It disappears behind the mouth some little distance above the anterior extremity of the latter. The shell is very narrowly rimate. The mouth is long and somewhat expanded, ovate, nearly vertical, sometimes narrowly rounded or truncate both above and below, sometimes pointed above and rounded below. The lip is thin and sharp and its curvature is often uneven but never highly convex. The callus is well developed above, joining the columellar border to the lip. The columella is long and twisted but not curved. The margin of the mouth is long, straight and vertical below the umbilicus. The columellar border is expanded and flattened over the umbilicus. The inner anterolateral border of the mouth is very slightly expanded and produced. The sculpture of the surface is not so well developed in this view as in the dorsal.

As seen from above, the spire increases gradually but often irregularly and the suture becomes gradually more impressed until it is practically canaliculate as it approaches the outer lip.

The radula has the dental formula 13.8.1.8.13. The central tooth though minute is distinctly bicuspid, having a small, sharp subsidiary cusp at the base of the main one, which is narrow and sharp. The laterals are tricuspid and their cusps are long, slender and sharply pointed. The lateral cusps are equal and a little smaller than the central one, but the inner cusp arises at a considerably lower level than the outer one. The marginals are very uniform in structure. Each has three (or occasionally four) subequal cusps arranged in a slanting line. The only difference between those of the inner and the outer rows is that in the later the cusps are blunter and a little less regular in shape.

The jaw is broad, dark and stout. The free margin of the upper part is broadly truncate and the internal surface is concave in the middle region.

The animal, as seen in a highly contracted state and preserved in spirit, offers no particular external diagnostic features. The mantle is pale with large dark spots.

The genitalia. On comparing the genitalia of this form with those of *L. gedrosiana*[1] we find that the hermaphrodite gland is much larger and more lobose. The hermaphrodite duct is much longer, more convoluted and more swollen in its distal portion. The situation of the prostate is similar but the gland itself is larger and the upper part of the male duct above the prostate much more swollen; the penis-sac is also more elongate. The uterus is swollen in the middle but pointed at the two ends. The spermatheca has a shorter duct than in *L. gedrosiana*, but nearly equal in length to the spermatheca itself.

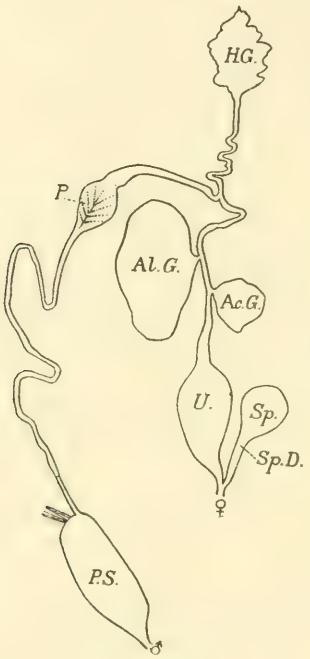


FIG. 1.—Genitalia of *Limnaea peregra canalifera*, Mousson.

Measurements (in millimetres) and Proportions of Shells.

Height	21	21	21	17	17
Maximum diameter ...	15	13	13	13	11
Height of mouth	16	17·5	15	14	12
Maximum diameter of mouth	8	8	7	7	5
Maximum diameter to height of shell	1 : 1·4	1 : 1·61	1 : 1·61	1 : 1·55	
Maximum diameter to height of mouth	1 : 2	1 : 2·17	1 : 2·14	1 : 2·4	
Height of mouth to that of shell	1 : 1·31	1 : 1·2	1 : 1·4	1 : 1.42	
Maximum diameter of mouth to that of shell	1 : 1·87	1 : 1·62	1 : 1·71	1 : 2·2	

[1] *Rec. Ind. Mus.* XVIII, p. 40, fig. 5B (1919).

The height of the shell is from $1\frac{2}{5}$ to $1\frac{3}{5}$ the maximum diameter; the height of the mouth at least twice its maximum diameter. The height of the shell is from $1\frac{1}{5}$ to $1\frac{2}{5}$ that of the mouth and the maximum diameter from $1\frac{3}{5}$ to $2\frac{1}{5}$ that of the mouth.

Capt. Boulenger obtained a number of living specimens in the Khandag Creek at Basra.

The specimen recently figured by one of us and assigned provisionally to *L. peregriformis*, Locard, is a young shell of this species. It differs considerably from older ones. Adult shells only differ from a series from the Rhineland in the Indian Museum, labelled *L. ovata* var. *inflata*, in having the upper surface of the body-whorl flatter and more depressed round the suture.

Limnaea cor, sp. nov.

(Pl. XIII, figs. 1, 2.)

The shell is moderately small (less than 15 mm. high), thin and fragile, diaphanous, tinged with rose-pink when fresh, conspicuously striate longitudinally, and remarkable for its short, erect acuminate spire, the base of which is deeply depressed, and its large, irregularly heart-shaped, transverse body-whorl, the maximum diameter of which is practically the same as the height.

In dorsal view the following particulars are apparent: The spire consists of three whorls and is not more than $\frac{1}{6}$ as high at the body-whorl. The apical whorl is minute and rounded, the second at least three times as deep and broad as the first, which is set upon it nearer the inner than the outer margin of the shell. It is somewhat convexly flattened above and its outer margin slopes gradually outwards and downwards, while its inner margin is vertical. The third whorl, which is at least five times as large as the second, possesses the same characters in a more developed manner. The suture of the spire is oblique, linear and depressed, but not very deeply. The body-whorl is bilaterally very asymmetrical and irregularly heart-shaped. Its upper surface is broadly flattened and decidedly angulate at its outer margin. The suture just above it is deep and broad. The inner margin is conspicuously Z-shaped. In its upper half it is very convex, representing an arc of nearly a semicircle. It then slopes gradually inwards for some distance, and finally projects outwards to form a semicircular lobe corresponding to the outer anterior extremity of the lip. Just above this lobe there is a broad, slanting longitudinal depression on the surface of the shell. The outer margin of the whorl possesses a fairly even convexity in an arc greater than a semicircle, but its middle region is often more or less flattened and straight. The upper and outer part of the whorl is tumid, but the surface slopes somewhat abruptly towards both the lip and the anterior extremity of the shell. The sculpture on this surface is conspicuous even to a good naked eye, but has a very delicate appearance. It consists, as seen under a powerful lens,

of numerous curved, flattened ridges or fine ribs separated by sharp-cut furrows and themselves composed of numerous sharp lesser ridges divided by striae. Transverse striae are ill-developed or obsolete. The polish of the surface is exceptionally bright.

In ventral view the spire appears nearly of the same size as in dorsal view and, except that the spiral is of course reversed, has much the same appearance. The body-whorl in this view is broad and transverse above, with its surface highly convex, but it disappears rapidly behind the mouth, which is of great relative length and nearly in the same axis as that of the shell. The mouth is more or less quadrate, narrowly truncate or subtruncate above and by no means broadly rounded at its anterior end, where the lip is hardly at all expanded or everted. Its upper extremity is situated a very short distance below that of the body-whorl The lip is sharp and convex in an arc greater than a semicircle. Its arc is, however, often a little flattened in the middle region and the extreme margin is occasionally introverted in this flattened part. The callus is well developed but not coarse above, connecting the columellar border with the lip. The columella is strongly arcuate. Its expanded border completely or almost completely closes the narrowly rimate umbilicus. Below the body-whorl the inner edge of the mouth is straight and vertical. The sculpture on this surface is not so delicate or regular as on the dorsal surface and the polish is less marked.

As seen from above the shell presents several characteristic features. Rapid and regular increase of the whorls is apparent and also the flattened upper surface of all the whorls but the apical one. It is also evident that the upper surface of the body-whorl is not only flattened towards its margin, but deeply hollowed outside the suture, especially in the region near the lip. The lip projects from the shell with an almost semicircular concavity in its margin and then slopes outwards gradually.

Measurements (in millimetres) and Proportions of Shells.

Height	12·0	11·0	10·5	8·25
Maximum diameter ...	9·5	8·5	9·5	5·5
Height of mouth ...	10·0	9·0	8·5	5·5
Maximum diameter of mouth	6·5	5·5	5·0	3·0
Maximum diameter to height of shell	1 : 1·26	1 : 1·29	1 : 1·1	1 : 1·5
Maximum diameter to height of mouth	1 : 1·45	1 : 1·54	1 : 1·7	1 : 1·83

The total height of the shell varies from almost equal to $1\frac{1}{4}$ times the maximum diameter. In young shells it may be as much as $1\frac{1}{2}$ times as great. The height of the mouth is about $1\frac{4}{5}$ times its maximum diameter and nearly $\frac{4}{5}$ the total height. Its maximum diameter is from about $\frac{1}{2}$ to about $\frac{2}{3}$ that of the shell. The proportions of the height of the spire and the body-whorl vary owing to the fact that the former is occasionally almost flat. *Type-series.* No. $\frac{11666}{2}$ M. *Z.S.I.* (*Ind. Mus.*).

The type-series consists of recent shells and was collected by Capt. C. L. Boulenger in a marsh five miles north of Samara on the lower Euphrates. Col. W. H. Lane also obtained many broken subfossil shells in a lake-deposit at Nasariyeh.

Limnaea cor bears a resemblance, perhaps quite superficial, to certain forms of *L. auricularia* and allied species or races, but the direction of the spiral, the form of the spire and body-whorl and especially the comparatively narrow, quadrate or subquadrate outline of the mouth are very different on actual comparison. It is probably an extreme form derived from *L. lagotis*. The young shell departs much less conspicuously from this type than the adult. It is unfortunate that we have no anatomical material.

Limnaea tenera race **euphratica**, Mousson.
(Pl. XIII, figs. 3–5.)

1874. *Limnaea euphratica*, Mousson, *Journ. de Conchyl.* XXI, p. 40.
1918. *Limnaea tenera*, Annandale, *Rec. Ind. Mus.* XVI, p. 165, pl. xx, fig. 3.

At first sight the shell looks like a connecting link between *L. peregra canalifera* and *L. cor*, but many differences from both appear on a close inspection. Both the adult and the young shell are more like those of *L. cor*.

The differences from *L. cor* to be noted in the dorsal aspect of the mature shell are the following. The spire is longer and more prominent and has its basal whorl less depressed and more swollen and its suture less transverse. The upper surface of the body-whorl is less broadly flattened and the suture above it less transverse. The outline of the shell is more graceful and still more asymmetrical. The upper part of the inner margin is less convex and the slope inwards more abrupt and the terminal lobe more prominent and narrower. The outer margin is practically semicircular. The sculpture of the surface is less regular and the composite longitudinal ribs less distinct and less curved.

In ventral view the part of the body-whorl visible is longer, narrower and less tumid. Its upper margin is more oblique and less flattened. The spire is considerably shorter than in the dorsal view. The upper extremity of the mouth is removed from that of the body-whorl by a distance nearly equal to the length of the spire as seen in this view. The outline of the mouth is regularly oval. The lip at its inner anterior extremity is distinctly expanded and flattened. The callus is poorly developed above the columella, which is straighter.

As seen from above, the most noteworthy differences between the shells are, apart from those already noted in the dorsal and ventral views, (1) that the surface of the body-whorl is much less concave and that its concavity near the lip has a less confined character; (2) that the lip on leaving the shell has at first a comparatively narrow concavity and then proceeds outwards and backwards abruptly with a slight arc.

The specimens we have examined are also colourless and opaque and seem to be thicker than those of *L. cor*, but they are perhaps not so fresh.

Measurements (in millimetres) and Proportions of Shells.

Height	13	10·5	11	10·5	7·5
Maximum diameter ...	8	9·5	7	7·0	5·25
Height of mouth ...	11	8·0	7·5	7·5	6·0
Maximum diameter of mouth	5·25	4·5	4·5	3·25	3·0
Maximum diameter to height of shell ...	1 : 1·5	1 : 1·1	1 : 1·57	1 : 1·5	1 : 1·33
Maximum diameter to height of mouth ...	1 : 2·09	1 : 1·77	1 : 1·37	1 : 2·3	1 : 2

These measurements, few as they are, illustrate the variable character of the race. We do not, however, find it possible to draw any line between the *forma typica* and Mousson's var. *angustior*, as narrowness of the shell and flattening of the arc of the lip are by no means always correlated and shells with the arc of the lip flattened are mixed indiscriminately with those in which it is convex. The mouth, however, is as a rule narrower and more elongate than in the typical *L. tenera*, Küster, and the shell seems to be more variable, some individuals departing from the *forma typica* more than others. (Küster, however, only figures one shell). For these reasons we think it best to recognize the Mesopotamian race as distinct, though not specifically. Fully adult shells are perhaps more different than young ones. The differences between the extreme types of the typical form of the race and its phase *angustior* and those between phases A and B of *L. bactriana* are very much the same, but intermediate individuals are much more numerous.

L. tenera euphratica is common along the banks of the lower Euphrates in both recent and subfossil deposits. Capt. Boulenger obtained a series of rather small shells in a marsh 5 miles north of Samara.

Limnaea hordeum, Mousson.

(Pl. XIV, figs. 4, 5.)

1874. *Limnaea hordeum*, Mousson, *Journ. de Conchyl.* XXII, p. 42.
1919. *Limnaea hordeum*, Annandale & Prashad, *Rec. Ind. Mus.* XVIII, p. 57, pl. vii. fig. 5.

We have found in the collection of the Indian Museum a shell (identified by Mr. H. B. Preston as *Succinea bensoni*, var.) which we believe to represent the adult of this species. It was associated with a young shell of *L. gedrosiana* under the same name and came from the banks of the Gaud-i-Zirreh in the Afghan desert, where it was collected by Sir Henry McMahon some years ago. This shell agrees better in dimensions with Mousson's type than those we have hitherto examined but is slightly larger. It differs from young shells in having the body-whorl proportionately smaller and the mouth larger and broader and the lip thinner—differences that

might be expected in an adult shell. The measurements are as follows:—Height 7 mm., maximum diameter 3·5 mm., height of mouth 4·7 mm., maximum diameter of mouth 2·2 mm.

The species is only known in what may be a subfossil state. It has been found on the banks of the lower Euphrates at two places, in Seistan, and in the Afghan desert to the south-east of that district. The Gaud-i-Zirreh is a great basin of strongly saline marshland into which the Helmand river at one time drained. See p. 4 and plate 1 of this volume.

The adult shell is still more like that of *L. truncatula* than the young, but the same differences persist in a sufficiently strong degree for specific separation. The Mesopotamian specimens we have examined are all young.

EXPLANATION OF PLATE XIII.

Limnaea cor, sp. nov.

FIG. 1.—Type-specimen from marsh near Samara, Mesopotamia. Actual height 12 mm.

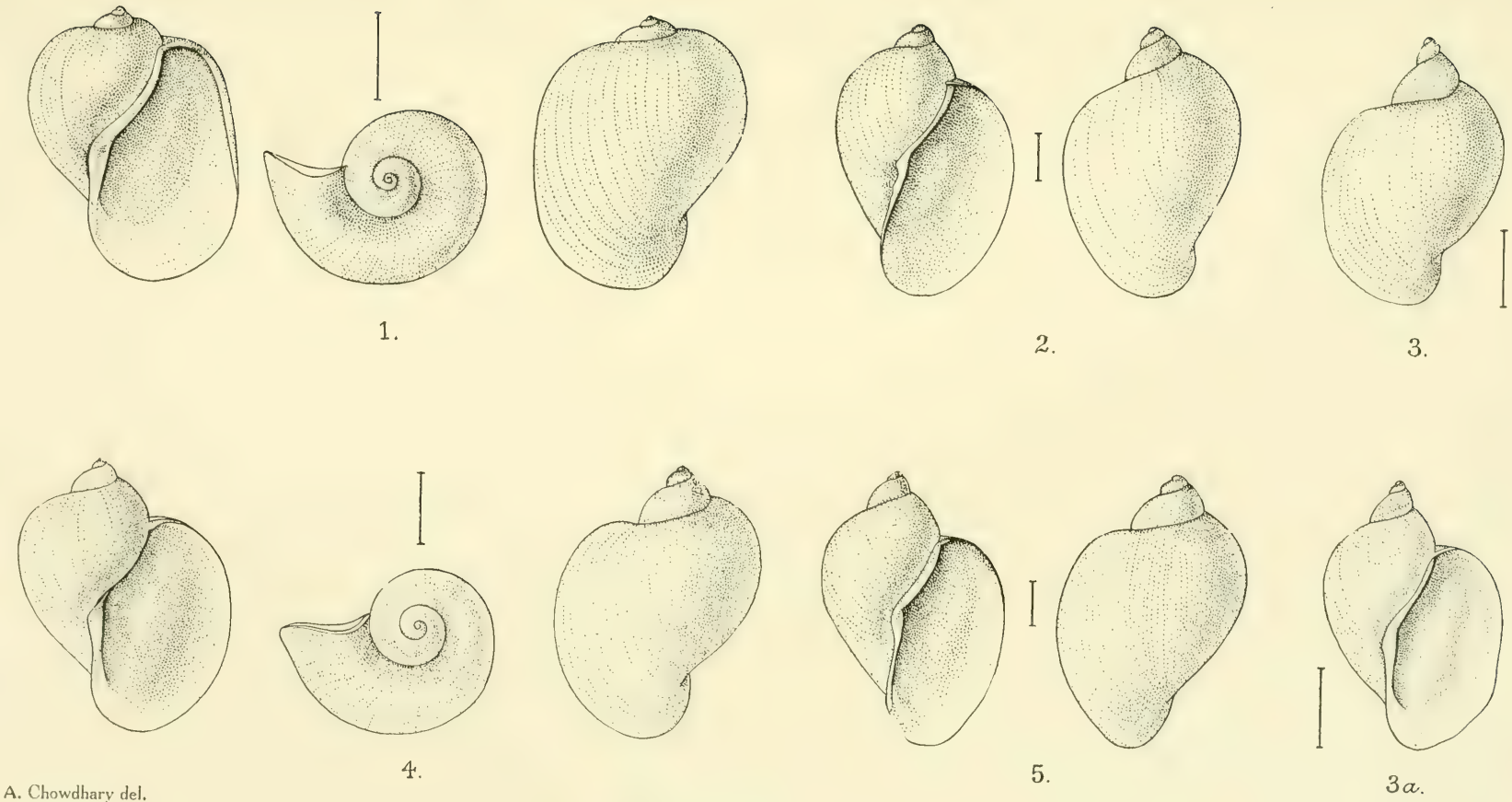
,, 2.—Young shell from the same locality. Actual height 6 mm.

Limnaea tenera euphratica, Mousson.

FIG. 3, 3*a*.—Shell of the phase *angustior*, Mousson, from a marsh near Samara. Actual height 10·5 mm.

,, 4.—Shell of the *forma typica* of the race from the same locality. Actual height 10·5 mm.

,, 5.—Young shell from the same locality. Actual height 6·5 mm.



A. Chowdhary del.

LIMNAEIDAE OF MESOPOTAMIA.

EXPLANATION OF PLATE XIV.

Limnaea peregra canalifera, Mousson.

FIG. 1.—Shell from Khandag Creek near Basra. Actual height 22 mm.

,, 2.—Young shell from the same locality. Actual height 7·5 mm.

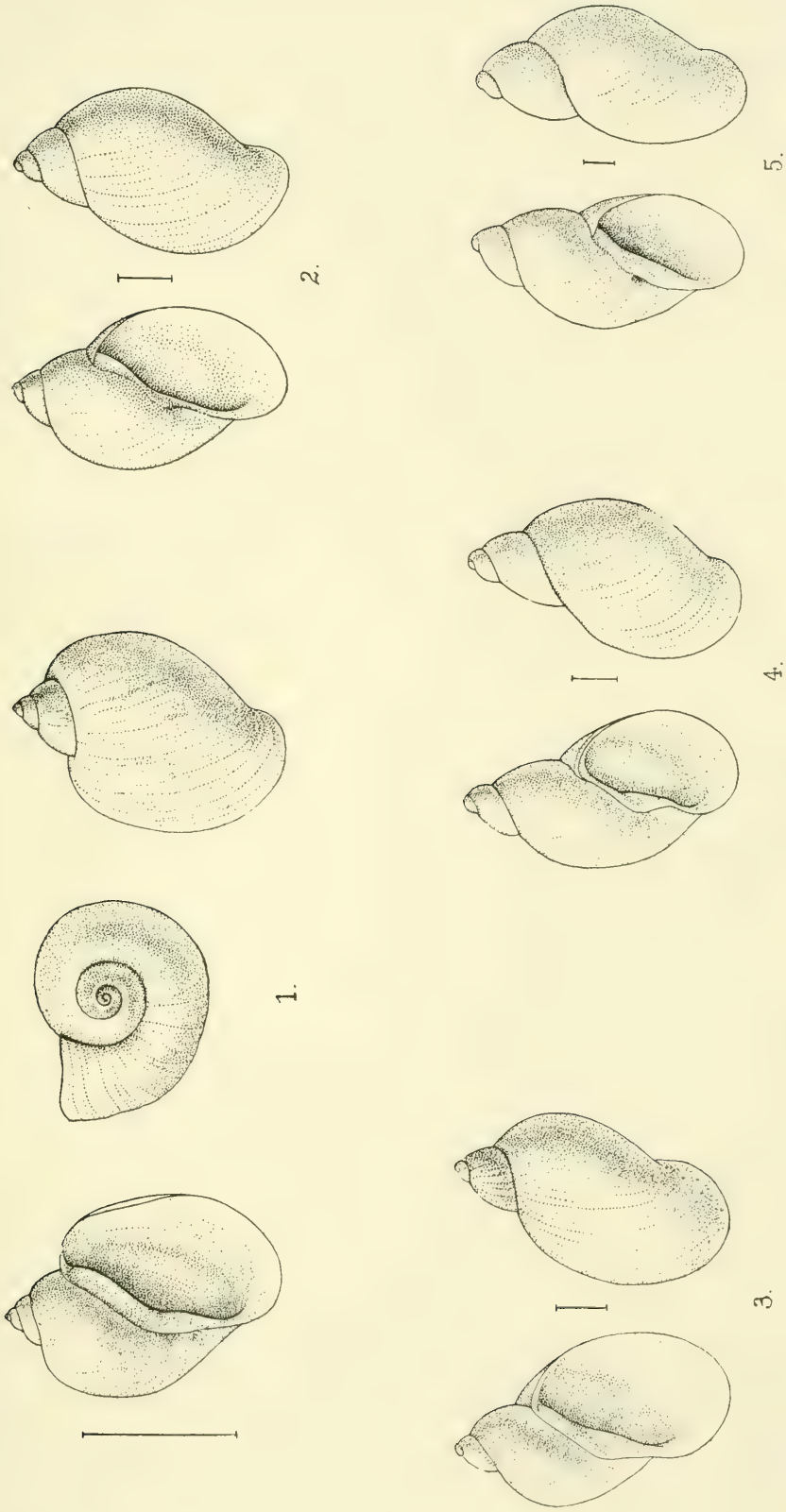
Limnaea bactriana, Hutton.

FIG. 3.—Shell from Khandag Creek near Basra. Actual height 8 mm.

Limnaea hordeum, Mousson.

FIG. 4.—Adult shell (? subfossil) from the Gaud-i-Zirreh in the Afghan Baluch desert. Actual height 7 mm.

,, 5.—Young shell (? subfossil) from the banks of the Euphrates at Nasariyeh, Mesopotamia. Actual height 4·5 mm.



LIMNAEIDAE OF MESOPOTAMIA.

A. Chowdhary del.

ON A NEW GENUS AND SPECIES OF COCCIDAE FROM NORTH-WESTERN INDIA AND EASTERN PERSIA.

By E. Ernest Green, *F.E.S.*, *F.Z.S.*

(With Plates XXI—XXII.)

Genus **Naiacoccus**, nov.

Characters as in *Erium* (of the subfamily Pseudococcinae): but with an enormously elongated ovisac, within the anterior extremity of which the adult insect lies concealed. Type *serpentinus*, Green.

Naiacoccus serpentinus, sp. nov.

Adult female occupying the extremity of a long, white, tubular ovisac which may form either a simple loop or be twisted into an irregular coil (see fig. 1). When uncoiled and extended the ovisac may attain a length of approximately one and three-quarter inches, the average length being well over one inch.

Adult female, removed from the ovisac, dull slaty grey or purplish brown: broadly ovoid when viewed from above (fig. 2*b*): irregularly tumescent when viewed from the side (fig. 2*a*): the dorsal area of the abdomen contracted and transversely wrinkled, the posterior segments assuming a dorsal position. Antennae small, 7- to 9-jointed (see fig. 3), the proportionate lengths of the several joints varying considerably. The normal number is apparently 8 (fig. 3*b*, *c*, *d*), the larger number (fig. 3*a*) being exceptional and produced by a fracture of the normal 4th joint, while the smaller number has presumably resulted from the fusion of two joints (fig. 3*f*). In some instances the division between the 7th and 8th is incomplete (see fig. 3*e*). Apex of terminal joint truncate or obtuse, with 5 or 6 stout hairs: each of the remaining joints usually with 1 or 2 small hairs on one side. Limbs small but comparatively stout (fig. 4): the tibia and tarsus together markedly shorter than the femur and trochanter; coxa unusually large, especially in some examples (see fig. 4*b*); digitules simple. Anal ring (fig. 5) with 6 stout setae: some smaller setae immediately above and below the anal aperture. Anal lobes inconspicuous, represented by two small rounded prominences on the dorsum—one on each side of, and slightly below the anal aperture (see fig. 2*b*). Spines of the form shown at fig. 5*b* occur in transverse series across the dorsum of the abdominal segments—sparsely on the basal but more numerously on the

posterior segments. Similar spines are clustered on the small anal lobes and on a corresponding tract on the preceding segment. Intermingled with the spines are many minute, obscurely trilocular pores, which occur (rather more abundantly) on the venter also. There are some larger circular pores near the posterior extremity of the venter. Length (under compression) 2·5 to 4 mm. Breadth 2 to 3 mm.

The early adult insect (before the production of the ovisac) is enclosed in a more compact, felted covering, of a grayish ochreous colour, which may be observed—even in older examples—as a pointed cap at the anterior extremity of the ovisac. The freshly deposited eggs are of a pale yellow colour, but become reddish before hatching. The number of ova produced by a single female probably amounts to several thousands.

On a large arboreal Tamarisk (*Tamarix articulata*). Lahore. Collected by Dr. N. Annandale in May. "*T. articulata* is one of the chief shade-trees in Lahore. Mr. Sundar Lal Hora, M.Sc., Research Assistant, Z.S.I., found the Coccid upon it in abundance in October, but I have failed to do so on several occasions in January. *N. A.*"

The extraordinary masses of tangled ovisacs must be very conspicuous objects on the trees, but might easily be mistaken for collections of bird droppings, such as may often be seen on branches beneath the roosting places of flocks of sparrows. The insects excrete a considerable amount of viscid fluid which soon assumes a brownish colour.

Lt.-Col. Stephenson (of the Government College, Lahore), to whom I am indebted for some excellent photographs of the insect and for fresh living material, informs me that—in nature—the long ovisac is always attached at each end, forming a simple loop. The subsequent tangled condition may be the result of wind.

Naiacoccus serpentinus var. **minor**, nov.

Distinguishable from the type by its smaller size and by the greater number of dorsal spines and dermal pores (fig. 6*f*). The circular pores of the venter are particularly conspicuous and are densely crowded on the posterior segments (see fig. 6*g*). The average size of the insect ranges from 1·5 to 3 mm.; but little difference can be observed in the length of the ovisacs which have precisely the same appearance as those of typical *serpentinus*. The antennae (figs. 6*a-d*) are shorter, the number of joints varying from 5 to 7, being usually reduced by complete or partial fusion. In some examples only 5 complete joints can be distinguished; but the 6-jointed from (fig. 6*b*, *c*) is the most frequent.

On *Tamarix stricta*. Collected by Dr. N. Annandale in two localities several hundred miles apart, viz.:—

No. 8740, "In desert north of Nasratabad in Seistan, Eastern Persia; November. The roots and stems of *T. stricta*, which

rarely grows larger than a small bush, are the chief source of firewood in Seistan."

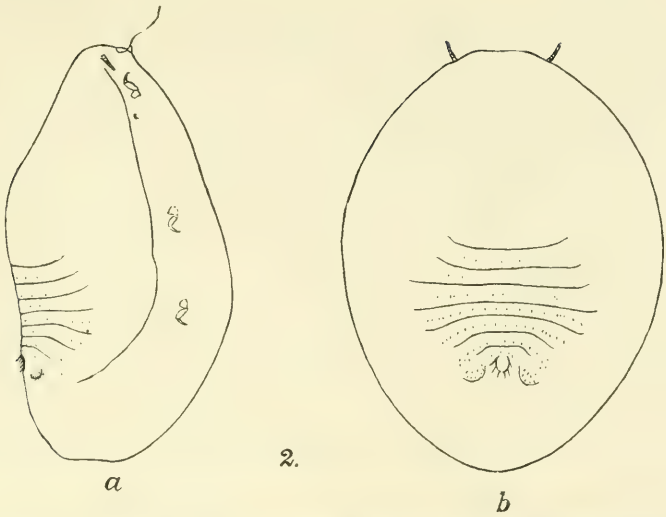
No. 8745, "From Kushdil Khan, in the Pishin District north of Quetta, Baluchistan; December."

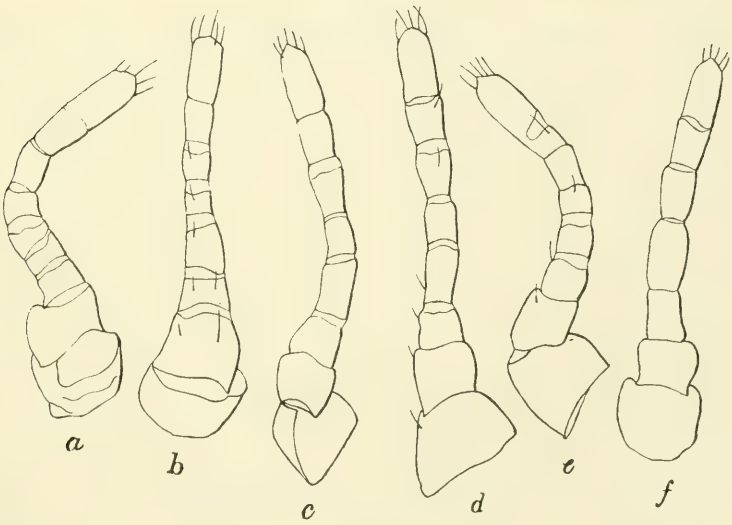
EXPLANATION OF PLATE XXI.

FIG. 1.—*Naiacoccus serpentinus.* Collection of ovisacs, on branch of *Tamarix articulata*; × about $\frac{3}{4}$. (From photograph by Lt-Col. Stephenson.)

,, 2.—*Naiacoccus serpentinus.* (*a*) Diagrammatic view from side of adult female; (*b*) dorsal view; × 15.

,, 3.—*Naiacoccus serpentinus.* (*a-f*) Different forms of antennae of adult female; × 220.





3.

COCCIDAE FROM N. W. INDIA & PERSIA.

EXPLANATION OF PLATE XXII.

FIG. 4.—*Naiacoccus serpentinus.* (*a-c*) Various forms of mid leg of adult female; × 220.

,, 5.—*Naiacoccus serpentinus.* (*a*) Anal ring of adult female and surrounding parts; × 130. (*b*) Spines and pores from dorsum; × 450.

,, 6.—*Naiacoccus serpentinus.* var. *minor.* (*a-d*) Different forms of antennae of adult female; × 220. (*e*) Mid leg of adult female; × 220. (*f*) Dorsal spines and pores; × 450. (*g*) Circular pores, from venter of abdomen; × 450.

COCCIDAE FROM N. W. INDIA & PERSIA.

NOTES ON TWO COLLECTIONS OF BIRDS FROM SEISTAN.

By E. C. Stuart Baker, *F.L.S., F.Z.S., M.B.O.U., C.F.A.O.U.*

In the years 1903-05 a small collection of birds numbering 106 specimens was made by Mr. J. W. N. Cumming and other members of the Seistan Arbitration Commission and has been described by him in *Journ. Bombay Nat. Hist. Soc.* XVI, pp. 686-699 (1905). Another, consisting of only 31 specimens, was obtained by Dr. N. Annandale and Mr. S. W. Kemp on their recent visit to Seistan. Both these collections belong to the Indian Museum. As it was throughout advisable that the specimens should be named after comparison with the magnificent material available in the British Museum, especially with that in the Hume collection, the Director of the Zoological Survey of India kindly sent me the birds to work out

The results show that the collection of 137 specimens contain examples of 79 species all of which belong to the Indian avifauna with the exception of *Sylvia mystacea* and *Passer moabiticus yatii.*

The geographical affinities are Indo-Palaearctic, the races of resident birds nearly all belonging to the Palaearctic rather than to the Indian forms; for instance *Corvus cornix sharpii*, *Corvus frugilegus tschusii*, *Coracias garrula semenowi*, *Falco aesalon insignis.* On the other hand a few sub-species, apparently resident, are typically tropical Indian, such as *Gallinula chleropus parvifrons.*

As many recent alterations in names have been made since Blanford's time, owing to discoveries by ornithologists of earlier names having priority, etc., it has been thought advisable to add in brackets the number of the bird according to Oates and Blanford's Avifauna. This will it is hoped facilitate recognition by those field workers who might otherwise be puzzled.

The field-notes in brackets over the initials *N. A.* have been added by Dr. Annandale.

[The birds of Seistan, as might be expected from the peculiar conformation of the country, are, with few noteworthy exceptions, either water-birds or desert-birds. As our work in Seistan was chiefly connected with water and occupied only a few weeks in the middle of winter, such observations as we made on bird-life were necessarily meagre and concerned only the birds of the Hamun-i-Helmand, for a brief account of which the Geographical Introduction to this volume may be consulted. Thirty-four of the seventy-nine races and species enumerated by Mr. Baker may be classed as water-birds. What struck us most in a general way about these birds was their enormous numbers and the apparent paucity of food for them. Nevertheless, both ducks and the wading-birds

were exceptionally fat. We watched large flocks of the Black-tailed Godwit and other species continually grubbing in the mud where we ourselves found no living thing. An examination of their stomach-contents proved that they were feeding on the seeds of water-plants, which were doubtless lying ready to sprout when the flood-season began.

Water-birds, especially the Coot and the Gray Lag Goose (of which no specimens were preserved) play an important part in the economy of the Saiyad or Hunters, a peculiar almost outcaste tribe, who live on the shores of the Hamun in primitive reed-huts and navigate its reed-beds in skiff-like rafts (*tutin*) of bulrush leaves.

In winter the most abundant and conspicuous birds in Seistan peculiar neither to the desert nor to the lake is the Rook. Enormous flocks, so large that we frequently mistook them for clouds in the distance, fly about the country at this season and settle on the ground in open spaces, often among tamarisk bushes round small pools in the desert. What they get to eat is a mystery. We were told that these flocks arrived about October and were popularly believed to eat up the "Hamun fly," a blood-sucking fly (? *Tabanus* or *Haematopota*) that spreads surra among camels and horses. It is quite possible that the birds do devour these insects, but it is also probable that their arrival coincides with the close of the flies' season of aerial life. *N.A.*]

1. **Corvus cornix sharpii** Oates. (6).

1905. *Corvus cornix*, Cumming, *op. cit.*, p. 686.

○. No. 24685; Rudbar, R. Helmand, Feb. 03.
♀. ,, 25492; Lab-i-Baring, *ca.* 1600 ft., 15.12.18.

2. **Corvus frugilegus tschusii** Hartert. (5).

1905. *Corvus frugilegus*, Cumming, *op. cit.*, p. 686.

♀. No. 24707; Nad-i-Ali on the Helmand, 13.3.05.
♀. ,, 24881; Kuhak, 20.3.05.
♂. ,, 25469; Lab-i-Baring, *ca.* 1600 ft., 15.12.18.
♂. ,, 25470; ,, ,, 15 12.18.

Of these Rooks the first two specimens have nearly completed their facial moult but still have all the nareal bristles present; No. 3 has the face quite bare whilst the fourth is a young bird with the face fully feathered. [See notes at end of introduction. *N.A.*]

3. **Argya caudata huttoni** (Blyth). (105).

1905. *Argya caudata*, Cumming, *op. cit.*, p. 686.

♂. No. 24880; Kuhak, 26.4.05.

This is a typical *huttoni* in appearance but is a very small bird with a wing of only 83 mm. The striae on the breast are almost obsolete.

4. **Tichodroma muraria** (Linn.). (348).

1905. *Tichodroma muraria*, Cumming, *op. cit.*, p. 686.

♀. No. 24877; Peshawaran, 20.12.06.

5. **Sylvia mystacea** (Ménétr.).

1905. *Sylvia jerdoni*, Cumming, *op. cit.*, p. 687.

♂. No. 24883; Kuhak, 21.3.05.

6. **Agrobates galactodes familiaris** (Ménétr.). (359)

1905. *Aedon familiaris*, Cumming, *op. cit.*, p. 686.

♀. No. 24875; Kuhak, 22.4.05.

7. **Prinia gracilis lepida**, Blyth. (462).

1905. *Prinia lepida*, Cumming, *op. cit.*, p. 687.

♂. No. 24879; Kuhak, 2.10.04.

8. **Lanius cristatus isabellinus**, Ehrenb. (479).

1905. *Lanius phoenicuroides*, Cumming (in part), *op. cit.*, p. 687.

♀. No. 24709; Kaod on the Asinki Canal, 28.3.03.

9. **Lanius cristatus phoenicuroides** (Hemp. and Ehrenb.). (480).

1905. *Lanius phoenicuroides*, Cumming (in part), *op. cit.*, p. 687.

♂. No. 24878, Kuhak, 22.4.05.

The former of these shrikes is presumably only a migrant but the latter is resident and breeds, for General R. Betham took many of its eggs and nests when stationed at Quetta.

10. **Sturnus vulgaris poltaratskii**, Finsch. (532).

1905. *Sturnus menzbieri*, Cumming (in part), *op. cit.* p. 687.

o. No. 24686; Hamun, Seistan, Jan. 04.

o. ,, 25489; Lab-i-Baring, *ca.* 1600 *ft.*, 12.12.18.

11. **Sturnus vulgaris nobilior**, Hume. (533).

1905. *Sturnus menzbieri*, Cumming (in part), *op. cit.*, p. 687.

♂. No. 25472; Lab-i-Baring, *ca.* 1600 ft., 11.12.18.

Hartert has recently written a long article on the races of *Sturnus vulgaris* (*Novitates Zoologicae* XXV, p. 327) but gives no key and in some cases does not even say how they can be discriminated. The deep colour of No. 25472, its almost black white-edged under wing-coverts and deep red wings satisfy me that this specimen must be referred to Hume's *nobilior*. The other two birds are certainly both *poltaratskii* with which *menzbieri* is now generally placed as a synonym.

[Both No. 25472 and No. 25489 were shot at the edge of the Hamun near Lab-i-Baring in December. Small flocks of starlings are not uncommon in the fields at this season, at which ploughing is just commencing in Seistan. *N. A.*]

12. **Oenanthe deserti atrogularis** (Blyth). (626).

1905. *Saxicola deserti*, Cumming, *op. cit.*, p. 688.

♂. No. 24712; Khwaja Ahmed, 3.4.03.
♂. ,, 24868; Khwaja Ahmed, Jan. 05.
O. ,, 25481; Lab-i-Baring, 7.12.18.
♂. ,, 25485; Lab-i-Baring, 8.12.18.

13. **Oenanthe alboniger** (Hume). (617).

1905. *Saxicola albinigra*, Cumming, *op. cit.*, p. 687.

♂. No. 24710; Kaod on the Asinki Canal, no date.
♀. ,, 25476; Lab-i-Baring, 7.12.18.

[Very common with the last in the Seistan desert in December. *N. A.*]

14. **Oenanthe picata** (Blyth). (618).

1905. *Saxicola capistrata*, Cumming, *op. cit.*, p. 687.

♂. No. 24711; Kaod on the Asinki Canal, 26.3.03.

This specimen belongs to the white-headed form which has generally been separated as *Oenanthe capistrata*.

15. **Oenanthe isabellina** (Cretzschem). (625).

1905. *Saxicola isabellina*, Cumming, *op. cit.*, p. 688.

♀. No. 24866; Kuhak, 31.3.04.
♂. ,, 24867; Kuhak, 3.4.04.

16. **Phoenicurus erythronotus** (Eversm.). (642).

O. No. 25480; In garden at Nasratabad, 18.12.18.

This bird although not sexed is obviously an adult female; the wing is rather small, only 72 mm.

17. **Monticola solitaria pandoo** (Sykes). (693).

♂. No. 24713; Khwaja Ahmed, 7.4.03.

This specimen is marked "male" but is undoubtedly an old female.

18. **Passer montanus dilutus**, Rechm. (779).

1905. *Passer montanus*, Cumming, *op. cit.*, p. 688.

♂. No. 24869; Kuhak, 20.4.05.

19. **Passer moabiticus yatii**, Sharpe.

♀. No. 24714; Nad-i-Ali on the Helmand, 13.3.03.

This specimen is not in adult plumage and has very little yellow on the lower plumage but is almost certainly of this race of the Palestine Sparrow.

20. **Motacilla alba personata**, Gould. (829).

1905. *Motacilla personata*, Cumming, *op. cit.*, p. 688.

O. No. 24870; Kuhak, 28.4.05.
♂. ,, 25477; Lab-i-Baring, 13.12.18.
♂. ,, 25482; ,, 13.12.18.

Of the three specimens the first is in full summer plumage, the two others in winter plumage. [Very common in the desert, and at the edge of the Hamun in December. *N. A.*]

21. **Alaemon alaudipes pallida** (Blyth). (854).

1905. *Alaemon desertorum*, Cumming, *op. cit.*, p. 688.

♂. No. 24871; Kuhak, 21.9.04.

Though marked "male" this is probably a female and even for that sex is an unusually small one, wing 126, bill from front 25 mm. This is considerably below normal measurements which are (vide Hartert) ♂, wing 138-141 mm., ♀, 128-130 mm. Larger series of *pallida*, Blyth and *desertorum* (Stone) might possibly prove that they are divisible but at present most ornithologists lump them together.

22. **Galerida cristata? magna**, Hume. (874).

1905. *Galerita cristata*, Cumming, *op. cit.*, p. 689.

♂. No. 24874; Kuhak, 20.4.05.
O. ,, 25478; Lab-i-Baring, 13.12.18.

These birds are very small both having a wing of 106 mm., whilst Hartert gives the minimum for this sub-species as 110 mm; on the other hand he gives the maximum for *chendoola*, the common Indian form, as 105 mm. As a matter of fact throughout the intervening country between the Northern and Southern areas the birds are intermediate both in size and general appearance.

23. **Ammomanes deserti iranica** (Hartert). (878).

1905. *Ammomanes phoenicuroides*, Cumming, *op. cit.*, p. 689

♂. No. 24873; Khwaja Ahmed, 24. 4. 05.

Quite a typical specimen.

24. **Ammomanes phoenicura zarudnyi**, Hartert.

O. No. 25484; Lab-i-Baring, 14.12.18.

I have compared this specimen with others in the Tring Museum as I was rather doubtful of some of those in the British Museum where the forms of *phoenicura* have not yet been thoroughly worked out.

25. **Coracias garrula semenowi**, Loudon and Tschusi (1024).

1905. *Corracias garrula*, Cumming, *op. cit.*, p. 689.

O. No. 24684; Khwaja Ahmed, May 1903.
♂. ,, 24861; ,, 24.4.05.

26. **Merops persicus persicus**, Pall. (1028).

1905. *Merops persicus*, Cumming, *op. cit.*, p. 689.

♂. No. 24862; Kuhak, 22.4.05.

27. **Caprimulgus mahrattensis**, Sykes. (1089).

1905. *Caprimulgus mahrattensis*, Cumming, *op. cit.*, p. 690.

♀. No. 24688; Helmand, no date.
♀. ,, 24689; ,, ,,

28. **Bubo bubo bengalensis** (Frank.). (1168).

1905. *Bubo bengalensis*, Cumming, *op. cit.*, p. 690.

♀. Juv. No. 24864; Shaharistan, 6.5.05.

This appears to be *bengalensis*, which has already been obtained in Afghanistan. The wings measure respectively, right, 380 and left, 370 mm., whereas *turcomanus* (Eversm.) has a wing varying between 425 and 500 mm. From the date on which killed, and also from its juvenile appearance, it is evidently a bird locally bred and it raises an interesting doubt as to the specific or sub-specific value of some of the differences hitherto held to be sub-specific only between some of the nearest allies of *Bubo bubo*. We cannot have two geographical races breeding in the same area and if *turcomanus* and *bengalensis* do breed in the same, then they are good species and not sub-species only.

29. **Athene noctua bactriana**, Blyth. (1180).

1905. *Athene bactriana*, Cumming, *op. cit.*, p. 691.

♂. No. 24863; Kuhak, 21.10.04.

30. **Buteo ferox** (Gmel.). (1239).

O. No. 24722; "Caught in Seistan," Feb. 1904.

An adult but beautifully pale bird in very fine plumage, apparently a male.

31. **Circus macrurus** (Gmel.). (1233).

o. No. 24716; Band-i-Seistan, Feb. 03.
o. ,, 24865; Shaharistan, no date.

Although these specimens have not been sexed the first is certainly a ♂ and the second almost equally certainly an adult female.

32. **Circus aeruginosus** (Linn.). (1237).

o. No. 24717; Takht-i-Shah, March 04.
o. ,, 24719; Nadali, March 03.
o. ,, 24720; ? no date.
♀. ,, 25494; Lab-i-Baring, 10.12.18.

[The commonest bird of prey over the reed-beds of the Hamun. We saw one capture a small water-vole or shrew among the reeds. *N. A.*]

33. **Falco aesalon insignis** (Clark). (1263).

o. No. 24724; Takht-i-Shah, March 04.

The wing measures 190 mm.

34. **Tinnunculus tinnunculus saturatus**, Blyth. (1265).

o. No. 24726; ? no date.

The wing of this specimen measures 236 mm.

35. **Columba livia intermedia**, Strick. (1292).

1905. *Columba intermedia*, Cumming, *op. cit.*, p. 691.

♀. No. 24850; Kuhak, 22.4.05.
o. ,, 25463; Lab-i-Baring, no sex; December.

Both these specimens are very typical *livia intermedia* with the lower back quite grey, not white. These geographical races of *Columba livia* are generally very inconstant, partly due, no doubt, to crosses with domesticated birds but also due to the very wide range of individual variation which occurs. Major C. R. S. Pitman informs me that even well North in Mesopotamia he found birds breeding together some of which were the true white rumped *livia*, whilst others were as dark as the darkest Indian *intermedia*.

36. **Columba eversmanni**, Bonap. (1295).

1905. *Columba eversmanni*, Cumming, *op. cit.*, p. 691.

♀. No. 24851; ? 28.4.05.

This is a resident Pigeon in Afghanistan and Persia.

37. **Streptopelia turtur decaorta**, Friv. (1310).

1905. *Turtur risorius*, Cumming, *op. cit.*, p. 691.

♂. No. 24858; Khwaja Ahmed, 7.5.05.

38. **Pterocles arenarius caudacuta,** Pall. (1316).

1905. *Pterocles arenarius,* Cumming, *op. cit.,* p. 691.

o. No. 25488; in desert S. of Lutak, 21.12.18.

This specimen is not sexed but is a female adult.

39. **Francolinus francolinus henricii,** Bonap. (1372).

1905. *Francolinus vulgaris,* Cumming, *op. cit.,* p. 692.

♀. Juv. No. 24847; Kuhak, Augt. 04.

Hartert in 1917 reviewed the races of *Francolinus francolinus* in *Novitates Zoologicae* and there points out that the small pale bird from Sind to Afghanistan must bear Bonapartes' name *henricii.* The present specimen is very typical, a small, decidedly pale bird.

40. **Coturnix coturnix** (Linn.). (1355).

1905. *Coturnix communis,* Cumming, *op. cit.,* p. 692.

♀. No. 24848; Kuhak, 22.9.04.

41. **Zaponia parva parva,** Bechst. (1392).

1905. *Porzana parva,* Cumming, *op. cit.,* p. 693.

♀. No. 24859; Kuhak, 6.9.04.

The wings are very imperfect, one moulting, and from the other several quills missing. They measure approximately 81 mm. In spite of its comparatively small size I have no doubt that it can be correctly assigned to this race. The colour generally is decidedly light and the bill is longer than in any specimen of *pusilla* in the British Museum Collection.

42. **Porzana porzana** (Lin.). (1394).

No. 24696; ? no date or sex.

43. **Gallinula chloropus parvifrons** (Blyth). (1402).

No. 24727; Band-i-Seistan, no date or sex.

This specimen is somewhat intermediate between typical *chloropus* of Europe and *parvifrons* of India, but is on the whole nearer the latter and should come under that name.

44. **Fulica atra atra,** Linn. (1405).

1905. *Fulica atra,* Cumming, *op. cit.,* p. 693.

♀. No. 25468; Lab-i-Baring, 9.12.18.
♂. ,, 25471; ,, 9.12.18.

These two specimens, both fully adult, were obtained at Lab-i-Baring, Seistan, E. Persia, at an elevation of some 1600 feet. I cannot separate these in any way from typical *atra.*

[Coot live in enormous flocks among the reed-beds of the Hamun. Large numbers are caught for food in nets stretched across channels in the reed-beds into which the flocks are driven by men on *tutin* or rafts. The nets are stretched on sticks stuck into the mud, their lower edge being in the water and their upper edge about 2 feet above the surface. *N. A.*]

45. **Cursorius gallicus** (Gmelin). (1423).

1905. *Cursorius gallicus*, Cumming, *op. cit.*, p. 694.

No. 24681; Khwaja Ahmed, April 1903, not sexed.
,, 24682; ,, ,, 1903, ,,
,, 24683; Nadali, Helmand, March 1903, ,,

46. **Chettusia leucura** (Licht.). (1438).

1905. *Chettusia leucura*, Cumming, *op. cit.*, p. 694.

♀. No. 24677; ? no date.
♀. ,, 24678; Shahgul on Rud-i-Pariun, 23.3.1903.
♀. ,, 24679; Nadali, Helmand, March 03.
♂. ,, 24849; Nasratabad, 6.5.05.

The White-tailed Plover is an exceedingly common bird in suitable parts of Persia and has been found breeding in great numbers during the Mesopotamian campaign, the nests being placed, as a rule, in small patches of raised land in the marshes. The eggs number three or four, most often the latter.

47. **Aegialitis dubia jerdoni**, Legge. (1447).

1905. *Aegialitis dubia*, Cumming, *op. cit.*, p. 694.

♂. No. 24854; Kuhak, 1.4.04.
♀. ,, 24855; ,, 9.5.05.

These specimens, which are both in full breeding plumage, belong, as we should expect in birds obviously breeding, to the Indian race of Little Ringed Plover. The wings measure about 110 mm., the yellow base to the bill is very distinct, especially in one bird, and the black on the forehead is very narrow. (See Hartert and Jackson, *Ibis* 1915, pp. 531-3.)

48. **Himantopus himantopus** (Linn.). (1451).

1905. *Himantopus candidus*, Cumming, *op. cit.*, p. 694.

♀. No. 24836; Kuhak, 3.9.04.
♀. ,, 24837; Khwaja Ahmed, 24.4.05.
♂. ,, 24838; Kuhak, 3.3.04.

Of the two females only the second is fully adult.

49. **Limosa limosa** (Linn.). (1456).

1905. *Limosa belgica*, Cumming, *op. cit.*, p. 695.

♂. No. 24852; Nasratabad, 6.5.05.
♂. ,, 25491; Lab-i-Baring, 12.12.18.
♂. ,, 25493; ,, 12.12.18.

The specimen killed in May is in an interesting stage of plumage, the breast being partly red and the plumage above also in rather more than half summer plumage. The two birds killed in winter are, of course, in winter plumage.

[Feeding in large flocks at the edge of the Hamun in December. *N. A.*]

50. **Totanus glareola** (Linn.). (1461).

1905. *Totanus glareola*, Cumming, *op. cit.*, p. 695.

o. No. 24730; ? no sex or date.
♀. ,, 24856; Khwaja Ahmed, 5.5.05.
♀. ,, 24857; Nasratabad, 7.5.05.

51. **Totanus totanus eurhinus**, Oberholser. (1455).

o. No. 24731; Seistan, Jan. 04, no sex.
o. ,, 24732; ,, 7.1.04. ,,
o. ,, 24733; ,, no date or sex.

The Eastern form breeding from the Himalayas to Eastern Siberia has been separated as a geographical race under the name of *eurhinus* by Oberholser (*Proc. U. S. Nat. Mus.* XXII, p. 208; 1900) on the grounds of its greater size. He gives the average size for his new sub-species as follows: wing 163 mm., culmen 46·6 mm., and tarsus 47·2 mm.

The three specimens noted above have the wings 157-165 mm., bills 43 to 45 mm., and tarsi 52 to 55 mm. They must all therefore be accredited to the Eastern rather than to the Western form. Specimens of both birds and eggs obtained in Tibet fully bear out Oberholser's diagnosis of *eurhinus*.

52. **Machetes pugnax**, Linn. (1468).

o. No. 24734; Shaharistan, Seistan, 1.3.03, not sexed.

The wing measures 167 mm., large for a female and small for a male, but probably the latter not yet adult.

53. **Tringa alpina alpina** (Linn.). (1478).

♂. No. 25474; Lab-i-Baring, 8.12.18.
♀. ,, 25475; ,, 7.12.18.
♂. ,, 25479; ,, 13.12.18.
♂. ,, 25483; ,, 13.12.18.

The wings of these four specimens vary from 108 to 115 mm. so that they must belong to the smaller Western sub-species rather than to the larger Eastern one.

54. **Grus grus** (Linn.). (1407).

o. No. 24728; Khwaja Ali, Feb. 03.

This specimen is that of a not quite adult bird with the crown of the head still fairly well covered with feathers as in the young bird.

55. **Larus ichthyaëtus**, Pall. (1489).

1905. *Larus ichthyaëtus*, Cumming, *op. cit.*, p. 695.

o. No. 24691; Seistan, March 1904.

In full breeding plumage.

56. **Larus ridibundus**, Linn. (1490).

o. No. 24736; Seistan, Jany. 1904.

o. ,, 25464; Lab-i-Baring, 11.12.18.

57. **Larus gelastes**, Licht. (1493).

1905. *Larus gelastes*, Cumming, *op. cit.*, p. 695.

♀. No. 24841; Kuhak, 26.4.05.

♀. ,, 24853; ,, 26.4.05.

58. **Larus argentatus cachinnans**, Pall. (1495).

o. No. 24738; Landi Barech, Feb. 03.

59. **Hydroprogne caspia** (Pall.). (1498).

1905. *Hydroprogne caspia*, Cumming, *op. cit.*, p. 696.

♀. No. 24842; Kuhak, 26.4.05.

60. **Sterna nilotica**, Gmelin. (1499).

1905. *Sterna anglica*,, Cumming, *op. cit.*, p, 696.

♀. No. 24839; Kuhak, 22.4.05.

61. **Sterna hirundo** (Neum.). (1506).

1905. *Sterna fluviatilis*, Cumming *op. cit.*, p. 696.

♀. No. 24860; Kuhak, 28.4.05.

The wing of this bird measures 265 mm.

62. **Sterna minuta gouldi**, Hume. (1510).

1905. *Sterna minuta*, Cumming, *op. cit.*, p. 696.

♀. No. 24843; Khwaja Ahmed, 5.5.05.

♂. ,, 24844; Nasaratabad, 7.5.05.

♂. ,, 24845; ,, 6.5.05.

The wings of the two males measure 163 and 175 mm. respectively and that of the female 170 mm.

All these specimens appear to be the same as the Indian *S. m. gouldi* rather than true *S. m. minuta*. They are identical in shade of grey on the upper parts and in colour of outer primaries with specimens from N.W. India.

63. **Pelecanus onocrotalus onocrotalus**, Linn. (1521).

1905. *Pelicanus onocrotalus*, Cumming, *op. cit.*, p. 696.

o. No. 24739; ? no sex or date.

A very typical specimen of this species with a bill fully 17 inches, or 435 mm., in length from forehead to tip of culmen.

64. **Phalacrocorax carbo subcormoranus** (Brehm). (1526).

1905. *Phalacrocorax carbo*, Cumming, *op. cit.*, p. 696.

o. No. 24740; Seistan, Feb. 04.

This is the form which Hartert has recently shewn (*Novitates Zoologicae*, XXIII, p. 294; 1916) must bear Brehm's name of *subcormoranus*.

[Cormorants are captured or shot in large numbers by the Saiyad. The down from the breasts is sometimes mixed with the soft wool out of which the felt hats worn by Persians are made. *N. A.*]

65. **Ardea cinera**, Linn. (1555).

1905. *Ardea cinerea*, Cumming, *op. cit.*, p. 696.

o. No. 24741; Khwaja Ali, Feb. 03; no sex.

o. ,, 24882; Farrah Rud, Dec. 04.

These are both adult birds.

66. **Botaurus stellaris**, Linn. (1574).

1905. *Botaurus stellaris*, Cumming, *op. cit.*, p. 696.

o. No. 24846; Farrah Rud, Dec. 04. No sex.

o. ,, 24744; ? Dec. 04. No sex.

These are both adult birds with wings of 335 and 342 mm. respectively, but otherwise call for no remark.

67. **Ixobrychus minutus** (Linn.). (1570).

1905. *Ardetta minuta*, Cumming, *op. cit.*, p. 696.

o. No. 24687; Khwaja Ali, Seistan, April 03.

An adult bird and evidently a male though it has not been sexed. The generic name *Ixobrychus*, Billberg of 1828 antedates that of *Ardetta*, Gray of 1842, which must therefore be discarded.

68. **Phoenicopterus minor**, Geoff. (1575).

1905. *Phoenicopterus minor*, Cumming, *op. cit.*, p. 697.

o. No. 24840; Kuhak, June 1904.

A young bird, but exceptionally large with a wing of 13-6 inches (345 mm).

69. **Cygnus cygnus** (Linn.). (1578a).

1905. *Cygnus musicus*, Cumming, *op. cit.*, p. 697.

o. No. 24884; Hamun-i-Sabous, Seistan, Dec. 04.

This is a very large specimen with a wing of 602 mm. (23·75 inches); bill 111 mm. (4·4 inches). Although not sexed it is undoubtedly a male.

70. **Tadorna tadorna** (Linn.). (1587).

1905. *Tadorna cornuta*, Cumming, *op. cit.*, p. 697.

♂. No. 25466; Lab-i-Baring, 14.12.18.
♂. ,, 24818; Seistan, 3.10.04.
♂. ,, 24819; Kuhak, Sept. 04.
♂. ,, 24820; Seistan, 3.10.04.
Juv. ,, 24821; Kuhak, Aug. 04.
,, ,, 24822; Seistan, no date.

The first bird is an adult in full plumage, the next three are ducklings of about a month old, or rather less, and the last two are still younger.

71. **Querquedula crecca** (Linn.). (1597).

1905. *Nettium crecca*, Cumming, *op. cit.*, p. 697.

♂. No. 24830; Kuhak, 3.10.14.
♂. ,, 25473; Lab-i-Baring, 11.12.18.
♂. ,, 25490; ,, 8.12.18.

Of these three birds the first is in eclipse plumage, the second in full breeding plumage, whilst the third appears to be a female and not a male. [One of the commonest ducks among the reed-beds of the Hamun. *N. A.*]

72. **Dafila acuta acuta** (Linn.). (1600).

1905. *Dafila acuta*, Cumming, *op. cit.*, p. 698.

♂. No. 25487; Lab-i-Baring, 8.12.18.

In full, but not very bright, breeding plumage. [Another very common species in the reed-beds. *N. A.*]

73. **Spatula clypeata** (Linn.). (1602).

1905. *Spatula clypeata*, Cumming, *op. cit.*, p. 698.

♂. 24832; Hamun-i-Sabari, 29.12.04.

This drake is still in eclipse plumage.

74. **Marmaronetta angustirostris** (Ménétr.). (1603).

1905. *Marmaronetta angustirostris*, Cumming, *op. cit.*, p. 698.

o. No. 24823; Kuhak, juv., 6.7.04.
o. ,, 24824; ,, ,, 6.7.04.
♂. ,, 24825; ,, adult, 22.4.05.
o. ,, 24826; ,, juv., 6.7.04.
o. ,, 24827; ,, ,, 6.7.04.

Apparently the four ducklings, though all young birds recently hatched when obtained, are in two stages of growth, the first two being some days older than the other two. This little duck breeds freely from as far South as the Mackran coast and Sind throughout South, Central and Eastern Persia wherever the country is suitable.

The two youngest birds of those above enumerated have the wing quills only just beginning to sprout.

75. **Netta rufina** (Pall.). (1604).

1905. *Netta rufina*, Cumming, *op. cit.*, p. 698.

♀. No. 24833; Farrah Rud, Dec. 04.

76. **Nyroca ferina** (Linn.). (1605).

1905. *Nyroca ferina*, Cumming, *op. cit.*, p. 698.

♂. No. 25465; Lab-i-Baring, 10.12.18.
♂. ,, 25467; ,, 10.12.18.

77. **Glaucionetta clangula**, Linn. (1610).

1905. *Clangula glaucion*, Cumming, *op. cit.*, p. 699.

♂. No. 24829; Hamun, Seistan, Dec. 04.

In full breeding plumage.

Stejneger has shown that we cannot use the generic name *Glaucion* for the Golden-eye and has substituted *Glaucionetta* in its place (*Proc. U.S. Nat. Mus.* VIII, p. 409; 1885).

78. **Podiceps cristatus** (Linn.). (1615).

1905. *Podiceps cristatus*, Cumming, *op. cit.*, p. 699.

♀. No. 24692; ? no date, adult.
♀. ,, 24694; ? no date, juv.
♀. ,, 24693; ? no date, adult.

79. **Podiceps fluviatilis albipennis** (Sharpe). (1617).

1905. *Podiceps albipennis*, Cumming, *op. cit.*, p. 699.

o. No. 24835; Seistan, juv., no date.
♀. ,, 25486; Lab-i-Baring, 11.12.18., adult.

[Very common among the reed-beds of the Hamun. *N. A.*]

NOTE ON THE OCCURRENCE OF THE LEECH *LIMNATIS NILOTICA* IN SEISTAN AND THE AFGHAN-BALUCH DESERT.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, and* AMIN-UD-DIN, *M.Sc., Research Assistant, Zoological Survey of India.*

Blanchard [1] has given numerous instances of the leech *Limnatis nilotica* causing haemorrhage in the throat of men and beasts when swallowed, while Masterman [2] supplies details of cases in Palestine. The oldest reference, however, is probably to be found in the story of how Gideon [3] chose out his picked men, careful and fitted for a sudden night-attack on the enemy. This he did by selecting those who lifted up water from a stream in their hands before drinking it, instead of lapping like a dog direct from the stream. The precaution is still a necessity for all who drink from streams and springs in Palestine (where the danger of swallowing a leech is real), and might still be used in separating careful from careless persons. In all cases investigated in Palestine the leech swallowed has been *L. nilotica* (*cf.* Masterman, *op. cit.*).

It is, therefore, of particular interest to put on record the occurrence of this leech on the borders and even within the boundaries of the Indian Empire. While travelling to Seistan in November 1918, Dr. Annandale and Dr. Kemp saw a member of an Indian labour corps carefully skimming water from the top of a spring at Makki in Western Baluchistan, close to the Afghan border. When asked why he did this, the man said that he was afraid of leeches. No leech was seen in this spring, but many were observed at Robat close to the point at which the Afghan, Baluch and Persian frontiers meet, and also at Hurmuk across the last. Specimens were not obtained at any of these places, but there can be little doubt from the observations made that they belong to the same species as one captured at Nawarchah, a place some distance north of Hurmuk and well within the district of Seistan, on the tongue of a horse.

The specimen is small, being only 2·5 cm. long and ·5 cm. broad as preserved in 90% alcohol, but it agrees in all essentials with small specimens of *L. nilotica* (Savigny) from Palestine. It belongs to the colour-form in which the dark markings are obscure or obsolete. The posterior sucker is of a characteristic size, the

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[1] *Boll. Mus. Zool. Torino* IX, No. 189, p. 43 (1894).
[2] *Parasitology* I, p. 282 (1908).
[3] *Judges* VII, 6. Frazer in his *Folk-lore in the Old Testament* adopts a ritualistic explanation.

diameter being about 5 mm. and that of the anterior sucker only 2 mm.

L. nilotica is easily distinguished from the common Indian species, *Limnatis* (*Poecilobdella*) *granulosa* (Savigny), by the absence of the colour-pattern characteristic[1] of the sub-genus *Poecilobdella* and by its smaller size.

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[1] See Blanchard in Weber's *Zool. Ergeb. Niederland. Ost.-Ind.* IV, p. 346, fig. 3.

NOTES ON SOME ASIATIC SPECIES OF *PALINGENIA* (ORDER EPHEMEROPTERA).

By F. H. GRAVELY, *D.Sc., Asst. Superintendent, Zoological Survey of India* (now *Superintendent, Government Museum, Madras*).

(With Plates XVIII—XX.)

The Ephemerid genus *Palingenia* has attracted the attention of many naturalists on account of the way in which immense swarms of adults hatch and die annually during the evenings of a few consecutive days only.[1]

The larvae are fossorial. They have six pairs of double gill-plumes arched upwards over the back and protected by five pairs of lamellae which are covered on the outer side by long hairs. According to Swammerdam (1758, p. 109), these lamellae are "oars that serve the creature for swimming." Male larvae may be distinguished from females by their larger eyes and, in the later stages, by their longer caudal appendages and developing forceps.

The genus has been provisionally divided by Eaton (1883, p. 23) into three subgenera as follows:—"*Palingenia* (typical), Burmeister, containing European and Western Asiatic species; *Anagenesia* containing Indo-Malay and a Siberian species; and a nameless subgenus containing Brazilian species," concerning the adults of which scarcely anything appears to be known.[2]

Eaton's system of reference to the venation of the wings[3] has been adopted throughout the following notes in order to facilitate comparison with his monograph. In the figures this system is supplemented by that used in Comstock's book "The Wings of Insects" (New York, 1918).

Subgenus **Palingenia**, Burmeister, *s. str.*

Adult with the fore-tarsus of the male about 2½ times as long as the femur; the praebrachial nervure (6) of the forewing forked beyond the middle; two conspicuous couples of longitudinal nervures (midway between 4 and 5, and 5-6) proceeding to the terminal margin of the fore-wing (pl. xx, fig. 21); the forceps with a long slender basal joint grooved on the inner side and (? always) at least five shorter terminal ones (pl. xx, figs. 22-3).

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[1] For references see Eaton, 1883, pp. 24-28; also Swammerdam, 1758, p. 104, concerning references by more ancient writers.

[2] The larva is figured by Eaton, 1883, pl. xxv, figs. 20-24.

[3] Eaton, 1883, p. 4.

Larva with the dorsal margin of the fore-tibia (? always) strongly toothed (pl. xviii, fig. 4).

Palingenia (*s. str.*) ? **longicauda**, Olivier.[1]

Palingenia sp. (*? robusta*), Needham, 1909, p. 191, pl. xx, fig. 8.[2]

Adult (pl. xx, figs. 21-23).—Nine pinned specimens from Seistan, all in bad condition. One of these was erroneously referred by Needham to the subgenus *Anagenesia*, to which *P. robusta*, Eaton, belongs, with the remark :—" The species will be recognized by the male forceps.... which is different from the forceps of any species that has been figured hitherto." His figure (1909, pl. xx, fig. 8) differs from Eaton's figure (see 1883-8, pl. i. 1*a* ♂) of the male genitalia of *P. longicauda* in having five instead of six terminal joints to the forceps. But Cornelius (1848, pp. 28-29) states that *P. longicauda* has only three such joints and shows only three in his figure (1848, fig. 4K), though the terminal one could be almost better interpreted as two joints than as one but for the accompanying statement, and might even be composed of three. The probability, it seems to me, is therefore that normally the forceps of *P. longicauda* consists of at least five terminal joints and one long basal one. In the specimens now under consideration most of the forceps are broken. In one the terminal joints appear to be six in number, the last being very small and imperfectly separated, in another they appear to be seven, the terminal one again being very small. Unfortunately no European specimens are available for comparison. The colour of the Seistan specimens appears to be duller and more uniform than in European specimens, but this may be due to their poor state of preservation.

The species probably occurs also in Mesopotamia, as Major Connor writes that he "saw millions of the large Mayflies on the Euphrates at about the beginning of April. They were being eaten up by the ordinary Caspian river tortoise as they lay in heaps in eddies and slack water. They swarm in the river even as far down as Basra."

Larva (pl. xviii, figs. 1-4).—Six males and eight females, none full-grown (length, excluding mandibles and caudal appendages, 21-25 mm.), from thick mud of pools in the bed of the Randa stream (otherwise dry) four miles northwest of Jellalabad, Seistan. 2.xi.18.

Dr. Annandale has supplied the following note on the finding of these larvae :—

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[1] For *P. longicauda*, see Eaton, 1883, p. 24, pl. i, fig. 1*a* ; and Cornelius, 1848, pp. 22-29, figs. 4-4K.

[2] The nymphs referred by Needham (*loc. cit.*) to this genus belong, in all probability, to the genus *Ephemera*. (See Vayssiére, 1882, pp. 38-42, pl. i, figs. 3-7; Eaton, 1883-8, pp. 58-59, pl. xxx, figs. 1-19; and Klapálek, 1909, pp. 29-30). They are very different from those of *Palingenia*.

"The larvae of *Palingenia* were collected about the end of November at the edge of small pools of very foul water left by the retreat of the annual floods in the bed of the Randa stream near the ruined city of Jellalabad, some twelve miles north of Nasratabad, the capital of Seistan. This stream is filled with water only in flood-time. For some considerable distance south the country consists of a flat barren plain the surface of which in winter is formed of bare and extremely hard grey clay. It is in fact one of those shallow basins, so common in Seistan, which are flooded every normal year by the rise of the Helmand. Towards the edge of this basin we noticed that the whole ground was pitted with little holes as though a rather narrow pen-holder had been repeatedly thrust into it. We were unable to account for this phenomenon until we examined the edge of the pools, where each hole was occupied by a *Palingenia* larvae. The mud was here fairly soft but was caking rapidly and the larvae, the gills of which were pressed tightly against the sides of their abdomens, were, though still living, apparently being gradually asphyxiated. The foulness of the water was due partly to the presence of large numbers of dead fish and partly to the fact that the several tribes of the district watered their flocks of sheep and goats at the pools. Doubtless the Mayflies of the same genus collected in large numbers in Seistan by the officers of Sir Henry MacMahon's Commission were captured in spring or summer."

The identity of Dr. Annandale's larvae with these adults from Seistan is extremely probable, but has not been definitely proved. The larvae appear to be identical with those of *P. longicauda* described by Swammerdam (1758) and Cornelius (1848). The caudal appendages are not very well preserved; they seem to be of almost equal length in both sexes, but this is probably due to their not being fully developed. These larvae differ from all other *Palingenia* larvae yet known in having the dorsal (outer) margin of both the mandibles and fore-tibiae very strongly toothed.

I have not been able to distinguish the second spine figured by Cornelius on the blade of the maxilla; but this may be a variable character (see below, p. 142). The labial palps bear hairs and spines like those of *P. robusta.*

The front legs closely resemble those of *P. robusta.* The group of spines on the inner side of the lower distal angle of the tibia is, however, composed entirely of simple spines somewhat longer and slenderer than the very stout simple spines of the outer half of the group in that species. The serrate spines on the tarsus, on the contrary, are somewhat coarser; they are also more numerous. The middle legs differ from those of *P. robusta* chiefly in the presence of a large conical tooth on the dorsal surface of the distal end of the tibia. The hind legs differ chiefly in having the outer distal angle of the tibia less produced. In both middle and hind legs the spines on this angle resemble those found in the same position on the front legs; they are much thinner than in *P. robusta.*

The gills and their protective lamellae have been somewhat crushed together, but appear to resemble those of *P. robusta.*

Subgenus **Anagenesia**, Eaton.

Adult with the fore-tarsus of the male shorter than the femur; the praebrachial nervure (6) of the fore-wing forked before the middle; three conspicuous couples of longitudinal nervures (midway between 4 and 5, 5-6, and midway between 6 and 7) proceeding to the terminal margin of the fore-wing (pl. xx, fig. 24); the forceps with a long flattened basal joint and two shorter terminal ones, the latter sometimes with a small and imperfect third joint between them (pl. xx, figs. 17-20 and 25).

Larva with the dorsal margin of the fore-tibia (? always) without conspicuous teeth (pl. xviii, fig. 8).

Palingenia (Anagenesia) lata, Walker.

Adult (pl. xx, fig. 17).—The Indian Museum collection contains pinned males from Sibsagar. See Eaton, 1892, p. 407.

Palingenia (Anagenesia) picta, n. sp.

Adult (pl. xx, figs. 24-25).—Two pinned males each about 22 mm. long, from Kapit, Sarawak, 24.vii.10. This species differs from *P. lata* in its slightly larger size and in having the terminal joint of the forceps distinctly smaller than the penultimate. The most striking difference, however, is in colour, *P. lata* being of an almost uniformly dull brown colour, whereas in *P. picta* the general colouration is bright reddish or yellowish brown, while the head is more or less black between the eyes, except for a strongly marked median brown line on the vertex; the mesonotum is almost equally dark; the wings are whitish with yellowish veins, the anterior pair having infuscate margins, especially in front and at the tips; the dorsal plates of the abdomen are somewhat dark, except for a narrow posterior border. The relatively pale pronotum stands out in marked contrast to the dark head and mesonotum.

Palingenia (Anagenesia) robusta, Eaton.

Palingenia robusta, Eaton, 1892, pp. 407-408.

Adult (pl. xx, figs. 19-20).—The imperfect type male from Cachar, two dry and six spirit males and three spirit females from the Dikko River, Nazira, Assam. The Dikko specimens were sent by Mrs. Maxwell, with the following information. They emerge annually at about the end of October, and for three or four days float down the river in countless millions. The natives say that they also appear on other rivers, such as the Desoi, Desang and Dihing, and that they come out at and under the edge of the water in the shallows after the rivers have left the hills and where they run through silt only; but Mrs. Maxwell says that so far as

she knows they do not occur on rivers actually rising in flat districts. The natives believe that until they have appeared there is always a chance of further floods and that consequently it is no use building the temporary bamboo bridges which they put up every cold weather until these "pani-pooka" (water insects) have gone. The caudal appendages of the males were 3 inches long and semi-transparent when fresh. The insects are so light and hollow that they cannot be kept under water; when just out they are white or creamy and look like foam when blown together by the wind. All the specimens collected as adults were males; the females were caught as nymphs and hatched in captivity.

This species is of about the same size as the last, but lacks its rich warm colour. The general colour of the male is whitish, with the upper surface of the head, mesothorax and posterior end of abdomen tinged with dull brown The margins of the fore-wings are narrowly tinged with the same colour. The second joint of the foretarsus is more distinctly longer than the first and third than in either of the two preceding species. The forceps seems normally to consist of the one long basal and two terminal joints characteristic of the subgenus; but the second of the latter joints, which is fully as long as or even a little longer than the first, is often divided quite definitely into two near the base, at least on the outer side.

The legs and caudal appendages of the female are smaller and feebler than those of the male, especially the caudal appendages, and the dorsal surface of the body is much darker in colour, being of a dull brown tint. The wings are whitish as in the male.

Larva (pl. xviii, figs. 5-8, pl xix, figs 9-16).—One male and two female cast skins, found floating in the surface water of the Dikko River, Nazira, Assam when adults were emerging, Oct. 26-30, 1918; three males and one female insect from the same locality, Oct. 1919.[1]

The total length (excluding the mandibles but including the caudal appendages) is 45-47 mm. in both sexes. The caudal appendages are 13 mm. long in the male and only 9 in the female, the body being therefore 4 mm. longer in the female than in the male.

The teeth on the anterior margin of the head are somewhat more scattered than in *P. longicauda.*

The mandibles (pl. xviii, fig. 7) are very hairy, long and slender and are upturned distally; they have a number of small teeth, much smaller than those of *P. longicauda*, scattered along the basal $\frac{2}{3}$ of the upper margin. They are intermediate in form between those of *Palingenia* (*s. str.*) *longicauda* (see Cornelius, 1848, fig. 3B) and those of *Ephemera vulgata* (see Eaton, 1883-8, pl. xxx, figs. 7-8). They are very different from the mandibles of the *Palingenia* (*Anagenesia*) larva from Ceylon[2] figured by Eaton (1883 8, pl. xxv,

[1] The description is taken from the cast skins, as the larvae were not received till it had been completed.

[2] No adult from Ceylon was known to Eaton. Banks (1914, pp. 612-613) has since described *Palingenia* (*Anagenesia*) *greeni* from there.

figs. 8-9), which are much shorter and stouter, are distally somewhat wedge-shaped and irregularly dentate instead of slender and pointed, and appear to be without the two small laminar teeth found below the molar tooth in the present species and in *P. longicauda* and *E. vulgata*. There is little or no difference between the teeth on the right and left mandibles.

The maxillae (pl. xix, fig. 9) and labium closely resemble those of Eaton's Ceylonese larva but are less pointed, especially the maxillary palps. The blade of the maxilla bears two spines distally as in Cornelius's figure of *P. longicauda*, but the lower one is more transparent than the terminal one, and is sometimes very hard to distinguish and possibly absent.

The labial palps (pl. xix, fig. 10) bear a number of transparent stout curved spines at the distal extremity and a tuft of spines on a tubercle at the base of the penultimate segment.

The front legs (pl. xviii-xix, figs. 8 and 11) are clothed with hairs and spines arranged in very definite series. The transverse line of hairs at the base of the femur and the two transverse lines at the base of the tibia are finely pectinate (pl. xix, fig. 14). The lateral filaments on these hairs are extremely minute, but probably form two series more nearly at right angles to each other than in one plane. The ventral aspect of the outer distal angle of the tibia bears a group of strong spines of which the outermost half are somewhat less stout than the innermost, and are coarsely biserrate Owing, however, to the angle which the two rows of serrations bear to one another not more than one of them can be clearly seen from any one point of view (pl. xix, fig. 12). The tarsus bears a number of more slender biserrate spines below its outer margin. Their serrations are more nearly in one plane (pl. xix, fig. 13). The remaining hairs and spines are simple.

On the last two pairs of legs the lines of pectinate hairs are absent, and there are no serrate spines, simple spines and hairs being more extensively distributed in place of them. The spines are strongest and most numerous on the third pair of legs. Except for a group of very stout curved spines of moderate length on the ventral aspect of the outer distal angle of the tibia, the spines are confined to the dorsal surface (pl. xix, figs. 15-16).

The first abdominal segment bears a pair of gills but no protective lamella. The five following segments bear both gills and lamellae. The three remaining segments are without appendages. The first two of these bear spines and hairs laterally. The last has hairs distributed over almost the whole of its dorsal surface; these hairs are thick behind, but there are no spines at all comparable in strength with those on the two preceding segments.

Each gill consists of two plumes, one situated behind and to the inner side of the other. The former is of about equal size on all segments, and being directed backwards it conceals the latter, which is considerably smaller—more so in the anterior than in the posterior segments.

All five protective lamellae are of about equal size. Each

consists of a finger-like process of the body-wall, bare on the inner side but fringed and entirely covered on the outer side with very long hairs.

Palingenia (Anagenesia) minor, Eaton.

Palingenia minor, Eaton, 1882, p. 408.

Adult (pl. xx, fig. 18).—Two specimens labelled "Karachi Museum" and one from Nattor, which is in the Rajshahi Division of Bengal, were described by Eaton from the Indian Museum collection. A specimen from Sara Ghat in Bengal, and one from Pakokku in the oil-fields of Upper Burma, have since been added. The species would seem, therefore, to be very widely distributed over the Indian Empire.

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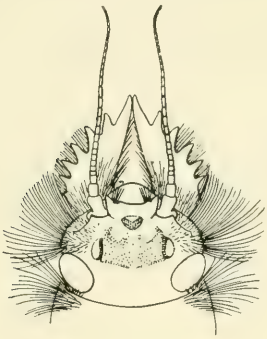
EXPLANATION OF PLATE XVIII.

Palingenia larva from Seistan.

FIG. 1.—Head of male.
,, 2.—Head of female.
,, 3.—Right mandible.
,, 4.—Left front tibia and tarsus from above.

Palingenia robusta, larva.

,, 5.—Caudal appendages of female.
,, 6.—Cast skin of male.
,, 7.—Right mandible.
,, 8.—Left front tibia and tarsus from above.



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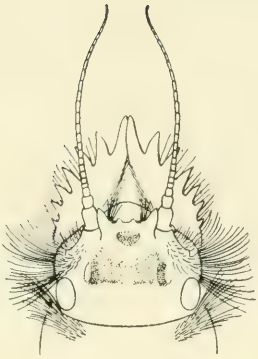

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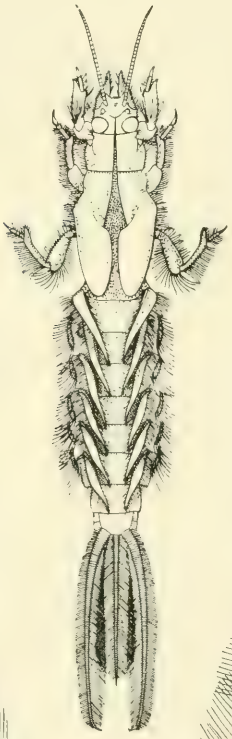

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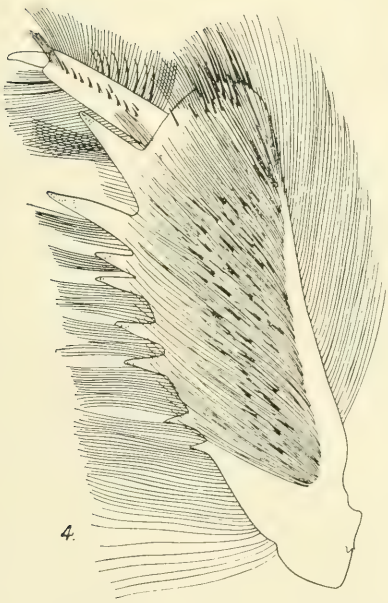

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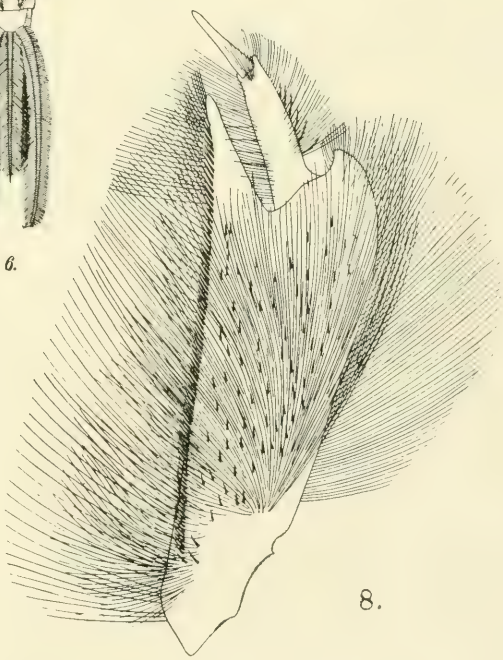

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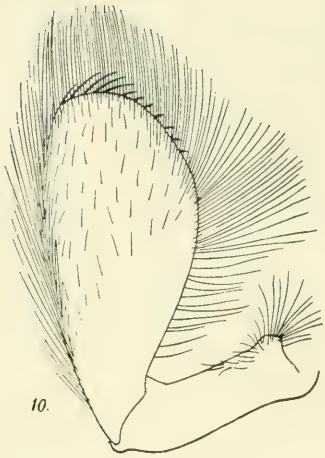
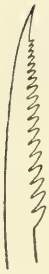
PALINGENIA LARVAE

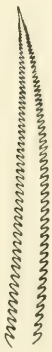
EXPLANATION OF PLATE XIX.

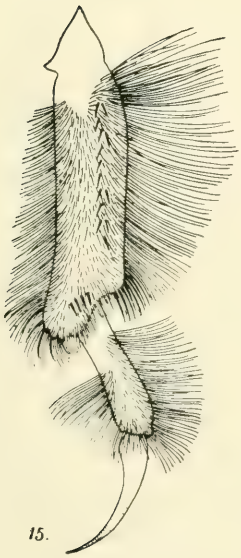
Palingenia robusta, larva.

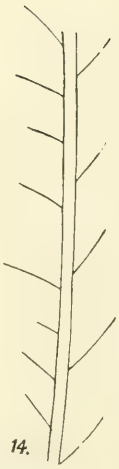
FIG. 9.—Right maxilla from below.
,, 10.—Right labial palp from below.
,, 11.—Left fore leg from below.
,, 12.
,, 13. } Spines and hairs from fore leg.
,, 14.
,, 15.—Left middle tibia and tarsus from above.
,, 16.—Left hind tibia and tarsus from above.

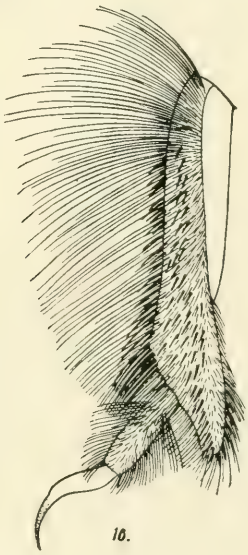












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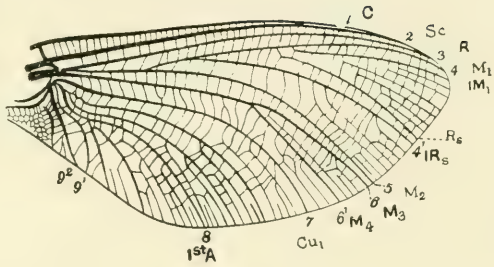
PALINGENIA LARVAE.

EXPLANATION OF PLATE XX.

FIG. 17.—*Palingenia lata*, terminal joints of forceps of male.
,, 18.—*Palingenia minor* ,, ,, ,,
,, 19.—*Palingenia robusta* ,, ,, ,,
,, 20.—*Palingenia robusta* ,, ,, ,,
,, 21.—*Palingenia* from Seistan, right fore wing.[1]
,, 22.—*Palingenia* ,, , forceps of male.
,, 23.—*Palingenia* ,, , terminal joints of forceps of male.
,, 24.—*Palingenia picta*, male from above.[1]
,, 25.—*Palingenia picta*, terminal joints of forceps of male.

[1] The numbers at the ends of the veins are the symbols used by Eaton in his monograph. The letters are those used by Comstock in his book on "The Wings of Insects" (see above p. 137).



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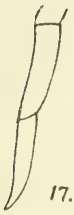

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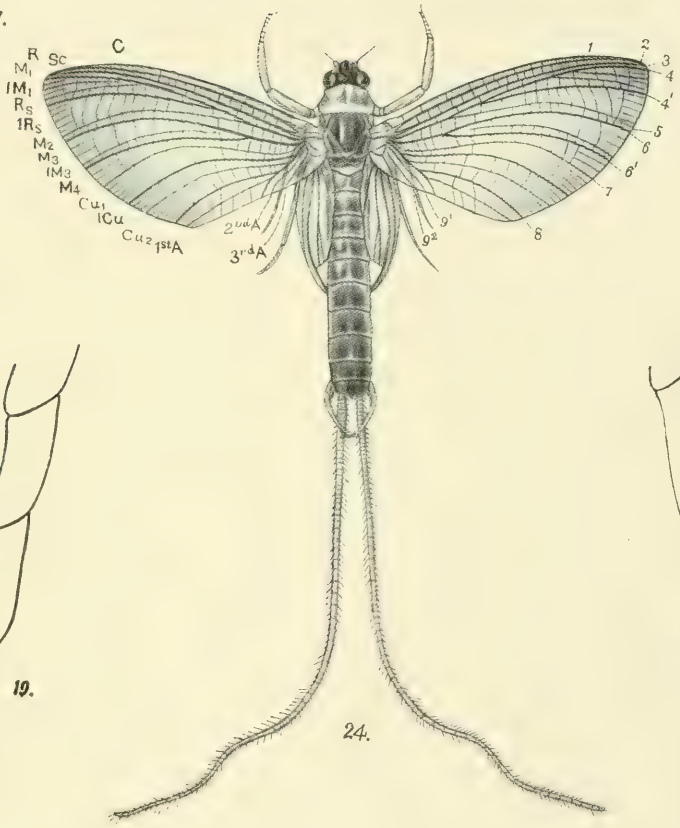

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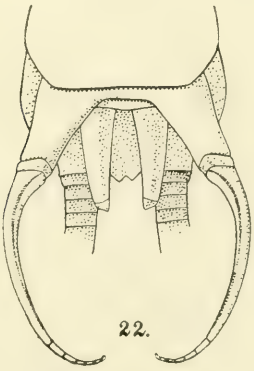

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PALINGENIA.

LIST OF ENTOMOSTRACA COLLECTED IN SEISTAN AND THE BALUCH DESERT.

By ROBERT GURNEY, *M.A., F.Z.S.*

[The few Entomostraca mentioned in Mr. Gurney's list are the only fresh-water Crustacea we saw in Seistan except the crab *Potamon* (*Potamon*) *Potamios gedrosianum*, Alcock, and certain small Ostracods abundant in springs in the desert. Owing to some accident no specimens of the latter were collected. The crab was found in considerable numbers buried in the mud at the bottom of pools of foul water in the bed of the Randa stream near Jellalabad. No trace of it was, however, observed in the Hamun-i-Helmand. Mr. S. W. Kemp has compared a series of specimens from Seistan and from Quetta, where it was seen in an active condition in winter, and can find no local difference. In the hill-country of Baluchistan, which is not represented in the collection examined by Mr. Gurney, at least two species of Amphipods are common in springs.—*N. Annandale.*]

(1) NASRATABAD, SEISTAN. Pools on Parade ground. 27-xi-18.

These pools were pits from which clay had been dug for bricks. There was a luxuriant growth of *Zannichellia*, but the water was very foul, being visited by large numbers of donkeys and camels.

Daphnia magna Straus. Abundant.
Simocephalus vetulus O.F.M. Abundant.
Cyclops strenuus Fischer-Sars.
,, *leuckarti* Claus.
Eucypris clavata Baird. Common.
Ilyocypris bradyi Sars.
Potamocypris villosa Jur.. Common.

(2) NASRATABAD, SEISTAN. Irrigation channel. 19-xii-18.

Leptestheria tenuis Sars. A single male specimen.

I do not feel at liberty to dissect this specimen, but it agrees so closely in external appearance with *L. tenuis* that I have no hesitation in so naming it.

(3) LAB-I-BARING, SEISTAN. Channels in reed-beds in Hamun. 10-xii-18.

The collection was made in small pools about 8 feet deep, blocked with *Potamogeton pectinatus.*

Daphnia longispina var. *rosea* Sars. Rare.
Ceriodaphnia pulchella Sars. Common. Ephippial females seen.
,, *reticulata* Jur. A few.
Simocephalus vetulus O.F.M.
Bosmina longirostris O.F.M. Two seen.
Cyclops viridis Jur. One female only.
Herpetocypris reptans Baird. One only.
Free ephippia of *Daphnia magna.*

(4) YAKMATCH, W. BALUCHISTAN. 13-xi-18.

Yakmatch is a station on the Baluchistan-Persia Railway in the middle of the desert. The specimens are from a small artificial pool lined with cement into which water is pumped from a spring. The only vegetation was a spongy grey alga.

The bottle contained a number of shells of Ostracods, but no complete animals. The shells of *Cyprinotus incongruens* Ramd. and of *Ilyocypris bradyi* Sars were identified.

(5) ZANGI NAWAR, 20 MILES FROM NUSHKI, BALUCHISTAN. 29-xi-18.

From small lakes of practically fresh water into which the Peshin-Lora river drains in the Baluchistan desert. The pools were full of submerged weeds.

Diaphanosoma brachyurum Liévin. Common. Males and females with resting eggs present.

Simocephalus exspinosus Koch. Abundant.

Ceriodaphnia reticulata Jur. Common.

Diaptomus salinus Daday. Common.

Eurycypris pubera O.F.M. Young only.

Cypridopsis dentatomarginatus Daday? One specimen only.

Limnicythere inopinata Baird? One young specimen.

Potamocypris villosa Jur. Shells only.

Ephippia of *Daphnia magna* found.

REPORT ON THE FRESHWATER GASTROPOD MOLLUSCS OF LOWER MESOPOTAMIA.

PART II.—THE FAMILY PLANORBIDAE.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India.*

I have examined shells of four species of this family from Lower Mesopotamia, three belonging to the genus *Gyraulus*, one to *Bullinus*. As all but one of these have recently been discussed in these "Records" and as the one species not hitherto considered is represented in the collections before me merely by empty shells, there is not much that can be profitably said here. I think, however, that it will now be convenient to treat *Bullinus* as the type-genus of a distinct subfamily, in which *Physopsis*, Krauss, may be provisionally included. At least one recent writer has talked of the family Bullinidae, but in view of the close resemblance between the young shell of certain species of *Planorbis* (*s.s.*) and the adult shell of *Bullinus*, this course seems to me to go too far.

Family PLANORBIDAE.

Subfamily *PLANORBINAE*.

Genus **Gyraulus**, Agassiz.

Of the three species found in Lower Mesopotamia, two have been discussed already in this volume. I have unfortunately no information about the anatomy of the third.

Key to the species of Gyraulus *of Lower Mesopotamia.*

1. Shell surrounded by a strong median keel; mouth of shell sharply pointed externally ... *G. euphraticus.*
2. Median keel absent or poorly-developed; mouth rounded or bluntly-pointed externally ... *G. convexiusculus.*
3. Mouth of shell relatively small, bluntly pointed externally; a fairly strong basal keel on periphery of shell ... ... *G. intermixtus.*

Gyraulus euphraticus (Mousson).

1919. *Gyraulus euphraticus*, Annandale and Prashad, *Rec. Ind. Mus.*, XVIII, pp. 40, 53, 55, figs. 5c, 7a, 8a.

I have nothing to add to our recent observations on this species except to say that shells occur mixed with those of *G.*

convexiusculus, which is the more abundant of the two, at the edge of the lower Euphrates at all points at which deposits are formed by floods. Probably Mousson included both species under the name *Planorbis* (*Gyraulus*) *devians* var. *euphratica*. There are no fresh specimens in the collections examined.

Gyraulus convexiusculus (Hutton).

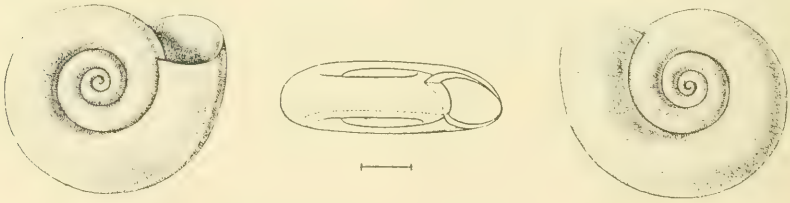
1919. *Gyraulus convexiusculus, idem, op. cit.*, pp. 40, 53, figs. 5*e*, 7*b*, 8*b*.

This is by far the most abundant species of the family in all the flood-deposits from Lower Mesopotamia from which I have examined shells. Capt. Boulenger obtained living specimens on mud-flats of the River Euphrates at Gurmut Ali, N. of Basra. As usual, the shell exhibits great individual variability and some examples come much nearer *G. euphraticus* than others. I can, however, detect no constant difference from series from India, Burma and China.

Gyraulus intermixtus (Mousson).

1874. *Planorbis* (*Gyraulus*) *intermixtus*, Mousson, *Journ. de Conchyl.* (3) XIV, p. 45.

This species is scarcer in the river-deposits of Lower Mesopotamia than either of the other two and I have only seen empty bleached shells. It is, however, widely distributed in this area.



Gyraulus intermixtus (Mousson).

It is closely related, as Mousson points out, to *G. euphraticus*, though that author did not recognize the identity of the latter species with the *P. compressus* of Benson and Hutton; but it differs in that the spiral is more transverse and deviates less below and in that the keel is situated at the base of the last whorl instead of round its middle. This is a very characteristic feature. Mousson refers to the sculpture as "*transverse tenuiter striata.*" In the specimens before me I can detect no transverse striae, but they are perhaps slightly water-worn. They agree well in other respects with the original description.

Subfamily *BULLININAE*.

Genus Bullinus, Adanson.

1918. *Bullinus*, Annandale, *Rec. Ind. Mus.*, XV, p. 167.

Mousson recognizes two species of this genus from flood-deposits in Lower Mesopotamia. He calls them *Physa* (*Isidora*)

Brocchii, Ehrenberg, and *Physa* (*Isodora*) *lirata*, Mousson, and distinguishes the latter by its more elongate body-whorl, regular spire, less distinct and less scalariform whorls, by the mouth of the shell being obtuse both above and below, and by the sculpture, which he describes as consisting of fine, sharp costae, which are somewhat distinct and represent lines of growth. The spiral and the form of the mouth in *B. contortus* (of which *Isidora brocchii*, Ehrenberg, is a synonym) are so variable and the sculpture so liable to be less or more distinct in different phases and individuals that I am inclined to regard these two forms as specifically identical, especially as I do not find that strong sculpture of the surface is always correlated with a more tightly wound shell or with any particular outline of the mouth.

Bullinus contortus (Michaud).

1874. *Physa* (*Isidora*) *Brocchii*, var. *approximans*, and *P.* (*I*) *lirata* (?), Mousson; *op. cit.*, pp. 42, 43.
1918. *Bullinus contortus*, Annandale, *op. cit.*, p. 168, pl. xx, figs. 6-11.
1919. *Bullinus contortus*, Boulenger, *Ind. Journ. Med. Res.*, VII, p. 19.
1919. *Bullinus contortus*, Kemp and Gravely, *tom. cit.*, p. 255.

The varietal or subspecific name *approximans*, Mousson, may perhaps be retained provisionally, but it seems probable that it represents a mere phase the peculiarities of which are due to life in water of abnormal chemical composition or to some other circumstance of the environment. The most marked feature of this phase is the extreme variability of the shell, but a precisely similar variability occurs in a series of shells collected in Lake Ashangi in Abyssinia by the late Dr. W. T. Blanford. These shells are considerably larger than the majority of those from river-deposits in Lower Mesopotamia, but Capt. Boulenger obtained fresh shells almost as big in a drying marsh 5 miles S. of Amara and in a recently dried irrigation channel close to the River Tigris at the same place. The largest specimens in these series are 12 mm. long.

It is curious that the species has not been found alive in Mesopotamia, but Capt. Boulenger's specimens from Amara are entirely recent. Some of them even contain remains of the soft parts. *B. contortus* is a bottom-loving mollusc and perhaps in Mesopotamia, like *Melanoides tuberculatus* in the Lake of Tiberias,[1] it only lives in comparatively deep water.

Capt. R. B. Seymour Sewell, I.M.S., recently obtained a large shell of *B. contortus* (empty) near Gaza in southern Palestine, while I have no doubt that Preston's *Physa tiberidensis* from the Jordan just north of the Lake of Tiberias is identical with the closely allied species or variety *B. dybowskii*.

[1] Annandale, *Journ. As. Soc. Bengal* (n.s.) XI, p. 466 (1915).

THE FISH OF SEISTAN.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director,* and SUNDER LAL HORA, *M.Sc., Research Assistant, Zoological Survey of India.*

(Plates XV—XVII.)

INTRODUCTION.

The fish of Seistan have a particular interest on account of their geographical isolation and of the peculiar structural modifications that some of them possess. An account of the geography of the country, in so far as it affects the aquatic fauna, will be found in the Introduction to this volume. It may be well, however, to reiterate here the fact that Seistan is a comparatively deep depression (less than 2,000 feet above sea-level), and lies surrounded by desert and mountains much higher than itself. Its only connection by water with the outside world (apart from a few short and fitful streams that flow into it from the Afghan hills directly to the north) is the Helmand, which runs through the Afghan desert from the mountains in the north-eastern part of that country. Seistan is, in an almost literal sense, the child of the Helmand, which alone makes it a living country. Moreover, no ancient connection with any sea or any other large river can be premised.

The following nine species of fish are known to us from Seistan or its immediate section of the Helmand system :—

Fam. CYPRINIDAE.

Subfam. CYPRININAE.	Subfam. SCHIZOTHORACINAE.
Discognathus adiscus.	*Schizothorax zarudnyi.*
*Discognathus phryne.**	*Schizopygopsis stoliczkae.*†
Scaphiodon macmahoni.	*Schizocypris brucei.*‡

Fam. COBITIDAE.

Nemachilus stoliczkae.†

Adiposia macmahoni. *Adiposia rhadinaea.*

The species whose name is marked with a * is also found in the hills of northern Baluchistan; those with a † are widely distributed in the headwaters of the rivers that run northwards from the Himalayas and the Hindu Kush, while that with a ‡ is only known, apart from Seistan, from the mountains of Waziristan on the North-West Frontier of India. The rest, so far as we know, are endemic in Seistan.

These endemic species belong to two categories, those allied to fish that live at high altitudes in Central Asia, and those allied to representatives of the fish-fauna of Baluchistan. To the former category belong *Schizothorax zarudnyi* and the two species of *Adiposia*, to the latter (with which may be classed *Discognathus phryne*) *D. adiscus* and *Scaphiodon macmahoni*. The fish-fauna of Seistan may, indeed, be separated as a whole into two geographical divisions. The Cyprininae, which do not occur in the highlands of Central Asia, represent an element derived from the country lying south and south-east of the Helmand basin; while the Schizothoracinae and the Cobitidae have been brought by the Helmand from the Hindu Kush and are probably descended from the fish-fauna of the ancient and once extensive Oxus system. There is very little affinity with the scanty fish-fauna of the Persian plateau, a noteworthy difference being the complete absence of the Cyprinodontidae, several species of which, as Jenkins[1] has shown, are common in the Shiraz district.

We have as yet little information about the fish of north-western Baluchistan and the adjacent parts of Afghanistan, which are not remote from the sources of the Helmand system, but probably these fish will be found to have Central Asiatic affinities and to be closely related to those of Seistan. The fish of southern Baluchistan seem to be quite distinct. They have recently been discussed by Zugmayer,[2] whose collection was mainly from Las Bela, Kelat and the Mekran. The fish-fauna of south-eastern Baluchistan was described many years ago by Day,[3] with a few records from the Quetta district, in his account of that of south-eastern Afghanistan; McClelland[4] as long ago as 1838 published descriptions of a good many species from the Kabul district, and Gunther[5] discussed a comparatively small collection, mainly from the Murghab river in western Afghanistan, in 1889. Not a single species recorded from any of these districts (except *Discognathus phryne* from Quetta) has been found in Seistan. We must look still further north for the main origin of its fish-fauna, and to a country lying at much greater altitudes above sea-level. This fauna, indeed, is a remarkable instance of the acclimatization of a mountain fauna in a low-lying swampy depression.

The acclimatization has probably taken place in comparatively recent times, and the question naturally arises, how far has it affected the structure of the fish? Before attempting to answer this question, however, it is necessary to say a little more about the *provenance* of the collections on which we have worked, and

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[1] Jenkins, *Rec. Ind. Mus.*, V, p. 123 (1910).

[2] Zugmayer, "Die Fische von Baluchistan," *Abh. k. Bayerischen Ak. Wiss.* (*Math.-phys. Klasse*), XXVI, pt. 6 (1913).

[3] Day, "On the Fishes of Afghanistan." *Proc. Zool. Soc. London*, p. 224 (1880).

[4] McClelland, *Journ. As. Soc. Bengal*, VII (2), p. 944 (1838).

[5] Gunther in Aitchison's "The Zoology of Afghan Delimitation Commission," *Trans. Linn. Soc. London*, V (2), p. 106 (1889).

the precise circumstances in which the different species were obtained.

Our specimens represent two collections, one made by Sir Henry McMahon and the other officers of the Seistan Arbitration Commission of 1902-1904, the other by officers of the Zoological Survey of India in the winter of 1918.

The specimens from the first of these collections are labelled, without further particulars, as being from Seistan; but in an editorial note prefixed to the description of two new species by Mr. Tate Regan,[1] it is stated that they came from "affluents of the Helmand." Now, the Helmand has no affluents in Seistan or anywhere near Seistan; none, indeed, in any district where other zoological collections were made by the Commission. We believe, therefore, that "affluents" is a *lapsus calami* for "effluents," and that the fish are from the lower parts of the Helmand system—if not actually from Seistan in all cases, at any rate from the adjacent parts of the Afghan desert. This is borne out by information kindly given us by Sir Henry McMahon, who writes, "The fish collected by us were to the best of my belief all from the Rud-i-Seistan near our permanent camp near Kuhak close to the take off of the Rud-i-Seistan from the Helmand..... Everything we got was of course from the 'deltaic mouths' of the Helmand and the area of the delta."

There is no doubt as to the more recent collection. It was made by Dr. N. Annandale and Dr. S. W. Kemp in small water-channels in the plains of Seistan, in pools in the desert and in half-dried beds of effluents of the Helmand in the same district, and in the Hamun-i-Helmand, the lake-basin into which that river ultimately drains.

Even in winter the smallest water-channels, provided they were of a permanent nature, were found to swarm with *Discognathus adiscus* and among large numbers of this species a single specimen of *D. phryne* was found at Nasratabad. *D. adiscus* was obtained in much smaller numbers in the reed-beds of the Hamun at the same season, but for some reason all the individuals seen were dead or dying, though healthy fish of the same species were captured in a small reedy water-course connected with the lake. The species occurred in enormous numbers, with young *Schizothorax zarudnyi* and a few young *Schizocypris brucei*, in bare pools of very foul water in the bed of the Randa stream near the ruined city of Jellalabad (not to be confused with the modern town of the same name in Afghanistan). Here again, for more obvious reasons, the fish were dead or dying, or rather the Cyprinidae were doing so, for the loach *Adiposia macmahoni*, which was buried in the mud at the bottom, was quite healthy. In the Hamun-i-Helmand itself the only fish that was apparently at all common in winter was *Schizothorax zarudnyi*, of which only adult specimens were obtained from the lake. This species was originally

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

described from the *Naizar* or "reed-country" that surrounds the Hamun.

Of the seven species [1] represented in the collection of the Arbitration Commission only three (*Discognathus phryne, Adiposia macmahoni* and *Schizothorax zarudnyi*) are common to it and the one of five species recently obtained. This is probably to be explained by the fact that the former collection was mainly if not exclusively of fluviatile origin, while the other was paludine or lacustrine, or at any rate not from rapid-flowing water.

We may now consider the question of structural modification in the Seistan fish, distinguishing carefully between those peculiarities they brought with them from their mountain home and those that may have been evolved in the basin of the Helmand.

A striking feature of the fish-fauna of Seistan is the degenerate nature of the scales. The degeneracy is not of the same kind, however, in all the species. In the *Schizothorax*, the *Schizopygopsis* and the *Schizocypris*—as, indeed, in all Schizothoracinae—the scales are small, partly buried in the skin and (if not completely degenerate) non-imbricate or almost so in the living fish, except in the anal and scapular regions. In *Discognathus phryne* they have almost completely disappeared on the ventral and dorsal regions, remaining normal in shape and size, but somewhat deciduous, on the sides; in *Scaphiodon macmahoni*, while normal on the sides and back, they are absent or degenerate on the ventral surface. In the three Cobitidae scales are altogether absent or merely vestigial. Only in *Discognathus adiscus* does the lepidosis appear quite normal, and in this species the scales are so deciduous that carelessly preserved specimens are almost naked.

The Schizothoracinae are the dominant fish of the streams and marshes of the high plateau of Central Asia, the waters of which they share with the Cobitidae, most of which are practically scaleless. Small size or absence of scales is, therefore, a conspicuous feature of the fish-fauna of that region, and the plates of Herzenstein's [2] great monograph offer in this respect a striking contrast to those illustrating the Cyprinidae in Day's *Fishes of India*. If, therefore, it had been only the Schizothoracinae and the Cobitidae which had manifested in Seistan signs of degeneracy in the scales, all that could have been said would have been that they were descended from species that possessed this feature, and provided no evidence that life in a low-lying country was affecting ancestral characters in this respect. The case would have been to some extent parallel to that of Salmonidae confined in land-locked waters, for the small size of the scales in both the Schizothoracinae and the Salmonidae is probably due to the importance of a supple

[1] *Discognathus variabilis, Scaphiodon macmahoni, Schizothorax zarudnyi, Schizopygopsis stoliczkae, Nemachilus stoliczkae, Adiposia rhadinaea, Adiposia macmahoni.*

[2] Herzenstein, *Fische*, in *Wiss. Res. Przewalski Central-As. Reis. Zool.*, III, 2), (1888).

integument in rapid-running water. Similarly with the Cobitidae, which have probably lost their scales in acquiring the burrowing habit. But the fact that the Cyprininae also of Seistan are, as it were, casting off their scaly garment and by a different process from either the Cobitidae or the Schizothoracinae, suggests that the phenomenon has some other, strictly local significance, and that there is something in the environment of these fish that renders scales an encumbrance rather than a protection. But what this something is, we do not know.[1]

Another general peculiarity of the fish of Seistan, possibly correlated with the degeneracy of the scales, is the brittleness of their fin-rays. This feature is so well-marked that difficulty was experienced in preserving specimens with the caudal and dorsal fins intact. Possibly both phenomena may be due, directly or indirectly, to the peculiar composition of the water in which these fish live; but this is a mere suggestion.

The species all seem to be mainly bottom-feeders, with at least partly ventral mouths and more or less flattened ventral surfaces. They do not, however, possess any highly specialized tactile organs, and their eyes, though rather small, are not degenerate. The fins are small, but at any rate in the Schizothoracinae and Cobitidae, much larger proportionately in the young than in the adult.

This is all we can say about the structural peculiarities of the fish-fauna of Seistan as a whole, but in two of the three species of Cobitidae a remarkable peculiarity occurs, namely, the persistence of the posterior part of the primitive dorsal fold in the form of a soft or adipose fin. This peculiarity has not been commented on hitherto in any Cyprinoid fish. It is not, however, found only in species from Seistan, for it is figured, apparently without comment in the Russian description, by Kessler in his *Nemachilus longicauda* from Turkestan. Moreover, as we will demonstrate later, the soft fin in these fish differs little in fundamental structure from the fold present in a young post-larval stage in the allied genus *Nemachilus*. Its persistence and slight modification in the species to which we give the generic name *Adiposia* is probably correlated with the necessity of burrowing in the mud in periods of drought. We will discuss the homology and function of the structure in detail when describing the genus.

All we can say, therefore, on the subject of structural modification in the fish of Seistan is that they are in several instances specialized forms, but that apart from a certain degeneracy of the scales, their specialization is not the result of evolution in their present home, but of long anterior specialization in the mountains of Central Asia. Their migration to the swampy

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[1] A suggestion has been made to us that the disappearance of the scales may be correlated with increased necessity for respiration by means of the skin, but this could hardly be affected by deciduous scales, which are only lost when the fish suffers rough treatment.

basin of Seistan has been in all probability too recent for any very marked change to have taken place in their structure, and, as is so often the case when a fauna survives in abnormal conditions, structural peculiarities are on the whole less marked than a physiological vigour and a power of reproduction sufficient to overcome adverse factors in the environment. It is too often forgotten that physiological evolution may take place, and frequently does take place, without visible bodily change.

DESCRIPTION OF THE FAUNA.

All the fish in the fauna of Seistan belong to the suborder Cyprinoidea and to the families Cyprinidae and Cobitidae. Those representing the former family belong to the two subfamilies Cyprininae and Schizothoracinae. Three species fall in the Cobitidae, and three in each of the subfamilies of Cyprinidae.

KEY TO THE FISHES OF SEISTAN.

A. Scales of large or moderate size present on some part of the body; posterior pharyngeal bones stout, bearing coarse teeth arranged as a rule in more than one row; air-bladder large, free ... ... Cyprinidae.

1. Lateral scales of large or moderate size, much less than 100 in lateral line; no greatly enlarged scales in the region of the vent ... ... Cyprininae.

a. Lower jaw sharp, with an internal horny sheath; no adhesive disk behind the mouth... *Scaphiodon.*

Scales 37-39$\frac{7}{8}$, 2 barbels; diameter of eye 4 to 4$\frac{1}{2}$ times in length of head, depth of body 3$\frac{3}{5}$ to 3$\frac{4}{5}$ in total length ... ... *S. macmahoni.*

b. Lower jaw blunt, without a horny sheath; an adhesive disk behind the mouth .. *Discognathus.*

i. Ventral surface covered with scales; 4 barbels; adhesive disk without posterior free border ... ... *D. adiscus.*

ii. Chest naked; 2 barbels; posterior border of adhesive disk free ... *D. phryne.*

2. Lateral scales, if present, small, more than 100 in the lateral line; a sheath of greatly enlarged scales in the anal region ... ... Schizothoracinae.

a. No lateral scales; a scapular patch of enlarged scales present; no barbels; lower jaw sharp ... ... *Schizopygopsis.*

Mouth extending backwards nearly as far as or slightly beyond the anterior border of the eye; pectoral fin much shorter than head ... *S. stoliczkae.*

b. Lateral scales present.

i. Mouth terminal or subterminal, lower jaw blunt; ventral scales present; 4 barbels ... ... *Schizothorax.*

Scales at base of fins slightly enlarged; anal sheath rather poorly developed; lips normal ... ... *S. zarudnyi.*

ii. Mouth ventral; lower jaw sharp, ventral scales absent; barbels vestigial or absent ... ... *Schizocypris.*

Origin of dorsal equidistant from eye and base of caudal, above posterior part of pelvic ... ... *S. brucei.*

B. Scales vestigial or absent; posterior pharyngeal bones slender, bearing a single row of slender teeth; air-bladder small, enclosed in bone; at least 6 barbels present ... ... Cobitidae.

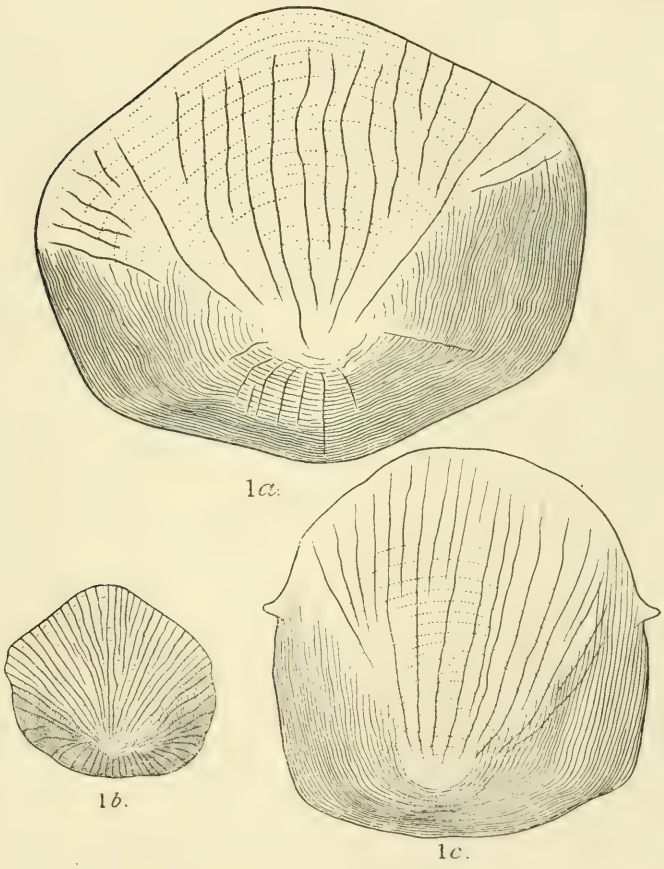
1. No soft dorsal fin ... ... *Nemachilus.*

Caudal peduncle at least 3 times as long as deep, length of head 4–4¾ times in total length (without caudal) ... ... *N. stoliczkae.*

2. A ridge-like soft dorsal fin present ... ... *Adiposia.*

a. Dorsal and ventral profiles straight, parallel... *A. rhadinaea.*

b. Dorsal profile irregular owing to the depression of the head and the convexity of the anterior part of the back. ... ... *A. macmahoni.*



TEXT-FIG. 1.—Scales of Cyprininae.

a. Dorso-lateral scale of *Scaphiodon macmahoni*, × 17½.
b. Dorso-lateral scale of *Discognathus phryne*, × 17½.
c. Dorso-lateral scale of *Discognathus adiscus*, × 17½.

Family CYPRINIDAE.

Subfamily *CYPRININAE.*

The Cyprininae are a dominant group in the fish-fauna of India and are well represented even in that of Baluchistan and

Sind. They form a large proportion of that of Persia and are abundant in western Asia. In Seistan, however, only three species and two genera are known, and these are the only species (except possibly *Schizocypris brucei*) that are not of direct Central Asiatic ancestry.

The two genera are *Discognathus*, Heckel (which we distinguish from *Garra*, Ham. Buch.) and *Scaphiodon*, Heckel. Both these genera probably originated in south-western Asia, but whereas *Scaphiodon* has proliferated specifically in Baluchistan and has extended its range from southern Arabia southwards and eastwards through Mesopotamia and southern Persia, along the Mekran coast and through Sind to the Malabar Zone of Peninsular India, *Discognathus*, of which only a few species are known, occupies a region extending from the North-West Frontier of India to Syria. Since or shortly before reaching India, however, it gave rise to a more highly specialized offshoot (*Garra*) which has separated into many species in the Peninsula and ranges, possibly from Syria[1] to Borneo and southern China. *Scaphiodon*, *Garra* and probably *Discognathus* occur together in Oman.

Genus **Scaphiodon**, Heckel.

1878. *Scaphiodon*, Day, *Fishes of India*, II, p. 550.
1913. *Scaphiodon*, Zugmayer, *Abh. Wiss. K. Bay. Ak.* (*Math.-phys. Klasse*), XXVI, p. 28.

The geographical distribution of this genus is peculiar. It seems to centre in Baluchistan, in which no less than six distinct species occur. Thence it extends westwards to Persia and southern Arabia and southwards through Sind down the Malabar Zone of Peninsular India and inland as far as the base of the Nilgiris.

Zugmayer (*op. cit.*) discusses the species known from Baluchistan and Seistan.

Scaphiodon macmahoni, Regan.

1906. *Scaphiodon macmahoni*, Regan, *Journ. As. Soc. Bengal*, II, p. 8.

To facilitate reference we quote Mr. Tate Regan's description of the species:—

"Depth of body $3\frac{3}{5}$ to $3\frac{4}{5}$ in the length, length of head $4\frac{1}{5}$ to $4\frac{2}{5}$. Snout obtuse, shorter than the post-orbital part of head. Diameter of eye 4 to $4\frac{1}{2}$ in the length of head, interorbital width $2\frac{3}{5}$, $2\frac{2}{3}$. Mouth inferior; lower jaw with nearly straight transverse anterior edge; barbel originating directly below the nostril, shorter than the eye. Scales 37-$39\frac{7}{8}$, 4 between lateral line

[1] The systematic position of the Syrian *Discognathus rufus*, Heckel, previously regarded by one of us as a race of *D. lamta*, Ham. Buch. is doubtful. No specimens are at present available to us, but the figure published in the *Journal of the Asiatic Society of Bengal* (N.S.) IX, p. 37, fig. 2, suggests that the species is a true *Discognathus* (*s.s.*).

and root of the ventral fin, 16-18 round the caudal peduncle; the two rows above the lateral line the largest; scales of the lower part of the abdomen small or rudimentary. Dorsal III, 10, its origin equidistant from tip of snout and base of caudal; third simple ray moderately strong, serrated in its basal half, $\frac{2}{3}$ to $\frac{3}{4}$ the length of the head and $1\frac{1}{4}$ as long as the last branched ray, free edge of the fin straight. Anal III, 6-7, the second branched ray a little longer than the first or the third and twice as long as the last, as long as or little longer than the longest dorsal ray. Pectoral, a little shorter than the head, extending $\frac{2}{3}$ or $\frac{5}{6}$ of the distance from its base to the base of ventral. Ventrals originating below the first branched ray of dorsal, extending nearly to the origin of anal. Caudal forked. Caudal peduncle $1\frac{1}{2}$ to $1\frac{3}{4}$ as long as deep, its last depth not more than $\frac{1}{2}$ the length of head. Greyish above, silvery below, fins pale or somewhat dusky.

Two specimens 70 and 110 mm. in total length. The larger with tubercles on the snout and on the rays of the anal fin.

Cyprinion kirmanensis, Nikolski, 1899, appears to be allied to this species, but differs at least in the larger eye, the thick and strongly serrated last simple dorsal ray, the form of the dorsal fin and the coloration."

The lateral scales agree fairly well with Cockerell's [1] description of those of other species of the genus but differ in having ill-developed radii on the basal part and in lacking tubercles between the radii. The base resembles that of his figure of the scale of *S. muscatensis*. Those on the ventral surface are entirely buried in the skin. They all appear circular on the surface, but the larger ones are sub-triangular, the distal end being produced and bluntly pointed. The smallest ventral scales are transversely oval and have the nucleus nearly central. Their basal radii are well developed. A large scale from the row above the lateral line has the following measurements:—length 3·9 mm., breadth 4·2 mm., distance of nucleus from base 0·8 mm.; in a sub-triangular ventral scale they are, length 1·7 mm., breadth 1·8 mm., distance of nucleus from base 0·5 mm.; in a small transversely oval ventral scale, length 1·1 mm., breadth 1·3 mm., distance of nucleus from base 0·5 mm.

Only two specimens are known, both collected by the Seistan Arbitration Commission in the delta of the Helmand. We have examined the larger of the two, which is preserved in the Indian Museum. The tubercles on its snout and fins referred to by Regan

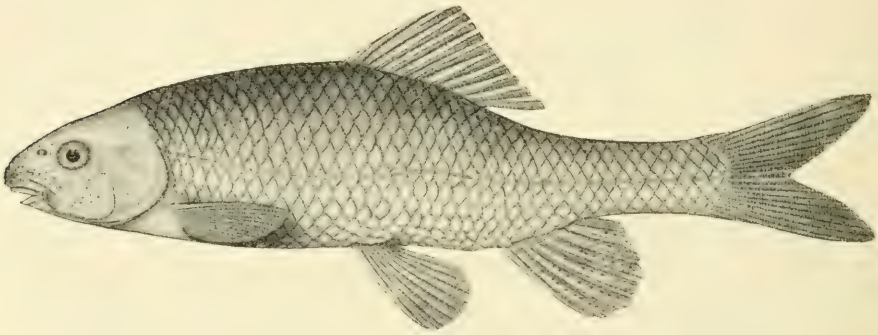
[1] Cockerell, *Bull. Bur. Fisheries* (Washington), XXXII, p. 138, pl. xxxiii, fig. 10 (1912).

are of parasitic origin, as is shown in the following note, for which we have to thank Dr. Baini Prashad :—

"The tubercles noted by Regan in the description of the large specimen of *S. macmahoni* are due to the encysted glochidia of some Unionid. The arrangement of these parasites in this specimen is rather striking. There are three to five slightly irregular rows on the snout and the region of the head below the eyes. On the anal fin there are six parallel rows following the lines of the fin-rays on either face.

The number of glochidia in each row varies from about three to ten. In addition to those in the two situations noted by Regan in his account, there are a few glochidia encysted on some of the scales of the ventro-lateral regions of the body between the ventral and the anal fins.

Owing to the glochidia being in an advanced stage of encystment and the poor preservation of the specimen, it is not possible



TEXT-FIG. 2.—One of the type-specimens of *Scaphiodon macmahoni* with encysted glochidia on head and fins.

to ascertain all the larval characters. It is, however, clearly seen that the hinge-line is not straight but curved, and that the surface of the shell-valves is minutely sculptured.

Owing to our limited knowledge of the anatomy of the Seistan Unionidae it is not possible to assign the glochidia to any definite species, but they may possibly belong to *Lamellidens marginalis* subsp. *rhadinaeus*, Annandale and Prashad,[1] a form widely distributed in the basin of the Helmand river and recently described."

Scaphiodon macmahoni, Regan (type).

Measurements (in millimetres), number of fin-rays, scales and proportions :—

1.	Total length (including caudal)	...	...	114·6	mm.
2.	Length of caudal ...	...	...	22·2	,,
3.	Greatest depth of body ...	...	...	25·4	,,
4.	Length of head ...	...	...	21·3	,,

[1] *Rec. Ind. Mus.*, XVIII, pp. 59-62, pl. viii, figs. 7-11 (1919).

5.	Width of head	14·7	mm.
6.	Length of snout	8·0	,,
7.	Diameter of eye	4·5	,,
8.	Interorbital width	8·2	,,
9.	Longest ray of dorsal	16·7	,,
10.	,, ,, ,, anal	17·9	,,
11.	Length of pectoral	17·4	,,
12.	No. of branched rays in dorsal	10	
13.	,, ,, ,, ,, anal	6	
14.	No. of scales in L.L.	38	
15.	,, ,, ,, in T. Series above L.L. ...	$7\frac{1}{2}$	
16.	,, ,, ,, below L.L.	$12\frac{1}{2}$	
17.	,, ,, between L.L. and Ventral ...	$4\frac{1}{2}$	
18.	$\frac{1}{2}$,, ...	*5·16*	
19.	$\frac{1}{3}$,, ...	*4·51*	
20.	$\frac{1}{4}$,, ...	*5·38*	
21.	$\frac{1}{7}$,, ...	*4·73*	
22.	$\frac{\text{1-Caudal}}{2}$	*4·16*	
23.	$\frac{\text{1-Caudal}}{3}$	*3·63*	
24	$\frac{\text{1-Caudal}}{4}$	*4·33*	

Discognathus, Heckel.

1843. *Discognathus*, Heckel in Russeger, *Reisen*, I, 2, p. 1027.
1863. *Discognathus* (s.s.), Bleeker, *Atl. Ichth.*, III, p. 24.
1919. *Discognathus*, group of *D. variabilis*, Annandale, *Rec. Ind. Mus.*, XVIII, p. 67.

The genus as restricted may be defined as follows :—

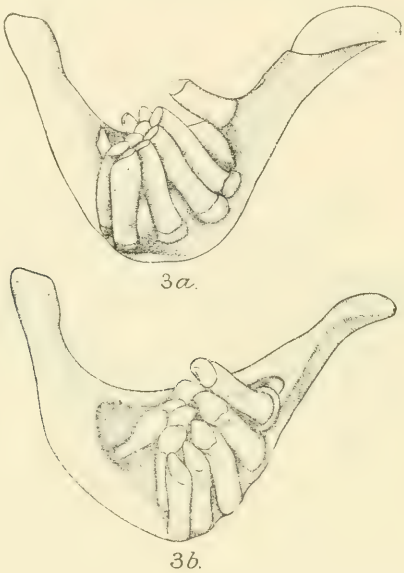
Cyprininae with a ventral mouth situated only a short distance behind the tip of the snout, with exposed cartilaginous jaws without horny covering, a fringed membranous, tuberculate upper lip, a vestigial lower lip ; situated behind the mouth a more or less well-defined adhesive disk less than half as wide as the head and consisting of a semi-cartilaginous pad with or without an anterior but always without a posterior specialized border, at least partially free round the margin but often adherent at the sides or posteriorly. The snout not modified in either sex. Seven or 8 branched rays in the dorsal fin and 5 in the anal. Form compressed, but ventral surface slightly flattened. Branchial opening moderate; opercular and praeopercular borders meeting those of the opposite side at an acute angle on the ventral surface some distance behind the adhesive disk ; branchial isthmus narrow. Scales at least nearly as broad as long, somewhat deciduous in the species examined, with well-defined radii at any rate on the distal part and concentric transverse striae at the base. Pharyngeal bones delicate, bearing 11 elongate fixed teeth and at least one free, minute tooth ; dental formula (omitting free teeth) 5·3·3 3·3·5 or 5·4·2 2·4·5 : teeth closely crowded together.

Type-species : *D. variabilis*, Heckel (selected by Bleeker).

This genus is distinguished from *Garra* (s.s.) by the more anterior position of the mouth, the less complex structure of the adhesive disk, less flattened ventral surface, and narrow branchial

isthmus. From *Cirrhina* and *Crossochilus* it is separated by the presence of an adhesive disk on the ventral surface of the head. The jaws are also less sharp and not so bony. They have no trace of horny covering. Further, except in *Cirrhina afghana* from the Nushki desert, the characters of which are very divergent, the scales of the Indian species of *Cirrhina* are always distinctly longer than broad. The teeth also are stouter than those of *Discognathus*.

The relationship of *Discognathus* to *Garra* seems fairly clear. There can be no doubt that the former is the more primitive of the two, departing less from the normal Cyprinid type. This is borne out not only by the structure of the adult *Discognathus*

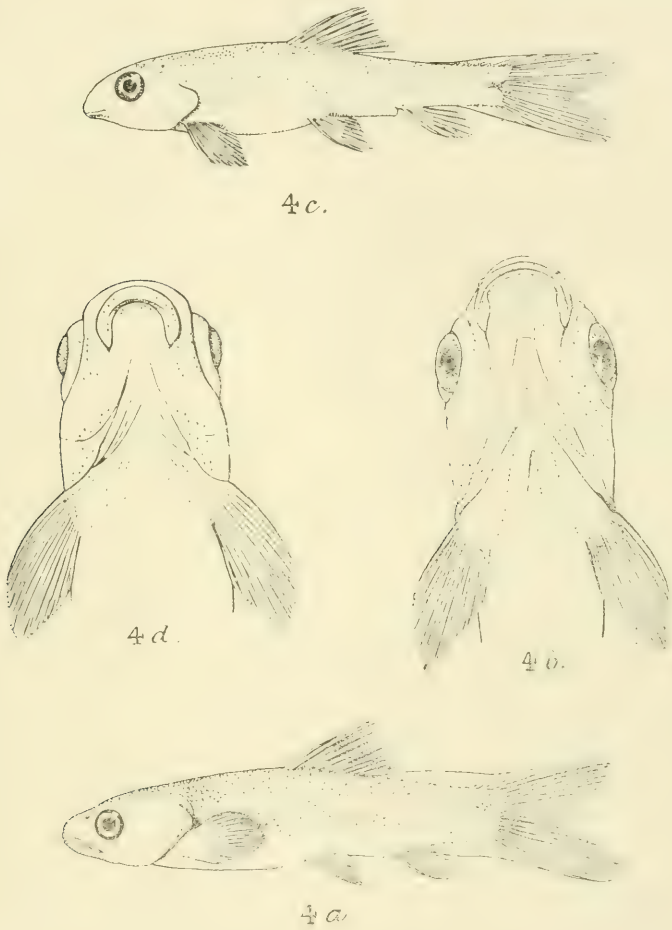


TEXT-FIG. 3.—Pharyngeal teeth of *Discognathus*.
a. D. adiscus.
b. D. phryne.

but also by the fact that the young *Garra* passes through a stage in which the structure of the head agrees with that of *Discognathus*. We figure a young specimen of *G. nasutus* 7·4 mm. long, illustrating this point, with one of about the same size of *Psilorhynchus* for comparision. It will be seen that its adhesive mental disk and also its branchial isthmus closely resemble those of *D. adiscus* (*Rec. Ind. Mus.*, XVIII, pl. xi, fig. 1). We refrain from discussing this point further because Prof. D. R. Bhattacharyya of Allahabad is at present engaged in a detailed study of the anatomy of the mouth-parts, etc., of these fish.

The genetic relationship in the opposite direction between *Discognathus* on the one hand, and *Crossochilus* and *Cirrhina* on the other, though undoubtedly close, is not yet capable of full

discussion, which would involve an examination not only of all the Indian species assigned to *Cirrhina* but also of the Malayan ones assigned to *Crossochilus*. We have made a somewhat cursory survey of the former but find so much diversity of structure and



TEXT-FIG. 4.—Young of *Garra nasuta* and *Psilorhynchus tentaculatus*.
a. Lateral view of young *D. nasuta* showing dorsal fold (magnified).
b. Lower view of head of same fish (further magnified) showing resemblance of ventral disk to that of *Discognathus adiscus*.
c. Young of *Psilorhynchus tentaculatus* at a slightly later stage of development (magnified).
d. Dorsal view of head of same fish (further magnified) showing complete absence of disk.

so little correlation between the different peculiarities noted in certain species by former authors, that we think it best to put the subject aside for further consideration when more material from the Malay Peninsula and Archipelago is available.

Another point on which a few words may be desirable is that of the use of the names *Discognathus* and *Garra*. The former was first applied by Heckel [1] to a group of fishes including species of both genera. The original work is not available in India, and we have to thank Mr. Tate Regan for the information that Heckel did not designate a type-species. Bleeker,[2] however, in 1863, while accepting *Garra* as a generic name, recognized *Discognathus* as a subgenus, for which he selected *D. variabilis*, a form closely allied to *D. phryne*, as type-species. The fact that he based the subgeneric division on the number of barbels, an unimportant character, does not invalidate his nomenclature, and if the group of which *D. variabilis* is a member is to be regarded as a distinct genus there can be no dispute as to its proper name.

The status of the name *Garra* is a little more doubtful. It was first proposed by Buchanan [3] as that of a division of *Cyprinus*, for a heterogeneous collection of convergent species including forms now referred to *Cirrhina*, *Psilorhynchus* and *Balitora*. No type-species was selected, but *Cyprinus lamta* was described first, and the name of the division was that given locally to this fish. As has been pointed out in a former note in this volume (p. 77), it is doubtful what *Cyprinus lamta*, which may have been a composite species, really was; but there can be no doubt that it was a member or set of members of the genus we now call *Garra*.

Various other names were applied to species of the same genus by the earlier writers on Indian ichthyology, such as *Chondrostoma*, *Goniorhynchus* and *Platycara*. The only one of these that need be considered is the last, as the others were originally given to fish unrelated to the Indian species. *Platycara* was coined by McClelland in 1838 to take the place of *Balitora*, Gray, which he regarded as barbarous and etymologically incorrect. Gray's *Balitora*, as is clear from the figure in the "Illustrations" (fig. 192, pl. 68) was a Homalopterid, but the only species definitely assigned to *Platycara* by McClelland in his earlier work [4] was *nasutus*, which is equally certainly congeneric with Buchanan's *Cyprinus* (*Garra*) *lamta*. In the same paper McClelland described the genus *Psilorhynchus*, for another species included by Buchanan in his group *Garra*, and the name *Platycara* is printed above that of *Psilorhynchus*. No one has disputed McClelland's right to separate this genus from *Garra*. In a slightly later, more comprehensive and better-known work,[5] however, McClelland definitely placed Gray's *Balitora maculata* in his genus *Platycara*, and as the earlier paper was clearly not meant to be comprehensive, it may be assumed that he always intended that this species should be what is now called the type-species of the genus.

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[1] Heckel in Rüssegger, *Reisen*, I, 2, p. 1027 (1843).
[2] Bleeker, *Atl. Ichth.*, III, p. 24 (1863).
[3] Buchanan, "*An Account of the Fishes of the Ganges*" (1822).
[4] McClelland, *Journ. As. Soc. Bengal*, VII, p. 944 (1838).
[5] McClelland, *Asiatic Researches*, XIX, p. 246 (1839).

The name *Garra* was used in a double sense by Bleeker,[1] as that of a genus, in which he included species of both the genera recognized by us, and also (*sensu stricto*) as that of a subgenus, from which he excluded the species accepted by us as the type-species of *Discognathus*. Buchanan was not acquainted with any form belonging to this latter group, which is not found in the territory explored by him.

Taking all these facts into consideration, we accept Jordan and Evermann's [2] finding that *Garra*, Ham. Buch. is the correct generic name of the species assigned by Day to *Discognathus*, but much of the synonymy in the *Fishes of India* under the latter name is incorrect.

Discognathus adiscus, Annandale.

1919. *Discognathus adiscus*, Annandale, *Rec. Ind. Mus.*, XVIII, p. 68, pl. x, fig. 2, pl. xi, fig. 1.

The formula of the pharyngeal dentition is capable of two interpretations. Omitting the minute free teeth (found not only in this genus but also in *Garra* and *Cirrhina*) it may be read either 5·4·2 2·4·5 or 5·3·3 3·3·5. The scales [3] are subcircular, but slightly longer than broad, sinuate at the base and rounded distally. Some have a pair of lateral processes as shown in fig. 1. They have nine or ten radii, which proceed obliquely forwards. About half of these radii arise near the nucleus, which is situated at about a sixth of the distance between the base and the distal margin; the others are much shorter and arise nearer the distal margin; long and short radii alternate, but not always. There are about 10 to 12 transverse striae near the base in fully formed scales. Dentritic blotches and minute round dots of pigment are scattered on the distal part. The measurements of a large lateral scale are as follows:—length 3 mm., breadth 2·7 mm., distance of nucleus 0·45 mm.

We give measurements, etc. of a series of specimens from Seistan.

In many respects this is the most primitive species of the genus known and the most closely related to *Cirrhina*. It is interesting to observe that the young of *Garra nasuta* [4], one of the most highly specialized member of its genus, passes through a stage at which the mental disk is very similar to that of *D. adiscus*.

D. adiscus lives in still or sluggish water and feeds on algae on a muddy bottom. It is markedly gregarious and may sometimes be seen on the surface of water-channels in the evening in shoals. In the plain of Seistan *D. adiscus* and the young of *Schizothorax zarudnyi* are almost equally abundant in pools left in

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[1] Bleeker, *Atl. Ichth.*, III, p. 24 (1863).

[2] Jordan and Evermann, *The Genera of Fishes*, p. 115 (1917).

[3] This statement is not in verbal agreement with that of Cockerell, *Bull. Bur. Fish.* (Washington), XXXII: 1912); but the question is one of degree.

[4] See Annandale, *Rec. Ind. Mus.* XVI, p. 132, pl. ii, fig. 2.

dry stream-beds in December. They perish annually in enormous numbers at this season as the water grows salt or foul owing to evaporation or to the excreta of large flocks of sheep and goats belonging to the nomad tribes who camp near the stream-beds. The *Discognathus* is found, alone or with *D. phryne*, also in permanent irrigation channels and is very abundant in those that supply the garden of the British Consulate at Nasratabad or Shahr-i-Seistan. A few moribund individuals were caught at the same season in the reed-beds of the Hamun-i-Helmand, but the reason why they were dying was not apparent, for the water was neither salt nor foul. Numerous healthy individuals were captured in a reedy canal leading out of the Hamun a few days later.

Discognathus adiscus, Annandale.

Measurements (in millimetres). Number of Fin-rays, Scales and Proportions.

1	Total length (including caudal)	50·5	58·9	41·0	70·4	41·5	56·3	57·3	54·8	63·7	60·0	52·3	46·0
2	Length of caudal ..	11·0	13·0	9·0	14·6	8·2	13·0	13·1	11·4	14·0	13·0	11·8	10·0
3	Greatest depth of body.	9·0	10·7	8·0	13·6	8·1	11·0	11·0	9·5	11·0	10·2	10·0	7·0
4	Length of head ..	9·[illegible]	11·5	7·5	12·9	8·0	10·6	10·8	10·3	11·5	10·6	10·4	9·0
5	Width of head ..	7·8	8·2	5·6	9·0	6·1	7·8	7·8	7·0	7·8	8·6	7·2	6·2
6	Length of snout ..	3·3	4·6	3·0	5·0	3·2	3·9	4·5	3·5	4·0	4·0	3·8	3·0
7	Diameter of eye ..	2·5	2·9	2·2	3·3	2·4	3·0	3·1	3·0	3·3	3·0	2·1	2·6
8	Interorbital width ..	4·3	5·0	4·0	6·8	4·0	5.0	5·0	4·9	5·0	5·2	5·0	4·2
9	Longest ray of dorsal.	9·2	12·5	9·2	14·6	8·3	11·0	11·3	10·6	13·0	12·2	10·8	9·8
10	Longest ray of anal ..	7·0	8·4	5·1	10·3	6·0	7·5	7·7	6·9	9·6	8·8	8·2	6.5
11	Length of pectoral ..	7·4	10·7	6·9	12·8	7·1	9·2	10·0	9.3	11·2	10·7	8·6	8·0
12	No. of branched rays in dorsal ..	8	8	8	8	8	8	8	8	8	8	8	8
13	No. of branched rays in anal	5	5	5	5	5	5	5	5	5	5	5	5
14	No. of scales in L.L. ..	37	36	36	37	37	37	37	37	37	35	35	36
15	No. of scales in transverse line above L.L.	5	5	5	5	5	5	5	5	5	5	5	5
16	No. of scales in transverse line below L.L.	6½	6½	6½	6½	6½	6½	6½	6½	6½	6½	6½	6½
17	$\frac{1}{2}$	4·59	4·53	4·55	4·82	5·06	4·33	4·37	4·8	4·55	4·61	4·43	4·3
18	$\frac{1}{3}$	5·6	5·5	5·12	5·17	5·12	5·11	5·2	5·76	5·79	5·88	5·23	6·57
19	$\frac{1}{4}$	5·31	5·1	5·46	5·45	5·18	5·31	5·3	5·32	5·53	5·66	5·03	5·11
20	$\frac{1}{5}$	3·8	3·9	3·41	3·9	3·3	3·53	3·48	3·43	3·5	3·53	2·73	3·46
21	$\frac{1\text{-Caudal}}{2}$, ..	3·59	3·53	3·55	3·82	4·06	3·33	3·37	3·8	3·55	3·61	3·43	3·6
22	$\frac{1\text{-Caudal}}{3}$, ..	4·4	4·3	4·0	4·1	4·13	3·93	4·0	4·57	4·51	4·6	4·05	5·4
23	$\frac{1\text{-Caudal}}{4}$, ..	4·3	4·0	4·26	4·32	4·16	4·08	4·07	4·21	4·32	4·43	3·9	4·0

Discognathus phryne, Annandale.

? 1897. *Discognathus variabilis*, Nikolsky, *Ann. Mus. Zool. Ac. Sci.*, St. Petersburg, II, p. 347.

1899. *Discognathus variabilis*, Nikolsky (? in part), *ibid.*, IV, p. 412.

1906. *Discognathus variabilis*, editorial note to Regan, *Journ. As. Soc. Bengal*, II, p. 8.

1919. *Discognathus phryne*, Annandale, *Rec. Ind. Mus.*, XVIII, p. 70, pl. x, fig. 3; pl. xi, fig. 2.

The arrangement and structure of the pharyngeal teeth is very similar to that in *D. adiscus*, but they are a little stouter. We find in two specimens of a large series that small vestigial scales occur on the sides of the abdomen. In these specimens 9½ scales, including the vestigial ones, can be distinguished below the lateral line on each side. We have not found any trace of scales on the dorsal line. Fully formed scales are shorter in proportion than those of *D. adiscus* and differ in being ornamented with radii below as well as above the nucleus. The circular striae are more numerous and less regular and the scale has a much more reticulate appearance. The following are the measurements of a large scale from just above the lateral line:—length 1·8 mm.; breadth 2 mm.; distance of nucleus from base 0·3 mm. The specimens of which measurements are given in the table are from the Pishin district of northern Baluchistan, except No. 6, which is the type-specimen from Seistan.

This species has been generally confused with *D. variabilis*, Heckel, from which it differs, according to the description given by Günther,[1] in the size of the eye as well as in its naked ventral and dorsal surfaces. It is impossible, therefore, to discuss the geographical distribution in detail. *D. variabilis* has been recorded from several localities in Syria, Mesopotamia and eastern Persia. Records from the last district probably refer to *D. phryne*.

D. phryne is, with the exception of *Nemachilus montanus* (McClell.) (not the *N. montanus* of Day), by far the most abundant fish in the small streams of the Quetta and Pishin districts of northern Baluchistan at altitudes between 5,000 and 6,000 feet. It is not found in very rapid water but lives in thickets of Characeae and other algae growing on a muddy bottom. Its food consists mainly of soft filamentous algae. At the Kushdil Khan reservoir it was observed in winter to collect in large numbers in pools into which water of a comparatively high temperature was flowing from underground sources into the outflow. The colour is much darker in very clear than in muddy water. In Seistan the species occurs in irrigation channels and probably (*fide* Nikolsky) in the reed-beds of the Hamun. Several specimens were captured by the members of the Seistan Arbitration Commission in the delta of the Helmand.

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[1] Günther, *Cat. Fish. Brit. Mus.*, VII, p. 71 (1868).

Discognathus phryne, Annandale.

Measurements (in millimetres). Number of Fin-rays, Scales and Proportions.

1	Total length (including caudal) ..	53·0	63·3	46·4	55·3	74·7	66·0	70·0	38·0	39·0
2	Length of caudal	12·4	14·4	10·7	12·6	15·0	15·0	12·0	9·0	8·0
3	Greatest depth of body	9·2	12·9	8·8	10·6	12·8	13·2	15·0	8·3	8·5
4	Length of head	10·5	13·2	9·6	11·4	13·8	12·8	13·0	8·1	8·0
5	Width of head	7·9	10·3	6·8	8·1	10·9	9·6	11·0	6·0	6·0
6	Length of snout	4·0	5·4	3·8	4·8	5·0	5·3	5·5	2·8	3·0
7	Diameter of eye	2·2	3·0	2·0	2·3	3·0	2·9	3·3	2·0	2·1
8	Interorbital width	5·0	6·8	4·6	5·1	6·0	5·8	6·8	4·0	4·0
9	Longest ray of dorsal	0·0	12·2	8·0	8·6	11·9	12·5	12·9	7·5	6·1
10	Longest ray of anal	7·8	10·5	7·5	8·6	9·7	9·5	10·0	5·2	5·3
11	Length of pectoral	9·9	11·5	8·0	9·7	11·5	10·4	11·5	8·0	6·6
12	No. of branched rays in dorsal ..	7	7	7	7	6	7	7	7	7
13	No. of branched rays in anal ..	5	5	5	5	5	5	5	5	5
14	No. of scales in L.L.	35	33	33	34	40	35	36	35	35
15	No. of scales in transverse line above L.L.	5½	4½	2½	4½	6½	5½	6½	5½	3½
16	No. of scales in transverse line between L.L. and ventral ..	4½	5½	5½	5½	6½	4½	5½	5½	5½
17	$\frac{1}{2}$	*4·27*	*4·4*	*4·33*	*4·37*	*4·98*	*4·4*	*5·81*	*4·22*	*4·87*
18	$\frac{1}{3}$	*5·76*	*4·9*	*5·27*	*5·21*	*5·83*	*5·0*	*4·66*	*4·57*	*4·58*
19	$\frac{1}{4}$	*5·05*	*4·8*	*4·83*	*4·85*	*5·83*	*5·15*	*5·38*	*4·69*	*4·85*
20	$\frac{4}{7}$	*4·77*	*4·4*	*4·8*	*4·95*	*4·6*	*4·41*	*4·03*	*4·05*	*3·81*
21	$\frac{1\text{-Caudal}}{2}$, ...	*3·27*	*3·4*	*3·33*	*3·37*	*5·98*	*3·4*	*4·81*	*3·22*	*3·87*
22	$\frac{1\text{-Caudal}}{3}$, ...	*4·41*	*3·8*	*4·05*	*4·02*	*4·66*	*3·86*	*3·86*	*3·49*	*3·64*
23	$\frac{1\text{-Caudal}}{4}$, ...	*3·86*	*3·7*	*3·71*	*3·74*	*4·32*	*4·0*	*4·5*	*3·58*	*3·87*

Subfam. *SCHIZOTHORACINAE.*

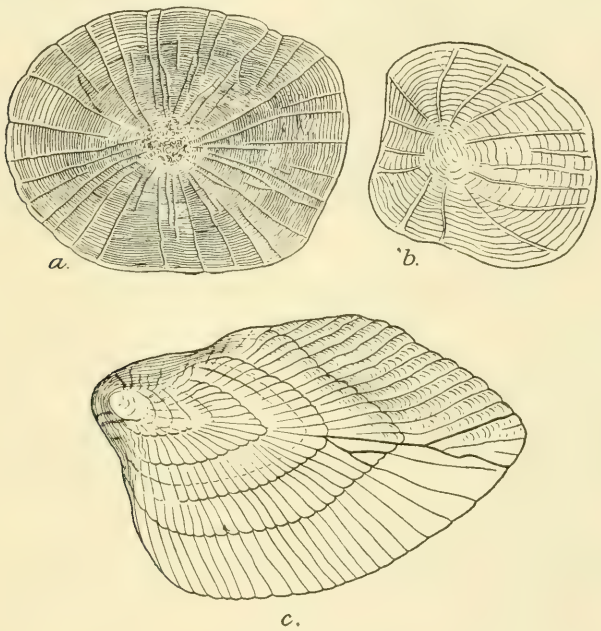
This subfamily is distinguished from the Cyprininae by the Salmonoid facies of the species, their small or degenerate lateral scales and the presence of an anal sheath consisting of folds of skin covered with greatly enlarged scales arranged in two parallel longitudinal rows.

We have already commented on the two most noteworthy features of the Schizothoracinae, their geographical isolation and their superficial resemblance to the Salmonidae. It may be well, however, to state more precisely the characters wherein this resemblance consists, and those whereby the subfamily is linked to the Cyprininae.

The resemblance to the Salmonidae is entirely external. It consists in the graceful but powerful frame of the fish, their small scales and usually silvery, often spotted colouration. The close relationship to the Cyprininae is manifested in the whole structure. One or two important features of agreement may be noted. The air-bladder in both subfamilies is normally very large and is divided into a larger posterior and a smaller anterior region by a transverse

constriction. The pneumatic duct is long and slender and opens into the posterior part of the bladder just behind the constriction. In *Schizothorax zarudnyi* the weberian ossicles closely resemble those of so different-looking a Cyprinid as *Labeo rohita*, to which one of us has recently devoted special study in reference to these bones. The alimentary canal also is closely similar in the two fish.

There is a strong probability that the Central Asiatic subfamily is related to the *Labeo* section of the Cyprininae, from which it has been derived as a result of isolation in mountain rivers flowing rapidly at high altitudes. An important factor,



TEXT-FIG. 5.—Scales of Schizothoracinae.

a. Dorso-lateral scale of *Schizothorax zarudnyi*, × $17\frac{1}{2}$.
b. Dorso-lateral scale of *Schizocypris brucei* (adult specimen), × $37\frac{1}{2}$.
c. Anal scale of *Schizopygopsis stoliczkae* from Siestan, × $17\frac{1}{2}$.

noticed by Stewart[1] in Tibet, is probably the necessity for long and arduous migrations at different periods of life.

The three species (each of a different genus) that live in the lowlands of Seistan are either identical with or very closely related to mountain forms, but, as we have already noted, their isolation in a depression has not produced any very noteworthy structural modification of a general kind, perhaps because it is still too recent.

[1] Stewart, *Rec. Ind. Mus.*, VI, p. 73 (1911).

Genus **Schizothorax**, Heckel.

1888. *Schizothorax*, Herzenstein, *Fische*, p. 96, in *Wiss. Res. Przewalski Central-As. Reis., Zool.* III (2).

1916. *Schizothorax*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova*, (3), VII, p. 123.

The genus is well represented in the Helmand system, whence Vinciguerra (*loc. cit.*) has given the names of the following five species:—*S. brevis*, McClell., *S. macrolepis* (Keys.), *S. minutus*, Kessler, *S. ritchianus* (McClell.), and *S. zarudnyi* (Nikolsky). There is also in the Indian Museum a mutilated skin from the old collection of the Asiatic Society of Bengal labelled "Schizothorax labiatus, McClell. Helmund R., Afghanistan." The specimen is too imperfect to substantiate the identification, but the species to which it has been assigned is too distinctive to have been readily mistaken. We have thus six species known from this river-system, but except *S. zarudnyi* all these species have been found only in the upper waters at comparatively high altitudes. *S. zarudnyi*, moreover, is so closely allied to *S. intermedius*, McClell., a species common in some parts of the mountains of Afghanistan, that there can be little doubt as to its having originated as an isolated race of that species.

Schizothorax zarudnyi (Nikolsky).

(Plate XV, figs. 1, 2).

1897. *Apiostoma zarudnyi*, Nikolsky, *Ann. Mus. Zool. Ac. Sci.*, St. Petersburg, II, p. 346.

1899. *Schizothorax zarudnyi, id., ibid.*, IV, p. 409.

This species is, as we have already stated, very closely allied to *S. intermedius*, McClell.,[1] but the following differential characters are constant in a large series of adult specimens:—

1. The paired fins are much smaller.
2. The branchial isthmus is longer and narrower.
3. The scales are slightly enlarged at the base of all the fins, especially the dorsal and the anal.

Among the races assigned to *S. intermedius* by Herzenstein *S. zarudnyi* comes nearest *affinis*, Kessler (*op. cit.*, p. 113, pl. xiv, fig. 1), but the snout is more pointed and the paired fins smaller and there are no greatly enlarged scales behind the opercular border.

These differences may seem to some ichthyologists of no more than racial value and we have already admitted that we believe *S. zarudnyi* to have originated from *S. intermedius* as a local race. The differences are, however, so constant that we consider it more convenient to regard the Seistan fish as now specifically distinct.

The colouration varies with the environment. In muddy water the back and fins are pale olive-green, the sides faintly

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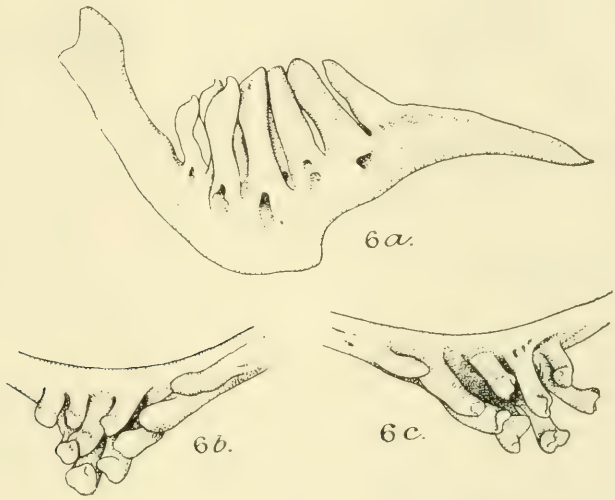
[1] Herzenstein (*op. cit.*, p. 106) does not regard the form identified with McClelland's species by Day as the *forma typica*, but see Günther, *Cat. Fish. Brit. Mus.*

tinged with green and the belly pure white. In the yellow water of the reed-beds the back and sides are much darker, sometimes almost black. A few silvery scales are always present on the back and some adult males have the fins reddish, and dull red specks scattered on the dorsal surface.

The following measurements of a large male and female were taken from freshly killed fish:—

	♀	♂
Total length	460 mm.	490 mm.
Length of head	92 ,,	106 ,,
Length of eye	11·5 ,,	13 ,,
Length of caudal fin ..	74 ,,	74 ,,
Depth of body	86 ,,	86 ,,



TEXT-FIG. 6.—Pharyngeal teeth of *Schizothoraz zarudnyi.*

a. Lateral view of lower pharyngeal bone (× 3).
b. c. Internal view of the bones of two sides in another specimen showing lateral variation.

There are great differences in appearance, proportions and lepidosis between young and adults of this species, the chief being that the young are more slender, more silvery, have very much larger dorsal and caudal fins and eyes, and more imperfectly developed scales. In specimens between 56 and 66 mm. long we can detect no scales at all, while in those from 91 to 95 long they are much smaller in proportion than in the adult and are devoid of circular striae.

In specimens up to 123 mm. long the caudal fin occupies about $\frac{1}{5}$ of the total length, while in the adult it occupies only from $\frac{1}{7}$ to $\frac{1}{6}$. In specimens up to 93 mm. long the dorsal fin is considerably deeper than the body; in one 123 mm. long it is almost as deep, but in the adult it is distinctly less deep. The

greatest depth of the body is contained from $8\frac{1}{4}$ to $6\frac{1}{4}$ times in the total length in young fish less than 124 mm. long, while in adults it is contained only from $4\frac{3}{4}$ to $5\frac{3}{4}$ times. In the proportions of the total length without the caudal to the greatest depth the differences are smaller, the figures 6 to $6\frac{1}{2}$ for fish under 67 mm. long, 5 for individuals between 90 and 123 mm. long and from 4 to $4\frac{3}{4}$ in the adult. The proportion between total length and length of head is less different at different ages, and that between head and body (without the caudal) and head is still more uniform, practically no difference existing between young and adult. In length of eye in that of head there is a great difference. In specimens between 56 and 92 mm. long it is roughly from $2\frac{3}{4}$ to $3\frac{3}{4}$ times, in one 123 mm. long $4\frac{3}{4}$ times, in the adult $7\frac{1}{2}$ to 8 times. In the young the spiny dorsal ray is also proportionately more slender and bears relatively much longer denticulations than in the adult. In the young these denticulations have a spiny character.

Schizothorax zarudnyi, Nikolsky.

Measurements (in millimetres). Number of Fin-rays, Scales and Proportions.

	Total length (including caudal)	55·7	65·9	91·3	92·1	122·5	320·3	421·0	285·5	252·0
2	Length of caudal ..	11·4	13·1	18·15	81·4	24·1	47·2	59·1	46·5	43·1
3	Greatest depth of body ..	6·7	8·9	14·4	14·5	19·5	67·0	83·2	56·5	45·3
4	Length of head ..	11·5	14·4	18·8	19·7	25·2	72·6	93·5	64·9	55·4
5	Width of head ..	6·2	7·7	10·12	11·3	14·2	39·8	51·9	35·5	29·6
6	Length of snout ..	3·1	3·5	5·0	6·1	7·8	24·5	30·4	22·7	18·6
7	Diameter of eye ..	3·6	4·3	5·1	5·1	5·3	9·8	12·0	8·1	7·45
8	Interorbital width ..	3·45	4·1	7·1	6·7	8·9	24·8	29·2	20·2	17·6
9	Length of caudal peduncle.									
10	Depth of caudal peduncle ..									
11	Longest ray of dorsal ..	12·25	14·6	19·5	20·4	24·6	47·5	65·3	46·0	41·7
12	Longest ray of anal ..	7·5	8·45	12·6	12·0	17·3	41·1	58·9	37·7	33·8
13	Length of pectoral ..	8·1	8·9	13·6	13·5	18·1	42·2	62·3	36·0	36·8
14	No. of branched rays in dorsal	8	8	8	8	8	8	8	8	8
15	No. of branched rays in anal	5	5	5	5	5	5	5	5	5
16	No. of scales in L.L. ..	..	..	..	..	..	107	110	108	106
17	No. of scales in transverse line above L.L. ..	..	..	$35\frac{1}{2}$	..	..	$35\frac{1}{2}$	$33\frac{1}{2}$	$33\frac{1}{2}$	$32\frac{1}{2}$
18	No. of scales in transverse line below L.L. ..	..	..	..	..	..	$34\frac{1}{2}$	$35\frac{1}{2}$	$35\frac{1}{2}$	$34\frac{1}{2}$
19	$\frac{1}{2}$	4·9	5·0	5·0	5·0	5·08	6·78	7·1	6·14	6·0
20	$\frac{1}{3}$	8·3	7·4	6·34	6·35	6·3	4·78	5·06	5.0	5·5
21	$\frac{1}{4}$	4·85	4·55	4·85	4·7	4·8	4·4	4·5	4·4	4·5
22	$\frac{1}{5}$	3·2	2·82	3·68	3·86	4·75	7·7	7·8	8·0	7·43
23	$\frac{1\text{-Caudal}}{4}$, ...	3·85	3·66	3·88	3·74	3·9	3·76	3·87	3·7	3·77
24	$\frac{1.\text{Caudal}}{2}$, ...	3·9	4·0	3·9	4·0	4·08	5·78	6·6	5·1	4·8
25	$\frac{1\text{-Caudal}}{3}$, ...	6·6	5·9	5·0	5·0	5·	4·07	4·3	4·0	4·6

Schizothorax zarudnyi is a gregarious fish abundant in an adult condition in the pools among the reed-beds of the Hamun-i-Helmand. The roe appeared to be ripe in specimens examined in December. Its food, unlike that of most species of its genus, consists largely if not exclusively of other smaller fish. From the fact that only adults were taken in the Hamun in winter, it is probable that the young make their way up stream in the flood-season. They are extremely abundant in pools left in the beds of effluents of the Helmand or in the desert near these effluents, when the floods subside. It seems probable that the specimens we have examined represent the growth of at least five years and that sexual maturity is not obtained in a shorter period than four years. If this be so, the young of a year old are about 56-66 mm. long; those of two years from 91 to 95 mm., and those of three years about 125 mm.

Both large individuals from the Hamun and young ones from small pools were infested by an immature Trematode, which was encysted in their skin, in the superficial muscles, in the membrane of the fins and on both the outer and the inner aspect of the operculum. The cysts were of a blackish colour and resembled those shown in Herzenstein's figure of *S. altior* (*op. cit.*, pl. xii, fig. 1). We hope that a description of this parasite will be published later.

S. zarudnyi is the only fish commonly caught for food in Seistan. A description of the methods by which it is caught will be found in the appendix to this paper.

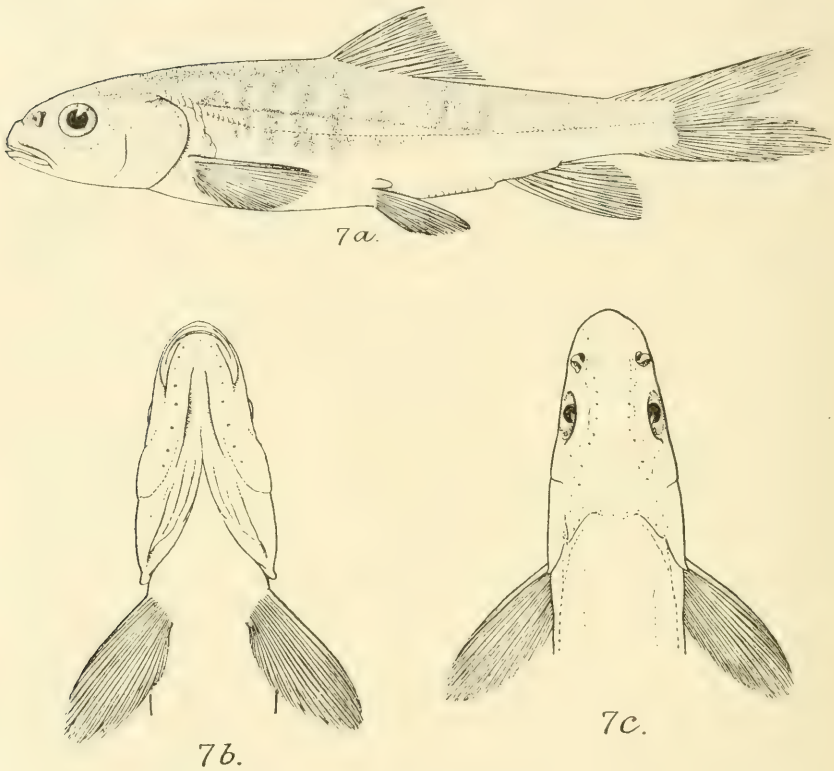
Schizopygopsis stoliczkae, Steind.

1888. *Schizopygopsis stoliczkae*, Herzenstein, *op. cit.*, p. 191, pl. xvi, fig. 3.
1911. *Schizopygopsis stoliczkae*, Stewart, *Rec. Ind. Mus.*, VI, p. 73, pl. iii, figs. 1, 2 and 3.

Specimens from Seistan, whence we have examined a fairly large series, apparently represent a dwarfed race. The largest we have seen is only 195 mm. long, and even smaller individuals are sexually mature. The two types of head referred to by Stewart (*op. cit.*) as the stoliczkae and the sevewzovi type are both found, without intermediates, in our series, but the former occurs only in two specimens and is not correlated with differences in proportions. We can discover no structural peculiarity in this low-altitude race except that there is a regular double row of large scales extending forwards in continuity with the anal sheath as far as the base of the ventral fins. Traces of a similar forward extension of the sheath are, however, to be found in certain specimens from high altitudes in the large collection from various localities preserved in the Indian Museum. We do not, therefore, consider it advisable to give the Seistan fish a racial name.

The series was collected by the Seistan Arbitration Commission in the delta of the Helmand. The species has a wide range in

the headwaters of streams and rivers on the north side of the Himalayas and Hindu Kush, but except in Seistan is only found at high altitudes.



TEXT-FIG. 7.—Adult specimen of Seistan race of *Schizopygopsis stoliczkae* (reduced in size).

Schizopygopsis stoliczkae, Steind. (Seistan).

Measurements (in millimetres). Number of Fin-rays, Scales and Proportions.

1	Total length (including caudal)	52·3	70·2	70·3	179·8	122·6	195·2	141·2	133·2	107·4
2	Length of caudal ..	10·1	13·6	14·4	26·3	22·5	32·8	26·9	26·3	20·0
3	Greatest depth of body ..	9·0	12·4	12·4	24·6	23·0	32·4	24·5	25·4	17·3
4	Length of head ..	11·6	15·1	15·3	34·1	26·8	39·6	28·3	30·2	22·4
5	Width of head	5·7	8·3	7·5	20·0	14·9	24·8	17·6	17·0	11·1
6	Length of snout .	3·3	4·7	4·9	9·8	8·2	12·0	9·2	9·5	6·2
7	Diameter of eye ..	3·5	4·2	4·5	6·8	5·2	7·8	6·2	6·0	5·2
8	Interorbital width ..	3·6	5·0	5·0	9·8	8·1	12·5	8·6	10·0	7·2
9	Length of caudal peduncle.	7·2	12	..	20·0	16·2	23·0	9·8	17·1	..
10	Depth of caudal peduncle.	3·0	6·0	..	8·8	7·0	10·0	4·3	8·0	..
11	Longest ray of dorsal ..	9·3	11·5	12·0	25·4	19·3	34·2	25·0	23·0	16·0
12	Longest ray of anal ..	6·6	9·2	8·2	24·6	18·2	29·3	24·0	24·1	15·4
13	Length of pectoral ..	7·1	9·5	10·0	23·0	18·1	31·5	22·7	22·0	15·8
14	No. of branched rays in dorsal	7	7	8	8	8	8	8	7	8
15	No. of branched rays in anal	5	5	5	5	5	5	5	5	5
16	$\frac{1}{2}$	*5·0*	*5·16*	*4·9*	*6·9*	*5·45*	*5·95*	*5·25*	*5·05*	*5·37*
17	$\frac{1}{3}$	*5·8*	*5·6*	*5·07*	*7·3*	*5·33*	*6·02*	*5·75*	*5·23*	*6·2*
18	$\frac{1}{4}$	*4·5*	*4·65*	*4·6*	*5·27*	*4·6*	*4·9*	*5·0*	*4·41*	*4·71*
19	$\frac{1}{5}$	*3·3*	*3·6*	*3·4*	*5·0*	*4·6*	*5·07*	*4·56*	*5·3*	*4·3*
20	$\frac{1\text{-Caudal}}{4}$, ...	*4·1*	*4·1*	*3·88*	*5·83*	*4·4*	*4·95*	*4·25*	*4·05*	*4·37*
21	$\frac{1\text{-Caudal}}{2}$, ...	*4·66*	*4·56*	*4·5*	*6·2*	*4·35*	*5·09*	*4·66*	*4·2*	*5·05*
22	$\frac{1\text{-Caudal}}{3}$, ...	*3·62*	*3·74*	*3·65*	*4·5*	*4·03*	*4·1*	*4·03*	*3·54*	*3·9*
23	$\frac{9}{10}$	*2·4*	*2·0*	..	*2·27*	*2·3*	*2·3*	*2·25*	*2·13*	..

Schizocypris, Regan.

1914. *Schizocypris*, Regan, *Ann. Mag. Nat. Hist.* (8), XIII, p. 262.

As Mr. Regan's description of the genus is very short, it may be redescribed as follows:—

Schizothoracinae with an inferior mouth, which is broad, transverse and protrusible. The snout projects beyond the mouth. The integument of the upper jaw is thin and adherent and there is no labial fold. The lower jaw is also covered with thin adherent integument. It is prominent but not very sharp and has a spatulate appearance from below. The barbels are absent or vestigial. The scales are confined to the sides and those of the scapular region are not greatly enlarged; those of both scapular and lateral regions are subcircular with radii well developed both above and below the nucleus and completely surrounded by circular striae, which are interrupted by the radii; the anal sheath is well developed. The dorsal fin is moderate, with 8 unbranched rays in the type-species; the last undivided ray is bony and denticulate. The form of the

body is graceful, somewhat compressed, but with a rounded belly. The caudal peduncle is distinct. The pharyngeal teeth are broad and differ from those of *Schizothorax*, in possessing a flat tip; the dental formula is 2·3·4|4·3·2.

In general facies this genus resembles *Schizopygopsis*, from which it is distinguished by the presence of small scales on the sides and the absence of large scales from the scapular region. It differs from *Schizothorax* in the structure of its mouth and pharyngeal dentition and in having the abdominal surface naked.

Schizocypris brucei, Regan.

(Plate XV, fig. 3).

1914. *Schizocypris brucei*, Regan, *loc. cit.*, fig. B.

The specimens before us are young and closely resemble immature specimens of *Schizothorax zarudnyi*, with which they were confused in the field, in appearance. Allowing for parallel differences in proportions we see no reason to regard them as distinct from the type-species of the genus, but as these differences exist, we think it best, in order to avoid any possibility of confusion, to describe our specimens in detail. The largest of them is nearly 48 mm. long without the caudal.

The dorsal profile is considerably and regularly arched, the ventral profile slightly convex. The greatest depth of the body is contained from $4\frac{1}{2}$ to $4\frac{3}{4}$ times in the total length without the caudal. The caudal peduncle in the largest specimens examined is twice or nearly twice as long as deep. The head is large, its length being contained from $3\frac{3}{4}$ to 4 times in the total length without the caudal. The snout is short and bluntly rounded and appears somewhat swollen in lateral view. It is slightly longer than the eye and less than half as long as the part of the head behind the eye. The upper surface of the head is flat. The nostrils are situated close to the eye, a little in front of it. The eye is large, its length being contained 3 to $3\frac{1}{2}$ times in that of the head and about $1\frac{1}{2}$ times in the interorbital width. The arc of the mouth is very wide and the posterior end of the maxilla is situated in front of and considerably below the eye. The fins are large and the dorsal is higher than the body; its margin is straight but slanting. The pectoral is shorter than the head. The scales appear to be fully developed and those of the lateral agree in structure with those of the scapular region. They are slightly broader than long, slightly sinuate at the base and differ markedly from those of *Schizothorax* in that the nucleus is situated at about a third the length of the scale from the free margin. The circular striae are about 7 in number. The radii are widely spaced and are considerably longer below than above the nucleus. The scales of the scapular region are of moderate size. They become gradually smaller from before backwards. Those on the upper parts of the sides, bordering the rather narrow naked dorsal region, are

very small, but those at the base of the dorsal fin are a little larger. Those near the lateral line are of intermediate size. Towards the tail all the scales are poorly developed and hard to distinguish. The lateral line runs along the middle of the caudal peduncle, then slopes gradually downwards, proceeds along the body well below the middle and finally slopes upwards just behind the head, along the top of which it runs to the tip of the snout. The colour is bluish above and silvery on the belly and sides There are sometimes a few small black spots on the latter.

Schizocypris brucei, Regan.

Measurements (in millimetres). Number of Fin-rays and Proportions.

1	Total length of body (caudal excluded)	45·2	47·8	42·4	42·7	32·5	23·8
2	Greatest depth of body ..	9·6	10·5	9·4	9·7	7·1	4·7
3	Length of head	11·6	12·2	11·2	11·0	8·5	6·3
4	Width of head	7·1	7·8	7·0	7·0	5·0	3·3
5	Length of snout	3·8	4·0	3·7	3·1	2·5	1·7
6	Diameter of eye	3·25	3·6	3·2	3·3	2·7	1·8
7	Interorbital width	4·9	5·0	4·3	4·2	3·8	2·5
8	Longest ray of dorsal	12·1	11·3	10·4	11·7	9·3	6·25
9	,, ,, ,, anal	8·0	8·6	7·6	8·2	5·6	4·35
10	Length of pectoral	9·0	9·1	8·3	8·1	5·8	4·5
11	No. of branched rays in dorsal ..	8	..	8	8	8	8
12	,, ,, ,, ,, ,, anal ..	5	5	5	5	5	5
13	Length of caudal peduncle ..	8	7·9	6·8	7·0	6·5	5·0
14	Depth of caudal peduncle ..	3·8	4·5	4·0	4·0	2·7	1·7
15	$\frac{1}{2}$	*4·7*	*4·55*	*4·51*	*4·4*	*4·57*	*4·21*
16	$\frac{1}{3}$	*3·9*	*3·91*	*3·78*	*3·88*	*3·82*	*3·77*
17	$\frac{5}{6}$	*3·57*	*3·39*	*3·5*	*3·33*	*3·15*	*3·5*
18	$\frac{13}{14}$	*2·1*	*1·75*	*1·7*	*1·75*	*2·4*	*2·94*

The species was described from Waziristan in the eastern district of the great mass of mountains that occupies northern Baluchistan and a great part of Afghanistan. A few specimens, the longest of which is 48 mm. long without the caudal, have been found among large numbers of young *Sehizothorax zarudnyi* and of *Discognathus adiscus* from the following localities:—a small pool connected in the flood-season with an effluent of the Helmand in the desert a few miles south of Nasratabad; pools in the dry bed of the Randa stream in the same district a few miles N.E. of the ruined city of Jellalabad; a still, reedy channel leading from the Hamun-i-Seistan on the road between Lab-i-Baring and Nasratabad. The largest specimens, which were alone distinguished at the time, are from the last locality. Their fin-rays were extremely brittle and unfortunately the caudal was broken in all those obtained but one. These specimens were collected in November and December, 1919.

Since drawing up this description we have been able to compare our specimens with one of the types of the species, received in exchange by the Z.S.I. through the courtesy of Mr. Tate Regan and the Trustees of the British Museum. Though the proportions

are naturally different we can find no structural difference. We have now no doubt that the specimens are specifically identical.

Family COBITIDAE.

The Loaches, which share with the Trout Carp (Schizothoracinae) the waters of the Central Asiatic plateau, are represented in those of Seistan by two genera, both of which also occur in Central Asia. One of these genera, *Nemachilus*, has a wide range in the Palaearctic and Oriental regions. Its single representative in Seistan is apparently dimorphic and occurs also in the head-waters of all the rivers immediately north and east of the great Himalayan range and the Hindu Kush. This species is *N. stoliczkae* (Steind.), of which we regard *N. stenurus*, Herz. as a dimorph. Apart from Seistan, *N. stoliczkae* is found only at high altitudes.

The other Cobitid genus that occurs in Seistan is here described as new. It is closely related in structure to *Nemachilus* but possesses one peculiarity, a soft dorsal fin, which differentiates it from most other Cyprinoidea and, together with its peculiar facies, constitutes it an apparent link between the Cobitidae and the Siluroidea. We discuss the structure, function and homology of this fin below. The genus, though strangely enough the soft fin has not been recognized as such hitherto, occurs also in Turkestan, and it is possible that Persian species assigned by Nikolsky to *Nemachilus* may also belong to it. The new genus is represented in Seistan by two species.

Genus **Nemachilus**, v. Hasselt.

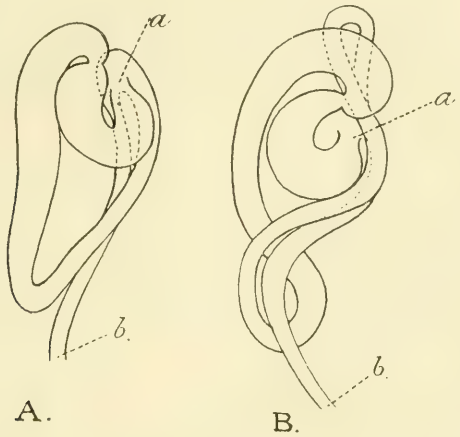
The one Seistani species (*N. stoliczkae*) of this genus belongs to a little group of Central Asiatic forms in which the Tibetan *N. lhasae*, Regan, and *N. yarkandensis*, Day, from Turkestan must also be included. This group is distinguished by the elongate form of the body and especially by that of the caudal peduncle. The fins are large, the eyes small, and scales are as a rule absent. The ventral surface is rounded and not specially adapted for purposes of adhesion. These fish are inhabitants of rapid but turbid streams, as a rule at very high altitudes. We have unfortunately no information as to the circumstances in which the Seistan form occurs.

Nemachilus stoliczkae (Steindachner).

1866. *Corbitis stoliczkae*, Steindachner, *Verh. Zool. bot. Ges. Wein.*, XVI, p. 793, pl. xiv, fig. 2.
1878. *Nemachilus stoliczkae*, Day, *Fishes of India*, II, p. 620, pl. clv, fig. 10.
1888. *Nemachilus stoliczkae*, Herzenstein, *op. cit.*, p. 14, pl. i, figs. 2-5; pl. iii, figs. 1-4; pl. vii, figs. 3-4; pl. viii, fig. 12.
1888. *Nemachilus stenurus*, *id.*, *op. cit.*, p. 64, pl. i, fig. 1.
1906. *Nemachilus stenurus*, editorial note to Regan, *Journ. As. Soc. Bengal*, II, p. 8.
1908. *Nemachilus stoliczkae*, Lloyd (in part), *Rec. Ind. Mus.*, II, p. 341.

1916. *Nemachilus stoliczkae*, Vinciguerra, *Ann. Mus. Stor. Nat. Genova*, XLVII, p. 146.
1916. *Nemachilus stenurus*, *id.*, *op. cit.*, p. 148.

The Indian Museum possesses a large number of specimens of this species from Tibet, northern Kashmir, Turkestan and Seistan. Among those identified by various ichthyologists as *N. stoliczkae* we find, however, four forms, one of which is without doubt specifically distinct. This is *N. lhasae*, Regan, from Tibet; we give measurements of a series of specimens but need not discuss the species further. The remaining three forms that have hitherto been placed together under the name *Nemachilus stoliczkae* in India belong in our opinion to that species and are identical respectively with the typical form (of which we have a topotype), the variety *leptosoma* of Herzenstein and *N. stenurus* of the same author. All



TEXT-FIG. 8.—Alimentary canal of *Nemachilus stoliczkae* from Seistan.
A. From specimens of *stoliczkae* type.
B. From specimens of *stenurus* type
a and *b* = cut ends of alimentary canal.

the specimens from Seistan were identified by Mr. Tate Regan as *N. stenurus*, but we find among them two distinct forms, one of which we regard as identical with *leptosoma*, while the other we retain under the name *stenurus*, which, however, we do not accept as specific.

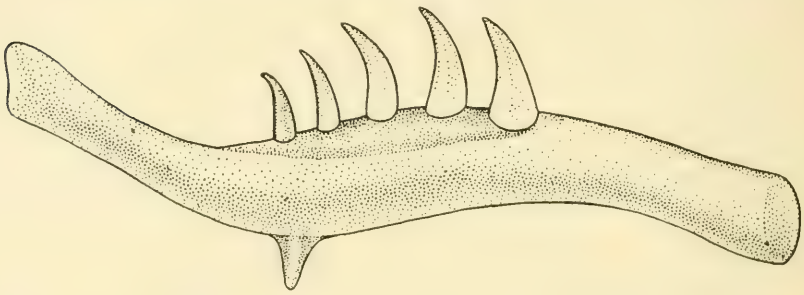
The first specimens we examined were those from Seistan labelled *N. stenurus*. The existence of two forms among them was visible on inspection and was on the whole confirmed by measurements. There were seven specimens in this series, as to four of which we had no hesitation in accepting Mr. Regan's identification. Of the remaining three specimens, one was an adult female, one a breeding male and one very young. The male agrees well with Herzenstein's figures of *N. stoliczkae* var. *leptosoma*, the female rather with that of var. *productus*. As the main difference between these two supposed varieties and *stenurus* lies

in their broader and thicker caudal peduncles, and this was precisely the difference noted in our specimens, we assigned them provisionally to *N. stoliczkae* var. *leptosoma*, in which it seemed necessary to include the var. *productus*.

On dissection we found that the alimentary canal of one of these specimens agreed with Herzenstein's figure (*op. cit.*, pl. viii, fig. 12) of that of *N. stoliczkae*. The alimentary canal of an individual of the same lot but belonging to the *stenurus* type differed considerably, as may be seen from fig 8.

There seemed, therefore, at this stage in our investigation to be good grounds for considering the two forms, though occurring together, as specifically distinct. On examining the other specimens in the collection we found two (from a stream running into the Ram-Tso lake in Tibet) that clearly belonged to the *stenurus* type. These had been confused with *N. lhasae*, which had also been assigned to *N. stoliczkae*. We also found two specimens from Leh belonging to this (the true *stenurus*) type.

We dissected one of the two Tibetan and one of the Ladakh



TEXT-FIG. 9.—Pharyngeal teeth of *Nemachilus stoliczkae* from Seistan (×25).

specimens of *stenurus*—to find that in both the alimentary canal agreed with that of the individual of the *leptosoma* type from Seistan. Subsequent investigations proved that the structure of both types was variable in this respect. The one constant difference that we could find between *stoliczkae* (s.l.) and *stenurus* lay in the proportions of the caudal peduncle, and even these varied, as may be seen from our table of measurements, within wide limits. It does not, therefore, seem justifiable any longer to maintain *stenurus* as specifically distinct. The difference is neither sexual nor racial, but appears rather to be a true instance of dimorphism affecting both sexes.

If this be so, the apparently discontinuous range of *N. stenurus*, which is recorded only from the mountains near the source of the Yangtse, from Scardo north of Kashmir and from Seistan, becomes explicable, for *N. stoliczkae* has the widest range of any member of its family in Central Asia.

Another point to be considered is the status of the different varieties of *N. stoliczkae* recognized by Herzenstein (*loc. cit.*). We find it difficult in the large collection before us to assign some

of the specimens definitely to any one variety and considerable individual variability undoubtedly exists. Some specimens from northern Kashmir and Turkestan, however, as well as those from Seistan certainly belong to the var. *leptosoma.* Unfortunately we have no very precise data as to their *provenance.*

Nemachilus stoliczkae (Steind.) (Seistan).

Measurements (in millimetres). Number of Fin-rays, and Proportions.

		Stenurus type.			*Stoliczkae type.*		
		♂	♂	♀	♀	♂	♂
1	Total length (including caudal) ..	105·2	75·0	90·7	109·1	94·6	80·0
2	Length of caudal	16·1	12·4	16·0	16·7	15·3	14·7
3	Greatest depth of body.. ..	13·3	10·1	13·6	13·2	12·5	10·0
4	Length of head	19·2	15·6	17·0	19·3	17·4	14·5
5	Width of head	13·4	8·8	10·3	11·5	10·5	9·3
6	Length of snout	9·2	6·6	9·0	7·8	7·4	6·5
7	Diameter of eye	4·0	2·9	3·2	3·5	3·4	2·9
8	Interorbital width	5·2	3·9	4·0	4·8	4·7	4·1
9	Length of caudal peduncle ..	21·7	15·5	15·4	21·7	15·1	12·6
10	Depth of caudal peduncle ..	2·8	2·4	2·9	6·1	5·2	4·3
11	Longest ray of dorsal	15·0	12·3	15·5	14·4	13.8	12·3
12	Longest ray of anal	14·1	10·5	12·8	12·6	12·0	9·8
13	Length of pectoral	16·2	13·3	15·2	15·0	14·5	12·2
14	No. of branched rays in dorsal ..	8	8	8	8	8	8
15	No. of branched rays in anal ..	5	5	5	5	5	5
16	$\frac{1}{2}$	*6·53*	*6·04*	*5·67*	*6·53*	*6·18*	*5·4*
17	$\frac{1}{3}$	*7·91*	*7·42*	*6·81*	*8·33*	*7·56*	*8·0*
18	$\frac{1}{4}$	*5·47*	*4·8*	*5·33*	*5·65*	*5·44*	*5·51*
19	$\frac{4}{7}$	*4·8*	*5·31*	*5·31*	*5·51*	*5·11*	*5·0*
20	$\frac{1\text{-Caudal}}{2}$, ...	*5·53*	*5·04*	*4·67*	*5·53*	*5·18*	*4·44*
21	$\frac{1\text{-Caudal}}{3}$, ...	*6·7*	*6·19*	*5·49*	*7·0*	*6·35*	*6·53*
22	$\frac{1\text{-Caudal}}{4}$, ...	*4·64*	*4·03*	*4·39*	*4·78*	*4·55*	*4·5*
23	$\frac{9}{10}$	*7·75*	*6·46*	*5·31*	*3·55*	*2·86*	*2·93*

Nemachilus lhasae, Regan (Tibet).

Measurements (in millimetres). Number of Fin-rays, and Proportions.

1	Total length (including caudal) ..	86·2	78·0	76·8	55·0	84·5	69·0
2	Length of caudal	13·2	11·2	13·2	9·2	14·0	12·0
3	Greatest depth of body ..	11·0	10·0	9·3	7·0	11·2	9·8
4	Length of head	17·0	16·0	16·5	11·6	17·0	15·5
5	Width of head	10·3	8·6	8·2	6·2	10·8	9 5
6	Length of snout	7·0	6·2	6·3	4·6	6·6	7·0
7	Diameter of eye	4·4	4·1	4·0	2·8	3·8	3·5
8	Interorbital width	4·0	4·1	4·0	2·8	4·6	3·3
9	Length of caudal peduncle ..	17·0	17·0	15·0	12·0	17·0	13·6
10	Depth of caudal peduncle ..	2·7	2·8	2·6	2·0	2·7	2·3
11	Longest ray of dorsal	14·0	13·0	14·0	10·4	16·0	12·2
12	Longest ray of anal	10·0	9·3	10·5	7·5	10·6	8·8
13	Length of pectoral	14·0	11·5	11·3	10·8	14·3	12·0
14	No. of branched rays in dorsal ..	8	8	8	8	8	8
15	No. of branched rays in anal ..	5	5	5	5	5	5
16	$\frac{1}{2}$	*6·53*	*6·96*	*5·81*	*5·97*	*6·35*	*5·75*
17	$\frac{1}{3}$	*7·83*	*7·8*	*8·25*	*7·85*	*7·5*	*7·04*
18	$\frac{1}{4}$	*5·07*	*4·87*	*4·65*	*4·74*	*4·94*	*4·45*
19	$\frac{4}{7}$	*3·86*	*3·9*	*4·1*	*4·14*	*4·47*	*4·43*
20	$\frac{1\text{-Caudal}}{2}$, ...	*5·53*	*5·96*	*4·81*	*5·97*	*5·35*	*4·75*
21	$\frac{1\text{-Caudal}}{3}$, ...	*6·63*	*6·68*	*6·83*	*6·54*	*6·29*	*5·81*
22	$\frac{1\text{-Caudal}}{4}$, ...	*4·3*	*4·17*	*3·85*	*3·95*	*4·14*	*3·07*
23	$\frac{9}{10}$	*6·3*	*6·07*	*5·77*	*6·0*	*6·3*	*5·91*

Genus **Adiposia** nov.

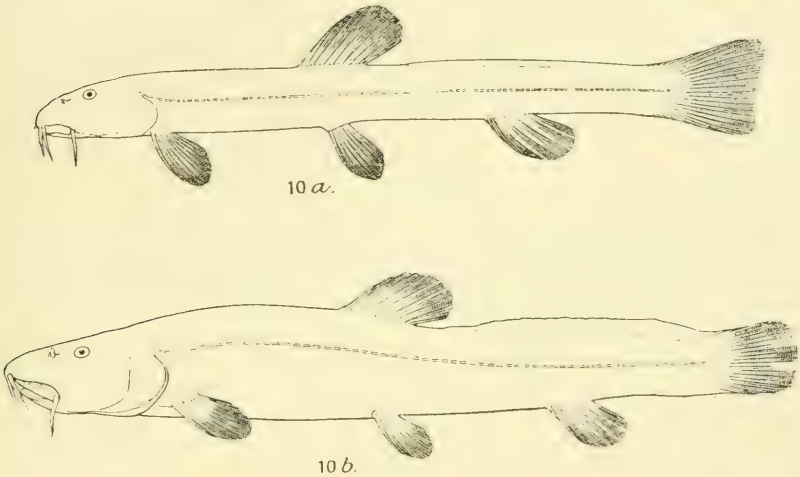
The genus may be described as follows :—

A genus of Cobitidae consisting of elongate species often of large size, with or without minute scales on the body, without a suborbital spine, with six barbels, *with an elongate band-shaded soft fin between the dorsal and the caudal.* The head is relatively small, flattened and Siluroid in appearance; the eye small, dorsal in position, of an elongate oval form, and surrounded by a free circular fold; the nostrils are situated close together in front of the eye, the posterior nostril being elongate and slit-like; the mouth is large, ventral in position and provided with tumid lips and with 6 barbels. The fins are relatively small and all the rays cartilaginous. The lateral line is well developed and extends all along the middle of the body in a straight or sinuous line. The pharyngeal bones are delicate and bear a single series of sharp slender teeth. The air-bladder, which is entirely enclosed in bone, is dumbell-shaped and transverse and consists of a pair of spherical lateral chambers connected by a tube. It possesses a short,

slender, tubular diverticulum, which is directed backwards from the transverse tube and ends in a vesicle.

Type-species: *Nemachilus macmahoni*, Chaudhuri.

Three species are known definitely to belong to this genus namely *Nemachilus longicauda*, Kessler,[1] *N. rhadinaeus*, Regan[2] and *N. macmahoni*, Chaudhuri,[3] but the most important generic character (the adipose fin), which is by no means conspicuous in badly preserved specimens, has escaped the notice of most ichthyologists. Chaudhuri in his description of *A. macmahoni* refers to it as a fold of skin, but sections show that it is a structure of much more definite nature. We give a full description of it below.



TEXT-FIG. 10.—Type specimens of Seistan species of *Adiposia* (reduced).
a. A. rhadinaea (Regan).
b. A. macmahoni (Chaudhuri).

Two of the three species at present known are from Seistan, the third (*A. longicauda*) from Turkestan.

The soft dorsal fin of Adiposia. This fin has the form of a ridge arising a short distance behind the dorsal and extending to the base of the caudal, in which it finally disappears. The anterior margin slopes upwards and backwards gradually, the posterior extremity is ill-defined. Its relative height varies in different species, and even to some extent in different individuals of the same species. In *A. macmahoni* the height may be as much as $\frac{2}{5}$ of that of the caudal peduncle in well-preserved specimens, but in shrivelled

[1] Kessler, "Pisces" in Fedtschenko's "*Reise in Turkestan*," p. 38, pl. vi, figs. 22, 23 (1874).
[2] Regan, *Journ. As. Soc. Bengal*, II, p. 8 (1906).
[3] Chaudhuri, *Rec. Ind. Mus.*, III, p. 341 (1909).

specimens it is considerably less. The fin is strongly compressed from side to side.

In vertical section an external wall and an internal core can be distinguished. The former is further divided into two regions, an external epithelial and an internal connective-tissue region. The epithelial region, which is similar to the integument of the body, consists mainly of several layers of small, more or less flattened and rectangular cells with well-defined cell-walls and relatively large oval nuclei. Among these are scattered numerous large ampulliform gland-cells. In the lower parts of the fin the gland-cells are situated mostly at the base of this region and constitute almost a separate layer, the small epithelial cells between them being somewhat elongated by pressure. Towards the crest of the ridge, however, there is no definite separation of the kind and the gland-cells are often on the surface.

The inner region of the outer wall consists of fibrous connective tissue, the fibres of which run completely round the fin in a horizontal and vertical direction, separating it below from the dorsal muscles, over which the epithelial layer does not extend. This region is similar to that lying immediately below the epithelial covering of the body.

In the region of the connective tissue and between it and that of the epithelium numerous longitudinal blood vessels can be easily distinguished. They have a narrowly oval outline in vertical section, with the longer axis vertical in the side-walls, and transverse above the dorsal muscles.

Just inside the region of connective tissue of the side-walls there are a number of small lucunae containing granular masses of black pigment. These have no definite walls.

The central core consists of a mass, conical in vertical section, of highly vacuolated tissue. The vacuoles are of relatively large size and irregular shape. No cell-walls can be distinguished but the spaces are surrounded by deeply staining protoplasm containing numerous minute oval nuclei. The contents of the vacuoles are gelatinous and appear to have a reticulate structure when stained with haemotoxylin. This structure, however, may be an artifect.

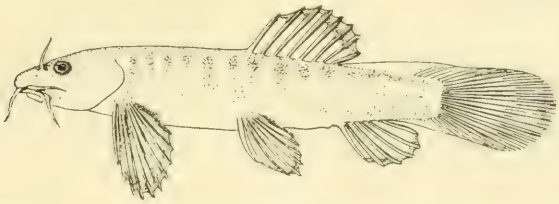
Comparatively large blood-vessels make their way obliquely upwards from the body into the central core of the soft fin at intervals and ramify in it. We have not been able to trace any connection between them and the smaller lateral and basal vessels.

In the upper part of the fin irregular fibrous strands, probably representing degenerate ceratotrichia, can be distinguished in the centre of the core. They run in a vertical direction, and are connected with a kind of reticulation formed by the walls of the vacuoles.

In external appearance the adipose fin of *Adiposia* closely resembles that of the soft fin of the Siluroid genus *Amblyceps*, which is assigned by recent authors to the family Sisoridae. We

have not been able to examine specimens of this genus preserved for histological investigation, but we have cut sections of the fin in a species of the related genus *Glyptosternum*. We have also sectioned the primitive dorsal fold in post-larval specimens of a species of *Nemachilus*. Before discussing the significance of the structure in *Adiposia*, we must give a brief account of that found in these other fish.

In young specimens of *Nemachilus evezardi* recently obtained by Major R. B. Seymour Sewell at Khandalla and easily recognized by the presence of a nasal barbel [1], the primitive dorsal fin-fold remains in a very interesting condition until the fish is at least 1 cm. long. The dorsal fin of the adult is already well-developed and has its rays fully formed, but behind it the fold persists, extending into the caudal. The anterior extremity of this vestige of the fold slopes gradually upwards and backwards. Externally the whole structure has a very close resemblance to the same parts of *Adiposia*. Indeed, the only differences to be noted



TEXT-FIG. 11.—Young of *Nemachilus evezardi* 1 cm. long showing dorsal fold.

on a superficial examination are that the ceratotrichia are well developed, especially in the posterior part of the fold, and that the fold also extends forwards from the caudal on the ventral surface.

We have examined a large number of species of *Nemachilus* from both mountainous regions and comparatively level country for traces of the persistence of this condition. In all we find a short, compressed pad, clearly representing the posterior part of the fold, at the base of the caudal fin both above and below. In some this fold persists as a ridge to a comparatively late age. In *N. savona* it is in this condition in a specimen 39 mm. long.

In vertical sections of the dorsal fold in a young *N. evezardi* about 1 cm. long we find the structure essentially similar to that of the soft fin of *Adiposia*, but, as might be expected, the tissues are less differentiated. The outer wall is thinner, its gland-cells are more numerous and its epithelial cells less distinct. The layer

[1] Jordan and Fowler regard this as a generic character but we are not prepared to accept their view.

of fibrous connective tissue is thin and incompletely differentiated and is not continuous across the dorsal muscles at the base. The central core has a more fibrous structure with smaller, ill-developed vacuoles. The blood-vessels are few and poorly developed.

We have cut sections also, as already stated, of the adipose fin of a species of *Glyptosternum* (Sisoridae) from the base of the Nilgiri Hills for comparison. It would be out of place in the present context to discuss the structure of this fin in detail. We may say here, however, that an inner core of highly vacuolated tissue, closely resembling that found in the fin of *Adiposia*, occupies the centre of the structure and that its wall consists of two regions, the structure of both of which differs considerably from that of the homologous regions in *Adiposia*. Our figures (pl. xvi, figs. 5 and 6) and the explanation of them will illustrate the differences sufficiently for our present purpose. These differences are so considerable that there can be little doubt that the adipose fin of *Adiposia*, though (like that of the Siluridae) derived from the posterior part of the primitive dorsal fold, has originated independently, probably in correlation with the assumption of the habit of burrowing in the mud of bodies of water liable to desiccation, and there aestivating or hibernating until the return of the flood season.

It seems to be clear, therefore, that the soft fin [1] of *Adiposia* is a highly specialized structure, but that it is fundamentally homologous with the posterior precaudal part at the primitive dorsal fold.

The function of this fin in *Adiposia* is possibly a double one. It may act as a reserve food-supply for a voracious fish that must occasionally be deprived of food for considerable periods. It probably is also an accessory breathing organ, to judge from its copious blood-supply, of use when the fish is buried in damp mud.

Relationships of Adiposia.—From what has been said above it is, we believe, clear that *Adiposia* is closely related to *Nemachilus*. Its resemblance to the Siluroidea is probably more apparent than real, being due mainly to the persistence, doubtless secondary, of a post-larval character and its slight modification. We have no reason to think that *Adiposia* is an extremely primitive form, as would be the case if the persistence of this one juvenile character were accepted as evidence of direct affinities with the ancestral forms of both the Cyprinoidea and the Siluroidea, for, indeed, the dorsal fin-fold is an ancestral feature common to al fishes, and even to other groups of primitive vertebrates. In all fish with a dorsal fin of any kind part of it persists and the adipose fin of Salmonidae is not supported by other evidence as proof of close affinity with the Siluroidea.

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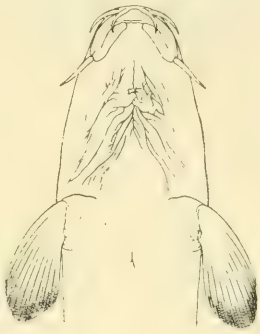
[1] A recent investigation of well-preserved specimens of *Acanthophthalmus pangia* proves the existence of a similar structure in that species.

Adiposia macmahoni (Chaudhuri).

(Plate XV, fig. 4; Plate XVI, figs. 1 & 2.)

1909. *Nemachilus macmahoni*, Chaudhuri, *Rec. Ind. Mus.*, III, p. 341.

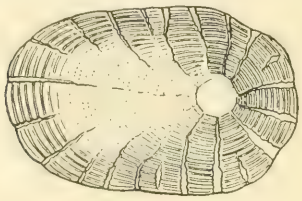
As Dr. Chaudhuri's description was based on a single specimen not in the best condition and bleached by exposure to light, we give a fuller account of the species here, based on numerous well-preserved examples.



TEXT-FIG. 12.—Lower surface of head of *Adiposia macmahoni* (× $\frac{3}{4}$).

The fish is one of the largest of its family, attaining a length of over 27 cm. and has an extremely Siluroid appearance owing to its elongate form, broad, flattened head, and small, dorsal eyes. The dorsal profile immediately behind the head is somewhat convex, but both the dorsal and ventral profiles behind the dorsal fin are nearly straight and parallel and the greatest depth is contained $6\frac{2}{5}$ to a little over 8 times in the total length without the caudal, $7\frac{1}{2}$ to nearly 10 times with the caudal. The head is depressed considerably below the profile of the back and its upper surface slants downwards from behind almost in a straight line; it is broad and flat and its length is contained from $4\frac{1}{2}$ to 5 times in the total length without the caudal. The specimens in our series seem to fall into two groups, in one of which the head is less flat and narrower than in the other. Possibly the difference is sexual, for it seems to be correlated with slight differences in the form of the vent, but the sexual organs are quite undeveloped in the fish recently collected, while they have been removed from the type. The length of the eye is contained $5\frac{2}{5}$ to $8\frac{2}{5}$ times in that of the head, but is relatively much less in the adult than in the young. The pupil is nearly in the midddle of the head. The nostrils are nearer to the eye than to the tip of the snout. The barbels are subequal in length, which varies considerably; the two anterior pairs usually reach to a vertical line from the nostrils if pressed backwards, and the posterior pair to one from the anterior border or middle of the eye. The cleft of the mouth does not reach as far back as the front of the eye. The anterior lip is continuous and minutely tubercular, the posterior lip smooth and widely interrupted in the middle line. The branchial isthmus is short and narrow. The chest and abdomen are flat. The pectoral fin, which is rounded at the tip, is much shorter than the head. The dorsal in quite young fish is higher than the body, but in the adult lower; it is situated nearer the tip of the snout than the base of the caudal. The ventral and anal are short, the caudal of moderate length,

rounded, truncate or slightly emarginate at the tip. The caudal peduncle is compressed and from $1\frac{3}{5}$ to $2\frac{1}{2}$ times as long as deep.



TEXT-FIG. 13.—Scale of *Adiposia macmahoni* (× 35), from base of dorsal fin.

We can detect no scales on the young fish, but in the adult minute but well-developed scales are present on the sides of the posterior part of the body. They are longitudinally oval in form and have the nucleus near the base. Their sculpture consists of numerous coarse radii and circular striae, both of which occur all round the scale. The scales are rather widely separated and buried in the skin. They appear to be much less conspicuous than in *A. longicauda*, Kessler.

The following note on the colouration was made from living fish :—" The loach is variable in colour ; it is usually very pale olivaceous, fading to silvery white on the belly and irregularly spotted on the head and upper part of the body with a darker shade. In some individuals the head and body are pale yellowish without markings or with a faint marbling. All the fins are tinged with dull red, which is more intense on the caudal than on the others, and are as a rule obscurely marked with small dark spots. There is always a narrow dark vertical stripe at the base

TEXT-FIG. 14.—Pharyngeal teeth of *Adiposia macmahoni* (× 7).

of the caudal on its peduncle." This description, which refers to young and half-grown fish, applies equally well to specimens carefully preserved in formalin and spirit, except that the olivaceous and yellowish tints have faded and the reddish colour disappeared from the fins.

The pharyngeal bones have the form normal in the Cobitidae, but are perhaps a little straighter than usual. There are about 12 teeth arranged mainly on an almost semicircular prominence. In the adult they are all shorter than the smallest diameter of the bone and (except those at the lower end of the series, which are very small) almost subequal in length, those in the middle of the prominence being slightly enlarged. In the young the central teeth are relatively longer.

The posterior diverticulum of the air-bladder is longer than the diameter of the transverse tube from which it originates and its vesicle is longer than the stalk.

Type-specimen No. F 1222/1 (*Z.S.I.*).

The type-specimen was obtained by the Seistan Arbitration Commission in the delta of the Helmand. Young and half-grown fish were found in great abundance in small pools in the bed of the Randa stream near the ruined city of Jellalabad some 12 miles north of Nasratabad, at the end of November. They were buried at a depth of some inches in the mud at the bottom of the pools and seemed to be in a healthy and active condition, although the water was extremely foul and most of the Cyprinidae in the pools were dead or dying. The species is evidently predaceous, for remains of other fish were found in the stomach, and also those of a may-fly larva (*Palingenia* [1]) that occurred in large numbers with it. Other members of the same association were the crab *Potamon* (*Potamon*) *potamios gedrosianum* and the molluscs *Corbicula fluminalis* and *Lamellidens marginalis rhadinaeus.*

Adiposia rhadinaea (Regan).

1906. *Nemachilus rhadinaeus*, Regan, *Journ. As. Soc. Bengal*, II, p. 8.

We again quote Mr. Regan's description of the species to facilitate reference.

> "Depth of body 7 to 10 in the length, length of head 5 to $5\frac{1}{2}$. Depth of head $\frac{3}{4}$ to $\frac{4}{5}$ its breadth, which is $1\frac{3}{5}$ to $1\frac{2}{3}$ in its length. Diameter of eye $7\frac{1}{2}$–$8\frac{1}{2}$ in the length of the head and $1\frac{1}{2}$ to 2 in the interorbital width. Snout longer than postorbital part of head. Cleft of mouth extending to below the nostrils; lips moderately thick, smooth, the lower interrupted medianly; six barbels; outer rostral barbel as long as the maxillary barbel, extending to or beyond the nostrils. Scales entirely wanting. Dorsal III 7, its origin nearer to tip of snout than to base of caudal; free edge of the fin convex. Anal II-III 5. Pectoral extending about $\frac{1}{2}$ of the distance from its base to the base of the ventral. Ventrals 8-rayed, originating below the anterior branched rays of the dorsal, extending $\frac{1}{2}$—$\frac{3}{5}$ of the distance from their base to the origin of anal. Caudal slightly emarginate. Caudal peduncle 2 to $2\frac{3}{4}$ as long as deep, its length 5 to $5\frac{1}{3}$ in the length of the fish. Large, oblong or rounded dark spots on the back and sides; dorsal and caudal with some small dark spots, lower fin pale, immaculate."

"Three specimens 165–260 mm. in total length."

[1] See Gravely, *Rec. Ind. Mus.* XVIII, p. 137 (1920).

"Perhaps allied to *N. sargadensis*, Nikolski, 1899, the description of which is somewhat deficient in structural details, but the colouration appears to be too different to justify identification."

The largest specimen referred to by Mr. Regan is now in the collection of the Zoological Survey of India and is labelled as the type. Our measurements do not altogether agree with his, for we estimate the length at a little over 268 mm. We find that the head is contained in the total length without the caudal fin $5\frac{1}{2}$ times and the greatest depth of the body nearly 11 times. The difference is evidently due to the fact that the specimen is somewhat curved. We have taken the mean length of the measurement obtained along the outer and that along the inner side.

TEXT-FIG. 15.—Air-bladder of *Adiposia rhadinaea*, × 2.

The bladder has been dissected out of its bony capsule but remains *in situ* pressed against the lower surface of the vertebral column.

We have failed to find any trace of scales. The air-bladder differs from that of *A. macmahoni* in that the posterior diverticulum is extremely short and its vesicle minute.

The fish is readily distinguished from its ally by its more elongate body, smaller, narrower and less flattened head and by marked differences in outline. These differences are shown in our figures of the types of the two species.

All the specimens known were obtained by the Seistan Arbitration Commission in the delta of the Helmand.

Adiposia from Seistan.

Measurements (in millimetres). Number of Fin-rays and Proportions.

		Adiposia macmahoni									*Adiposia rhadinaeus.*
1	Total length (including caudal) ..	76·5	90·6	107·9	113·2	118·5	124·0	129·0	132·2	273·2	268·4
2	Length of caudal ..	14·3	15·2	16·6	17·0	16·5	18·5	19·2	20·6	30·0	37·8
3	Greatest depth of body	7·7	9·5	12·5	15·0	15·0	16·3	15·4	14·4	36·5	21·2
4	Length of head ..	13·6	15·5	18·5	23·0	23·0	25·1	25·0	22·0	57·7	41·8
5	Width of head ..	8·6	9·7	11·7	15·3	15·8	17·3	17·0	13·8	36·5	27·2
6	Length of snout ..	6·0	6·6	8·4	10·3	10·3	11·0	11·0	10·2	4·6	19·5
7	Diameter of eye ..	2·7	2·9	3·3	3·4	3·1	3·6	3·3	3·3	6·7	5·5
8	Interorbital width ..	3·6	4·2	5·2	6·0	6·3	7·0	6·8	5·7	18·0	11·2
9	Longest ray of dorsal.	12·7	14·2	16·4	17·4	17·0	16·0	18·2	19·8	25·2	37·5
10	Longest ray of anal..	10.5	11·0	14·8	13·5	15·2	15·4	14·0	17·0	29·4	30·8
11	Length of pectoral ..	11·4	13·3	14·5	15·0	15·5	15·5	16·0	17·5	26·1	26·7
12	No. of branched-rays in dorsal	7	7	7	7	7	7	7	7	7	7
13	No. of branched-rays in anal.. ..	5	5	5	5	5	5	5	5	5	5
14	$\frac{1}{2}$	5·35	5·95	6·5	6·65	7·18	6·7	6·71	6·41	9·1	7·1
15	$\frac{1}{3}$	9·93	9·53	8·63	7·54	7·9	7·6	8·37	9·18	7·76	12·66
16	$\frac{1}{4}$	5·65	5·84	5·83	4·92	5·15	4·94	5·16	6·00	4·73	6·42
17	$\frac{1}{7}$	5·03	5·36	5·6	6·76	7·41	7·0	7·57	6·66	8·37	7·6
18	$\frac{1\text{-Caudal}}{2}$, ..	4·35	4·95	5·5	5·65	6·18	5·7	5·71	5·41	8·1	6·1
19	$\frac{1\text{-Caudal}}{3}$, ..	8·07	7·94	7·3	6·41	6·8	6·41	7·13	7·75	6·66	10·87
20	$\frac{1\text{-Caudal}}{4}$, ..	4·57	4·86	4·93	4·18	4·43	4·2	4·39	5·07	4·21	5·51

APPENDIX.

NOTE ON THE FISHERIES OF THE DELTA OF THE HELMAND AND ON THE USE OF SHAPED RAFTS OF BULRUSHES IN INDIA AND SEISTAN.

By N. ANNANDALE, *D.Sc.*, *F.A.S.B.*

There can be few lakes that bear fish and have a piscivorous population on their shores in which the fisheries are of a more simple character than those of the Hamun-i-Helmand. Apparently only one species the Seistan Trout Carp (*Schizothorax zarudnyi*) is pursued, and only one method of capture used.

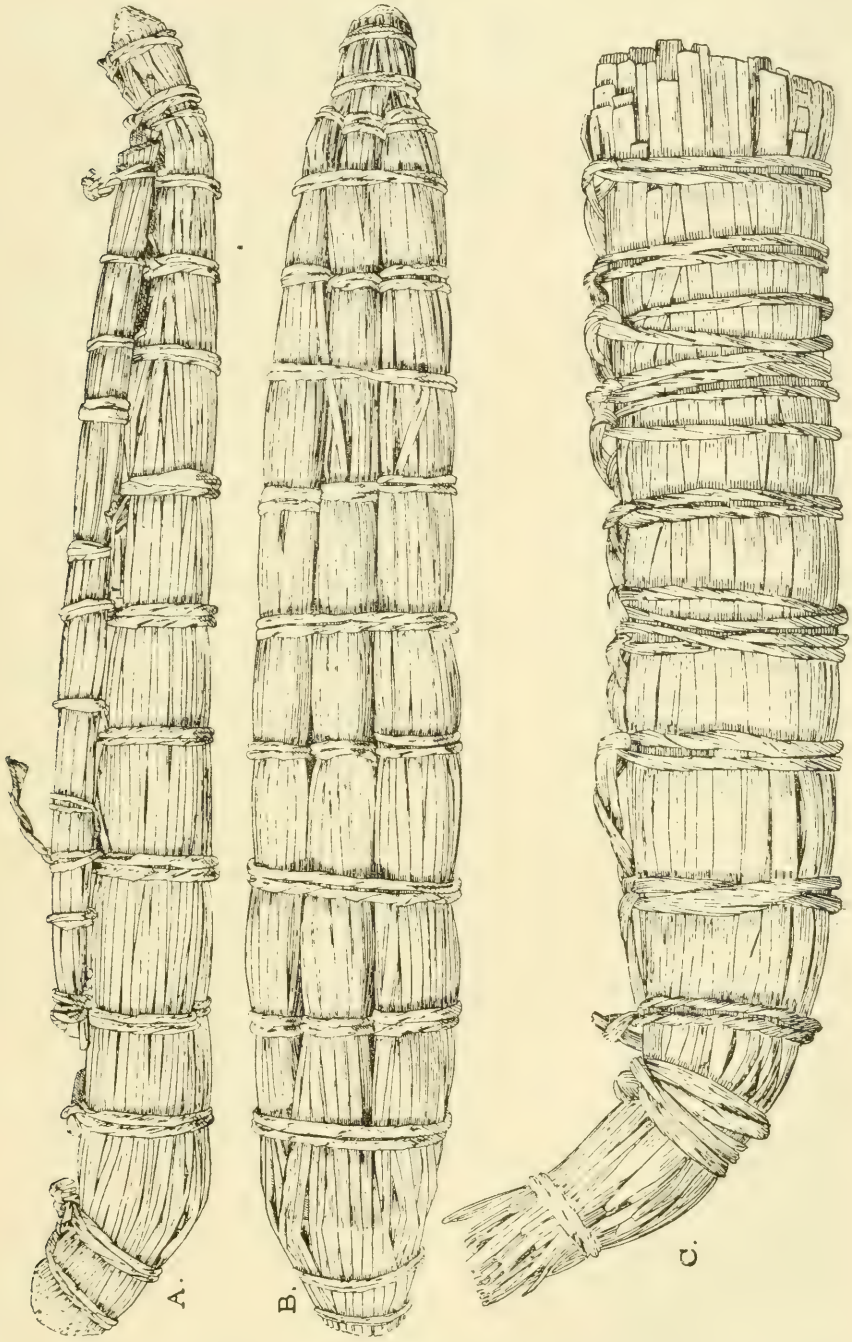
Schizothorax zarudnyi is a fish that bears considerable but quite superficial resemblance to a trout and reaches a length of at least 49 cm. (19 inches). The flesh has an excellent flavour, distinctly "trouty," but is so full of little sharp, stiff bones that it is difficult for a European to eat it. The Persian officials in Seistan get over this difficulty by cooking it in vinegar, which softens the bones; but the fishermen of the Hamun adopt no such refinements. They split and gut the fish and insert a small sharpened stick into the head from below. They then make a small fire of tamarisk-roots and arrange the fish round it in a circle, supported in a slanting position on the sticks. The flesh is thus slowly roasted.

There is some evidence that the flesh of the Seistan Trout Carp, and especially its roe, may be poisonous to those not accustomed to it. We ourselves experienced considerable intestinal disturbance and colic after eating a dish of the roe, and all our assistants and servants except one were taken ill in a similar but more violent manner on another occasion after eating the flesh. In both cases the fish was perfectly fresh. The people of Seistan, however, know of no such inconvenience.

Before describing the method of catching this fish it is necessary to say something about the fishermen and their neighbours on the shores of the Hamun-i-Helmand, and about their peculiar rafts of bulrushes. I take the opportunity also to publish a note on a similar craft used in India.

The shores of the Hamun are inhabited by two different types of people,[1] both more or less nomadic, but occupying different positions in Seistani society. They are called Gaodar (Gavdar) or Herdsmen and Saiyad (Saiad) or Hunters. The Herdsmen are regarded as eminently respectable people, but the Hunters, probably as a result of ancient Buddhist influence, are practically

[1] For a fuller account of these people see Tate, *Seistan*, pt. IV, pp. 297 and 303.



TEXT-FIG. 16.—Shaped rafts of bulrushes and sedges from Seistan and India.

A.B. *Tutin* used by fishermen and fowlers on the Hamun-i-Helmand.
C. *Bindi* used by fishermen of the Sirkula tribe, Roorkee, U.P.

outcastes. Both tribes pay an annual rent to the Persian government for the right to exercise their respective callings on the shores or in the waters of the lake; the Herdsmen for the pasturage of their cattle, the Hunters for the privilege of fishing and fowling.

One of the most striking features of the Hamun-i-Helmand is the vast reed-beds by which it is surrounded. These vary in extent with the season, but a considerable part of Seistan is known as the *Naizar* or reed-country. The reed-beds provide a livelihood to both the Herdsmen and the Hunters. The reeds are of three kinds. The most abundant is a form of *Phragmites communis*, the common large reed of the fens of England. The dwellings of both tribes are constructed of this plant. Next in abundance is the sedge *Scirpus littoralis*, on which the herdsmen feed their cattle, and finally we have a bulrush (*Typha augustata*), out of which both tribes construct the only craft known on the lake.

No true boats are used in Seistan, but their place is taken by curious "shaped" rafts that may almost be called skiffs and may be compared with the Papyrus skiffs[1] of ancient Egypt and the rafts used in Babylonian times in the delta of the Tigris and Euphrates. These rafts are made entirely of the leaves of the bulrush tied together in bundles. For purposes of transport comparatively stout and clumsy structures[2] of the same kind are employed, but these can only be used in the flood-season and we did not see them. I shall, therefore, describe only those used in fishing and fowling on the Hamun.

These are slender and even elongate structures each made of three bundles of fresh bulrush leaves and about six times as long as broad. Omitting the rail or bulwark along the top, they are about twelve times as long as deep. The bulrush leaves are bent upwards at both ends and the bundles are so arranged that the craft tapers slightly behind. A rail is added on each side above in the form of a thinner bundle of leaves. The rafts are about ten feet long and one and a half feet broad. They are constructed in the following manner (pl. xvii, fig. 2):—

The leaves are cut off close to the roots so as to be as long as possible. All those that are in any way damaged are rejected and the narrow tips are cut and thrown away. Perfect leaves thus treated are then laid out on the shore parallel to one another and arranged in bundles in such a way that there are a few more at one end of the bundle than at the other and that the broader bases of the leaves are all at the same end. Ropes are meanwhile manufactured from other leaves of the same plant, two men or boys doing this by twisting the leaves together in opposite directions by hand. When the thick bundles and ropes are ready each

[1] For an illustration see King's *History of Babylon*, p. 201, fig. 44 (1915), and for Egyptin references Erman's *Life in Ancient Egypt* (*trans.* Tsiard), p. 470 (1894).

[2] For illustrations see McMahon, *Geor. Journ.*, XXVIII (1906), and Tate, *Seistan*.

bundle is bent upwards at either end and fastened together by five bands of rope. Considerable force is exercised in doing this as the stability of the craft depends largely on the tightness of the bundles. After the rope has been twisted round the leaves two men pull the opposite ends taught, pressing against the bundle with their feet and sitting on the ground. The leaves are left free at two ends of the bundle, but the unbound part is considerably longer at the stouter end (at which the basal part of the leaves is situated) than at the narrower, the stern of the embryo raft. Three bundles are thus formed for the body of the raft. They are then tied together, in the same way as each was made individually, by some nine bands of leaf-rope. Two of these bands are situated near each end, and those at the thick end or prow are tied very tight so that the cut basal ends of the leaves expand somewhat. Finally the rail, a thinner bundle of leaves, is added above at each side for comfort's sake to a passenger, and the whole is finished by a short cross-bundle in front between the two rails.

A craft of this kind has a curious resemblance, when unloaded in the water, to an Egyptian mummy (pl. xvii, fig. 1). It can carry a passenger as well as a boatman, who propels it by punting with a pole of tree-tamarisk, but can be used only in very calm water. It is only on exceptionally still days that the Hunters or the Herdsmen, who also use rafts of the kind in moving about the reed-beds, venture into the open lake upon them. They are temporary structures, depending as they do for their buoyancy entirely on the air enclosed in the air-cells of the leaves, which soon decay. Their life is never longer than two months; in hot weather less. The Seistani name for them is *tutín*, from *tut*, a bulrush.

My figures in the text (figs. 16A & B) are drawn from a model made at Lab-i-Baring on the Hamun. It is accurate except in two points,—(1) the leaves employed are of full size and are therefore relatively larger and less numerous than would be the case in the real raft, and (2) the protuberance at the prow is rather too small (*cf.* the photograph on pl. xvii).

On our return journey from Seistan I happened to show this model to Mr. W. J. Good of the Calcutta Port Trust, who was then a member of the Indian Reserve of Officers. He told me that he had seen similar rafts in the Roorkee district of the United Provinces and kindly put me into communication with Lt.Col. A. Cunningham, R.E., who has supplied me with the following interesting note, with the photograph reproduced in fig. 3 of plate xvii, and with the model from which text-figure 16C has been drawn.

"The floats used for fishing in the *jheels*, of the Solani and Ganges Rivers *kadir* near Roorkee, U.P., about 20 miles to the South East, are about 8′ long by 2′ diameter, and the cross section is circular, flattened at top and bottom a little. They are solid, made of the local *jheel* grasses, the bundle being tied round at several places with rough ties of grass. The prow is formed into

a point and turned up, the model shows this fairly well. They carry one man, or even two at a pinch; the man stands up and the *Bindi* is propelled by a pole of common bamboo, etc., about 10 to 12 feet long. They are crank and difficult for a European to manage. The fishing is with a spear or a circular casting net.

"They are used by the "Sirkulas," a Mahomedan tribe, numbering about 50 families perhaps. They say they came from Sind from the Manchar Lake, about three generations ago (about 1820 probably); my informant says it was in the time of his grandfather, and he himself is an old man of 60 about. They came because there were wars in Sindh. This is corroborated, as they speak Sindhi, and know all the different kinds of duck by the Manchar Lake names, (I have been to the Manchar and know these names myself, having kept a note of them). They do not intermarry with the dwellers in the kadir villages, who are Hindus of the low caste of Chumar: the chumars do not fish, nor do they use Bindis for other purposes. So presumably the "Sirkulas" brought the shape of the Bindi with them from Sindh, however I do not remember seeing any Bindis on the Manchar; perhaps nowadays the wooden dugout of the present-day Manchar fishermen has ousted the Bindi there.

"The *Bindi* is made preferably from the flat dark-green rush called here *Patera* the *Typha latifolia*: this rush floats even when newly cut, and it will last in a Bindi for about six months, before it rots. This rush is fairly strong and stiff when bound up into a Bindi, and the best Bindis are made of it. The round green reed, called *Tukla* locally, the *Cyperus alterifolius*, is also used at times for making Bindis, it also floats when freshly cut, but the disadvantage of it (compared to *Patera*) is that it is not strong nor stiff, like *Patera*, and the Bindi made of it does not last so long, and will not bear so much handling. The Latin names have been got from the Superintendent, Government Botanic Gardens, Saharanpur, to whom specimens of the grasses were sent.

"The *Patera* grows in water, to about 12 feet high, while the *Tukla* only runs to about 5 feet at most, it also grows in water.

"One of the characteristic points of the shape of the Bindi is the way the prow, or front end, is brought to a point and sticks up about a foot or so above the level of the top surface of the body of the Bindi. The grass in the Bindi is tied round at intervals with wisps of the same grass made into a rough sort of rope."

In many parts of the Madras Presidency rough bundles of reeds are used as rafts by fishermen, especially in the large tanks and reservoirs that are a feature of southern India; but these bundles are not shaped and I have heard of no instance of shaped rafts being employed in Perninsular India. The fact that the people who use them in the United Provinces are of Sindi origin is interesting as suggesting an actual historic connection between their manufacture in those provinces and in Seistan, for Sind is in many respects a country intermediate between India and Persia. As to the possible but more remote connection with Babylonia and

Egypt, I have not the learning necessary for a discussion on the subject. The *bindi* (fig. 16C) is of simpler construction than the *tutin*, but may be degenerate.

Except their bulrush rafts and punting poles the only implement used in fishing by the fishermen of the Hamun is a cotton net of simple structure. The cotton is grown locally. The net is oblong in shape, about 4 feet deep and 100 feet or more in length. The mesh is very large, allowing all small fish to escape.

In setting the net it is tied above and below at each end to a pointed tamarisk stick. The pointed end of these sticks is struck into the bottom of the lake and they are arranged in such a way in reference to the direction of the wind, and therefore of currents in the water, that the net forms a semicircle with its lower edge on the bottom and its upper edge slightly above the surface. It is set in a position into which it is easy to drive the fish, often in an open channel in the reed-beds or, in exceptionally calm weather, just outside one in the open lake. In the former case the channel is usually one that leads out of an open pool and suitable pools are apparently kept free of reeds for the purpose.

A considerable number of fishermen, each on his *tutin*, take part in driving the fish into the net. They arrange their rafts in a wide semicircle opposite that of the net and gradually converge towards it, beating the water with their poles and ululating with the peculiar sound conventionally transliterated "halelujah" in English religious works. They show great skill in directing a few vigorous downward strokes with their poles to give the rafts an impetus, and then striking the water before the forward movement ceases. The fish are gregarious and apparently rather sluggish and are easily frightened into the net in this manner.

When the semicircle of rafts has completely converged on that of the net the supporting sticks are pulled out of the water simultaneously by the men in the two end *tutins*, and turned up horizontally in such a way that the net is transformed into a bag. The two ends are then drawn at the same time into the two *tutins*, which approach one another as rapidly as possible.

Unlike Indian fishermen the Saiyad despise all small fish and do not attempt to catch any much less than a foot in length.

We saw a similar method of fishing used in small channels leading out of the Hamun. Here the net was much shorter and was stretched right across the channel. The men who used it waded in the water.

The only other method of fishing that we saw in Seistan was employed in pools in the dry stream-bed of Randa near the ruined city of Jellalabad. Here a rude and particularly clumsy kind of trawl was used. The net was a large bag, with considerably smaller meshes than that employed in the Hamun. It was fastened to one horizontal and two upright poles. The horizontal pole lay on the bottom of the pool and the two upright ones were held in position by means of ropes attached to their upper ends. Four men worked this trawl, two pulling ropes attached to the

ends of the horizontal pole and two other ropes fixed to the upper end of the upright ones. The four men waded along in the water. The awkwardness of the apparatus lay in the fact that unless all of the men moved together the upper ends of the two poles fell towards one another and the net refused to work properly.

We were told that around Nasratabad the favourite method of fishing was for men to go out into the swamps in the flood-season with swords and to strike at any fish they saw. Our informant, who had had great experience of the country, said that quite large fish were killed in this way.

In the Helmand River in the east of Seistan a more elaborate method of fishing is apparently practised. The following notes are taken from an official document. The author of part of these notes believes that the fish captured belongs to the genus *Schizothorax*. There is a single specimen of *S. zarudnyi* in the collection of the Seistan Arbitration Commison from the Helmand, but the largest fish caught by the author of the note weighed 12 lb., which is much heavier than any fish seen in the Hamun-i-Helmand. *Schizothorax* would seem to be the only genus of fish captured for food in Seistan.

"SEISTANI FISHING NET.

"The net used is a bag about 7·0′ long 9″ diameter at the lower end and 6′ × 2′ wide at the mouth. The net is held open by a pair of poles or prongs tied together at one end to make a fork. The fork pivots on a post on the bank. The fisherman sits on a platform. Across the mouth of the net fine lines are arranged, the lead string of which the fisherman holds in his hand to get timely warning that a fish has entered the net, whereupon he pulls the net up and removes the fish. The fork that holds the net is held in position by the strain of guy ropes. The net is placed on the bank near a pool at a place where there is a swirl or back water so as to intercept the fish moving along the edge of the bank; sometimes it is put up across the mouth of a small canal; a shallow channel is sometimes obstructed by a line of stakes along which the fish move till they come to the opening where the net is arranged and are caught. Below the Band-i-Seistan the net is arranged opposite a small leak in the *Band* and fish moving along the down stream face of the *band* are swept into the net by the force of the current at this place.

The favourite spots for the big fish are in the slack back water close to where the backwater meets the force of the down flowing current. At such places the small fry, which at certain seasons work their way up the river in thousands swimming as close to the bank as possible, are checked by the current and fall an easy prey to the larger fish which feed on them ravenously.

The autumn is the best season for fishing operations of this nature. The season of 1903 commenced as early as August and continued for several weeks. In 1904 it was late in September

before fish moved and not really well till October. March and April are also sometimes favourable if the river is not very full, but the fish do not move so freely then as in the autumn. During the hot weather (May-August) the fish are quite out of condition.

"LIST OF TECHNICAL TERMS CONNECTED WITH THIS METHOD OF FISHING:—

Name in Roman Characters.	*Explanation of the meaning and use of the word.*
[1] Bok	Platform on which the fisherman sits.
Ruka	Each pole or prong of the frame of two tamarisk poles fitted together to form a fork which holds the net.
Shingalak	The strut which separates the two poles or prongs of the fork.
Achchá	A forked pole, here used as supports to the platform.
Āsak	The piece of wood which acts as a trunion or pivot on which the fork of the frame revolves.
Dahan-i-ruká ..	The taut rope which holds together the ends of the poles of the fork.
Dast kash	The rope by which the frame and net are raised or lowered, and by which it is maintained in its position in the water.
Pish-áb	The rope that stays the frame against the whirl of the water, as the net is usually set up where there is a swirl in the water.
Sarkash	A stay that is used when there is a strong wind.
Maraká	The string which passes to the finger of the fisherman, and to which are connected the lines which are spaced across the mouth of the net. The fish touches these lines and warns the fisherman of its advent, whereupon he lifts the net out of the water.
Pásáo	The line which holds the upper side of the net, and is made fast to a stake on the bank. The lower side of the net is made fast to the lower pole.
Mushtak	A ring in the rope on the *dahani-rúká* where the *maraká* and *pásáo* are made fast.
Kisá	The pocket of the net.

[1] The Baluchis use the same words in describing the parts of this fishing net except that for *k* they say *Barmak* and for *Kisa* they say *Kito*.

Gislak	The line on which the fish that are caught are strung by the gills and kept in the water.
Shak	The handle of wood at the other end of the *gislak* for attaching it to a stake on the bank; it also acts as a needle to pass the line through the gills of the fish.
Dám	Is the net.
Dám-i-boki	This whole arrangement for catching fish.
Charkháb	Swirling back water forming a suitable place to set up this arrangement to catch fish.
Máhígír	Fisherman.
Máhí	Fish."

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EXPLANATION OF PLATE XV.

Fish of Seistan

Schizothorax zarudnyi (Nikolsky).

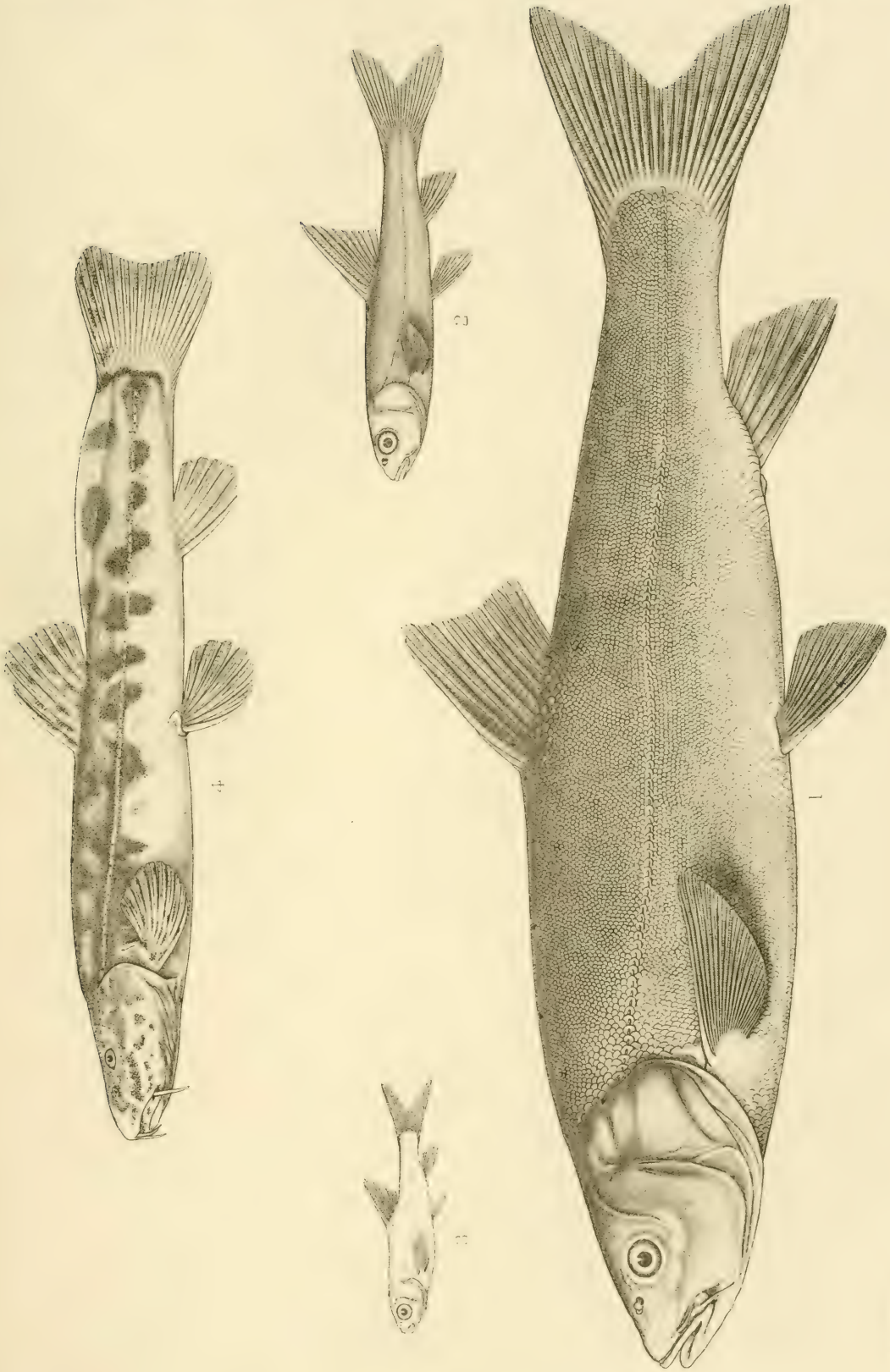
Fig. 1.—Adult fish (reduced).
,, 2.—Young fish (nat. size).

Schizocypris brucei, Regan

,, 3.—Young fish (nat. size).

Adiposia macmahoni (Chaudhuri).

, 4.—Half-grown fish (nat. size).



FISH OF SEISTAN.

EXPLANATION OF PLATE XVI.

Soft fin of **Adiposia**, etc.

FIG. 1.—Vertical section of soft fin of *Adiposia macmahoni*, stained with haematoxylin, × 60.

,, 2.—Part of the lateral region of the same preparation, × 200.

,, 3.—Vertical section of the dorsal fold (behind the dorsal fin) of a post-larval *Nemachilus evezardi* 1 cm. long, stained with haematoxylin, × 200.

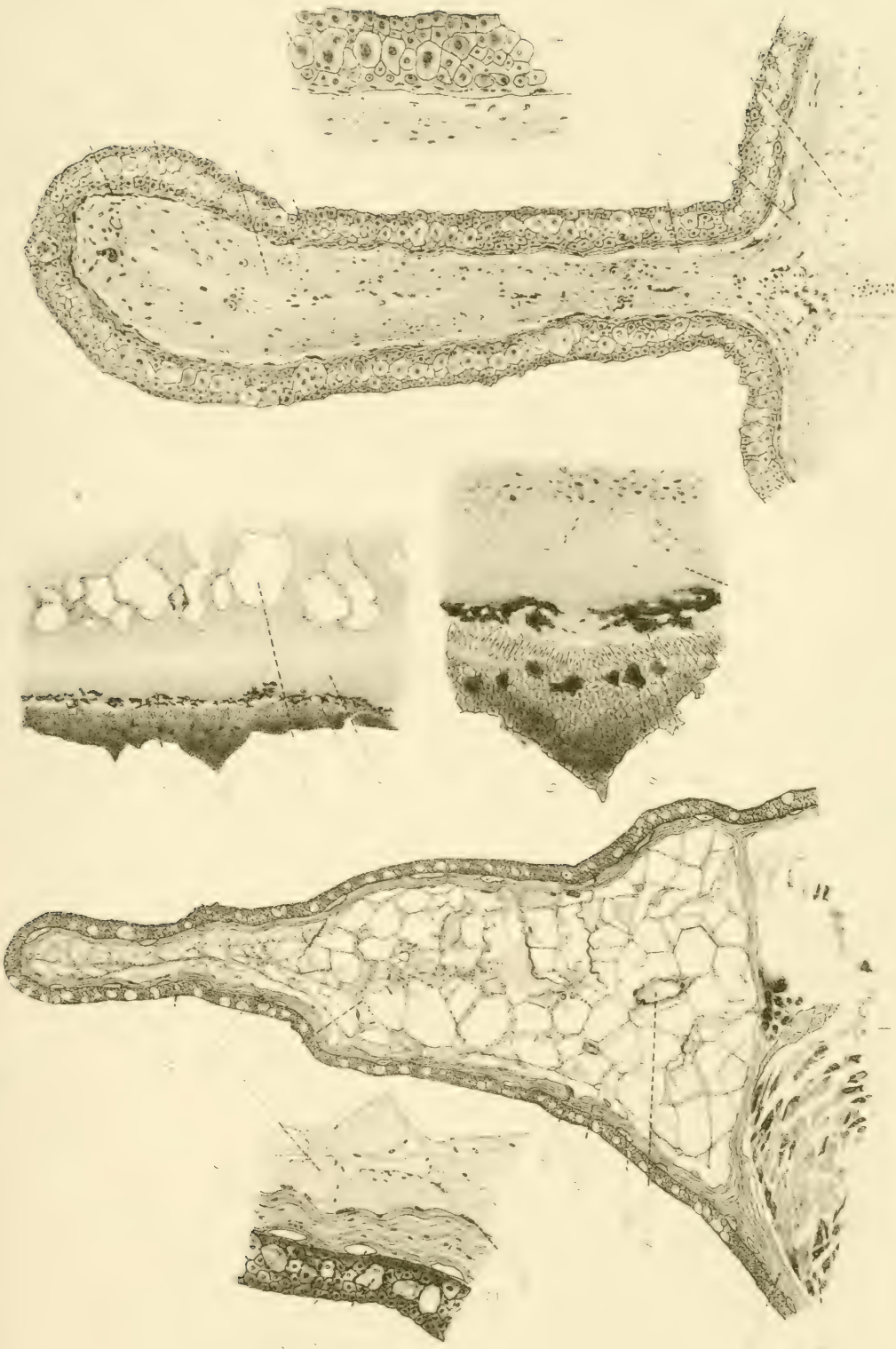
,, 4.—Part of the lateral region of the same preparation, × 300.

,, 5.—Part of the lateral region of a vertical section of the soft fin of *Glyptosternun* sp. (fam. Sisoridae, suborder Siluroidea), stained with haematoxylin, × 80.

,, 6.—Part of the same preparation, × 200.

EXPLANATION OF LETTERING.

a=vacuolated tissue. *b*=epithelial region. *c*=fibrous connective tissue. *d*=large blood-vessel. *d'*=small blood-vessel. *e*=dorsal muscles. *f*=gland-cell. *g*=pigment-masses. *g'*=dendritic pigment-cell. *h*=unstriped muscle cells.



EXPLANATION OF PLATE XVII.

SHAPED RAFTS FROM INDIA AND SEISTAN.

FIG. 1.—Fisherman's *tutin* among the reed-beds (Scirpetum) of the Hamun-i Helmand.

,, 2.—Men and boys making a *tutin* on the shore of the same lake.

,, 3.—Fisherman's *bindi* on swamp near Roorkee, U.P., India.

1

2

3

SHAPED RAFTS IN INDIA AND SEISTAN.

Photo.-engraved & printed at the Offices of the Survey of India, Calcutta, 1920.

THE RHYNCHOTA HETEROPTERA (NOTONECTIDAE & CORIXIDAE) OF SEISTAN.

By W. L. DISTANT.

Fam. NOTONECTIDAE.

Subfam. *NOTONECTINAE.*

Genus **Notonecta.**

Notonecta glauca Linn.

Linn., *Syst. Nat.* ed. X, p. 439 (1758); Dist., *Faun. Brit. Ind. Rhynchota* III, p. 41 (1906).

Var. **marmorea**, Fabr.

Fabr., *Syst. Rhyng.*, p. 103 (1803).

Daulatabad, Seistan (village pond).

Anisops fieberi, Kirk.

Kirk., *Entomologist*, 1901, p. 5; Dist., *Faun. Brit. Ind.* III, p. 46 (1906).

Nasratabad, Seistan (pools in parade ground); Lab-i-Baring, Seistan (channels in reed-beds in Hamun).

Fam. CORIXIDAE.

Macrocorisa geffroyi, Leach.

Leach (*Corixa*), *Trans. Linn. Soc.* XII, p. 17 (1818); Dist. (*Macrocorisa*), *Faun. Brit. Ind.* V, p. 339 (1910).

Daulatabad, Seistan (village pond).

Corixa hieroglyphica, Duf.

Duf., *Hem.* p. 86, f.f. 85—87 (1838); Fieb., *Eur. Hem.*, p. 93 (1861); Dist., *Faun. Brit. Ind.* III, p. 49, fig. 29 (1906).

Randa Stream, 4 mi. N.W. of Jellalabad, Seistan; Nasratabad, Seistan.

Corixa affinis, Dist.

Dist., *Faun. Brit. Ind.* V, p. 341, fig. 202 (1910).

Channel 8 miles east of Lab-i-Baring, Seistan; Randa Stream, 4 mi. N.W. of Jellalabad, Seistan; Lab-i-Baring, Seistan (channels in reed-beds in Hamun); Nasratabad, Seistan (pools in parade ground).

Corixa substriata, Uhlet.

Uhlet (*Corisa*), *Proc. U.S. Nat. Mus.* XIX, p. 275 (1896); Dist., *Faun. Brit. Ind.* V, p. 340 (1910).

Nasratabad, Seistan (irrigation channels).

Corixa seistanensis, sp. nov.

Body, elytra and legs ochraceous; pronotum with transverse black lines, the clavus with moderately oblique black lines, remaininig elytra with somewhat close black mottlings; eyes black; posterior tarsi more or less suffused with black; margins of the clavus and elytra ochraceous, impunctate.

Long 6½ millimetres.

Water-channels near Nasratabad, Seistan.

Allied to the Palæarctic *C. rogenhoferi* Fieb.

Corixa randana, sp. nov.

Head ochraceous between eyes, which are black; pronotum dull dark greenish ochraceous with closely arranged transverse black lines; elytra dull dark greenish ochraceous mottled with black, the clavus with transverse black lines, the lateral margins ochraceous, impunctate; body beneath and legs ochraceous; posterior tarsi with black or blackish suffusions; head between eyes a little longer than broad, eyes much broader than long, their apices deflected a little beyond the anterior angles of the pronotum.

Long 7½ millimetres.

Randa stream, N.W. of Jellalabad, Seistan; Lab-i-Baring, Seistan (channels in reed-beds in Hamun).

Micronecta desertana, sp. nov.

Head dull pale ochraceous with a central longitudinal, reddish linear spot, eyes black; pronotum dull pale ochraceous with a small dark obscure spot near each lateral margin which is paler and brighter in hue; elytra dull dark ochraceous with some scattered obscure fuscous shadings, the margins paler and brighter ochraceous; body beneath and legs dull pale ochraceous; head shorter than breadth at base, subequal in length to pronotum; eyes not projecting beyond the anterior lateral angles of the pronotum.

Length 3 millimetres.

Hurmuk, Persian side of Perso-Afghan-Baluch boundary, 3,000 ft. (desert-spring).

Micronecta biskrensis, Horv.

Horv., *Rev. d'Ent.* 1899, p. 104.

Hurmuk, Seistan 3,000 ft. (desert-spring); Algeria (Brit. Mus.).

The British Museum possesses an example of this species from Algeria, and determined by Dr. Horvath. With this specimen the examples from the Seistan desert entirely agree.

THE GROSS ANATOMY OF *CORBICULA FLUMINALIS* (Müller).

By B. PRASHAD, *D.Sc., Assistant Superintendent, Zoological Survey of India.*

In a recent paper on the molluscs of Baluchistan and Seistan [1] Dr. Annandale and I have discussed the synonomy of *Corbicula fluminalis* at some length. A few additional remarks may, however, be made regarding the type-species of the genus *Corbicula*. This genus was established in 1811 by Megerle [2] with Müller's species *Tellina fluminalis* [3] as the type. Preston [4], admitting this, referred to "*Corbicula fluminalis*, Megerle" as the type-species of the genus *Corbicula*; this is evidently a mistake since the author of the species *C. fluminalis* was Müller and not Megerle; the latter author only separated some of Müller's species of *Tellina* under the new name *Corbicula*.

The anatomy of the various species of *Corbicula* is very imperfectly known, the only work of any importance being a paper on the anatomy of a Chinese species (*C. lagillierti*) by Fischer.[5] I have therefore thought it desirable to describe the soft-parts of *C. fluminalis*, specimens of which, collected by Captain C. L. Boulenger at various places on the Euphrates, Mesopotamia, the original locality of Müller's species, and from Seistan, collected by Dr. N. Annandale and Dr. S. W. Kemp, are now available.

Animal. Corresponding to the shape of the shell the animal is trigonal, very much swollen in the umbonal region and greatly depressed below. Specimens preserved in spirit are of a creamy colour, the muscles and foot being of a much darker shade of yellow.

The mantle is transluscent and thin up to the palleal junction, the further lower part is much thicker owing to well-developed radial palleal muscles, while the free border is still thicker. The margin of the mantle is entire and without any papillae along the edge. There is, however, a row of small conical papillae on the inner surface a little behind the edge. The papillae are much reduced or even absent in the middle region of the pedal orifice. In the siphonal region also there are papillae in the same situation, but these are much smaller in size. The mantle-flaps of the two sides are not free from one another but owing to the absence of a supra-

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[1] *Rec. Ind. Mus.* XVIII, p. 58, pl. viii, figs. 1-6 (1919).
[2] *Mag. Ges. Naturf. Freude Berlin*, V, p. 56 (1811).
[3] Müller's *Verm. Terr. Fluv.* II, p. 205 (1774).
[4] *Faun. Brit. Ind., Freshw. Moll.*, p. 210 (1915).
[5] *Journ. Conchyliol.* XI, pp. 1-10, pl. i, figs. 1-3 (1863).

anal aperture and the formation of a siphonal orifice consequent on the development of the two siphons, the arrangement is different from that in the Unionidae. Anteriorly the two flaps are united with one another to a point a little below the anterior adductor muscle. From this point to an imaginary vertical line drawn in continuation of the anterior border of the posterior adductor muscle to the free edge of the mantle, the two flaps are separate, forming the large pedal orifice for the protrusion of the foot. At the posterior termination of the pedal orifice the two flaps are united by a well-developed muscular connection, thus separating off the pedal from the siphonal orifice. The siphonal orifice extends to a little below the upper margin of the posterior adductor muscle, and encloses the anal and the branchial siphons. The mantle in the siphonal region is notched a little below the middle, marking off the regions for the two siphons. Above the siphonal orifice the mantle flaps are united with one another as on the antero-dorsal border.

There are two adductor muscles. Of these the anterior one lies a little below the anterior margin of the pedal orifice, and is circular in outline and of about the same size as the posterior adductor. The latter lies just above the anal siphon. A small pedal retractor muscle, ovoidal in outline, is situated above the posterior adductor muscle; its fibres, which by their contraction retract the foot as the shell-valves close, are easily traceable to the foot. The well-developed radiating palleal muscle-fibres of the mantle have been referred to already; they originate near the palleal line and end slightly behind the free edge of the mantle. In consequence of the absence of a distinct siphonal sinus on the shell the siphonal contractors are feebly developed and appear as specialized radial palleal fibres, which are more numerous in this region, are specially thickened and have a distinct antero-posterior course.

In all the preserved specimens the siphons are fully contracted. It is not possible, therefore, to decide as to their respective lengths. The two siphons are, however, quite separate from one another, the upper or anal siphon being the smaller of the two. It has a rounded orifice with one or two small papillae surrounding it, and has the anus opening into it anteriorly just behind the posterior adductor muscle. The lower or branchial siphon is much larger, with an ovoidal orifice in the contracted condition, and bears three to four rows of elongate papillae on its external orifice.

The attachments of the gills are quite normal. The outer lamellae of the outer pair are attached to the mantle, the inner lamellae of the outer pair to the outer lamellae of the inner, while the inner lamellae of the inner pair are attached along a little more than the anterior half to the abdominal mass, the rest becoming fused with the same part of the lamella of the gill of the opposite side. The outer pair of gills are much shorter in both length and width than the inner pair.

The palps are comparatively short, fleshy structures somewhat triangular in outline and the two palps of each side are of about the same size. The abdominal mass is much larger comparatively than that of *C. lagillierti.* The foot is small and feebly developed, it is rounded posteriorly and has a slightly pointed tip on the anterior side. The rest of the digestive system is very similar to that of the genus *Galatea.*[1] The rectum and the heart, lying in the pericardium, are plainly visible through the mantle.

There is nothing special to note about the nervous, circulatory and excretory systems. Regarding the genital system the only point of interest is the more swollen condition of the abdominal mass in the females.

Affinities, etc. The animal closely resembles that of *C. lagillierti* described by Fischer (*loc. cit.*), only differing in the better development of the siphons, the abdominal mass and the palleal muscles. The siphonal muscle is poorly developed and the palps are much smaller. These differences may possibly be correlated, as Dr. Annandale has suggested to me, with the peculiar conditions in which *Corbicula fluminalis* is found. These are its living buried in soft mud and the long period of hibernation during the dry weather.

Fischer's remark as to the main distinguishing characters of the genus *Corbicula*, when he says, " On distinguera aisément les cyrènes à levrs branchie non réunies en arriere avec celles du côté opposé,'' is far from a correct description for, as has been described, the inner lamellae of the inner pair of gills of the two sides are united with each other in the posterior part and are not free. Fischer himself had recognized this, for in his " Manuel de Conchyliologie '' (p. 1091) he described the animal of the genus *Corbicula* as having " branchie réunies en arrière.''

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[1] Rang in *Ann. Sci. Nat.* XXII, pp. 152-164, pl. v (1832).

NOTE ON THE LEECH *LIMNATIS NILOTICA*.

By TOKIO KABURAKI, *Research Student, Imperial University, Tokyo.*

(*From the Zoological Laboratory, The Museums, Cambridge.*)

A considerable number of accidents caused by the leech *Limnatis nilotica* (Savigny), which is well known under the term "Horse-leech," exist in literature.[1] In the process of being swallowed, the leech attaches itself to the mouth, throat and nasal cavity of men and beasts, causing hæmorrhage as well as hindering respiration. When it penetrates deeper the hæmorrhage may sometimes be very serious and even fatal.

I owe to Dr. N. Annandale of the Indian Museum the opportunity of examining one specimen of leech, which seems to be identical with the species mentioned. The material was obtained, apparently at Quetta, Baluchistan, from the throat of an Austrian prisoner, who had been brought from Persia. In drinking from dirty pools in Persia, he sucked up six individuals, all of which had been at the back of his throat for eight days. This information comes from Capt. A. G. R. Hardwick, R.A.M.C., who has communicated it to Dr. Annandale.

The specimen is of large size, measuring 85 mm. long, exclusive of the posterior sucker, by 16 mm. across, taken almost in front of the posterior fifth of the body, from which the trunk tapers more gradually to the anterior end than to the posterior. The trunk is subcylindrical, presenting on the ventral surface of its anterior end the sucker which is destitute of the three powerful jaws, and in this respect it is unlike the medical leech. The upper lip of the sucker is divided on its inferior surface into two lobes by a deep longitudinal groove. The jaws are covered by papillae and provided with more than 100 minute teeth. The posterior sucker, which is distinctly separated from the trunk by a constriction, is of a circular shape, the diameter being about 12 mm.

The leech, being preserved in spirit, cannot be expected to have retained its original colour. The body is of a uniform brownish grey colour, without being traversed on the dorsal surface by any trace of such four black lines and a median yellow or green stripe as has been described by Blanchard.[2] Along each side,

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[1] Blanchard, R., Courtes notices sur les Hirudinées, 1. *Bull. de la Soc. Zool. de France*, XVI, 1891, p. 218. Hirudinées de l'Italie continentale et insulaire. *Boll. Mus. Zool. Univ. di Torino*, IX, 1894, p. 42. Masterman, E. W. G., Hirudinea as Human Parasites in Palestine. *Parasitology*, I, 1908, p. 282.

[2] See Blanchard, *loc. cit.*, 1894, p. 43.

separating the dorsal from the ventral surface, is a well-defined, dull orange lateral stripe. In colouration the present specimen can be easily distinguished from *Limnatis* (*Poecilobdella*) *granulosa* (Savigny), which presents the colour-pattern peculiar to the sub-genus *Poecilobdella*.[1] The latter species is common in British India.

The trunk is made up of 101 annuli, of which the 5th and 6th are fused ventrally to form the posterior margin of the anterior sucker. The same is true of the 7th and 8th annuli. In the 95th and 96th annuli I have been unable to demonstrate such a tendency of dividing into two as has been put on record by Blanchard.[2]

There are five pairs of eyes, of which the first three pairs are arranged on the first three annuli, forming a semicircle; the 4th pair lie on the 5th annulus; the 5th pair on the 8th annulus.

The male genital aperture lies in the posterior edge of the 30th annulus, appearing to exist between the 2nd and 3rd annuli of the X somite; the female aperture occurs five annuli behind the male, between the 2nd and 3rd annuli of the XI somite.

The nephridial pores lie in the posterior edge of the last annulus of each somite, but their total number could not be enumerated.

The alimentary tract agrees in the main with the medical leech, the crop being provided with some ten pairs of coeca, which are filled with blood, revealing a deep red colour. The intestine opens out on the dorsal surface of the last annulus, just in front of the posterior sucker.

Limnatis nilotica is of wide distribution, extending from the Azores, through part of Western Europe as well as Northern Africa, to part of Western Asia. It is of interest that its range extends, as stated by Dr. Annandale,[3] into the borders and even within the boundaries of the Indian Empire.

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[1], [2] Blanchard, Révision des Hirudinées du Musée de Turin. *Boll. Mus. Zool. Univ. di Torino*, VIII, 1893, pp. 27, 28.

[3] Annandale, N., Note on the Occurrence of the Leech *Limnatis nilotica* in Seistan and the Afghan-Baluch Desert. *Rec. Indian Mus.*, XVIII, pt. III, 1920, p. 135.

REPORT ON THE FRESHWATER GASTROPOD MOLLUSCS OF LOWER MESOPOTAMIA.

PART III.—THE FAMILIES NERITIDAE, HYDROBIIDAE AND MELANIIDAE.

By B. PRASHAD, *D.Sc., Assistant Superintendent, Zoological Survey of India.*

Since the publication of the first two parts of this series, the Indian Museum has received a valuable collection of Mesopotamian molluscs from Dr. E. W. Bowell, made by him at Basra during August 1917—February 1919, and placed with great generosity at our disposal. This collection, together with the collections mentioned in the previous parts of this report has rendered the working out of the Mesopotamian molluscs much easier and more satisfactory. Specimens of the families reported on in the first two parts of the report are also represented in this collection, but these do not offer any specially interesting points for further discussion. They belong to the following species:—

Limnaea tenera euphratica.	*Gyraulus convexiusculus.*[1]
Limnaea peregra canalifera.	*Gyraulus euphraticus.*
Bullinus contortus.	*Gyraulus intermixtus.*

The only point to be noted in reference to these is that the large series of *L. peregra canalifera* exhibits much greater individual variability than the specimens previously examined.

Family NERITIDAE.

Genus **Neritina**, Lamarck.

Subgenus **Dostia**, Gray.

1919. *Dostia*, Annandale and Prashad, *Rec. Ind. Mus.*, XVI, pp. 242, 243

In the paper cited above Dr. Annandale and I considered *Dostia*, Gray, as distinct from *Neritina*, Lamarck, but asa result of further examination of the rich collections in the Indian Museum I am inclined to consider it as worthy of subgeneric rank only.

[1] We would invite attention to the fact that there has been an unfortunate transposition of lettering in reference to *Gyraulus euphraticus* and *Segmentina calathus* in fig. 5 on page 40 of this volume. The figure D refers to the *Segmentina* and the figure F to the *Gyraulus*. [*N. A.* and *B. P.*].

In the Mesopotamian collection before me it is represented by Mousson's species *N. schlaeflii* which was originally described from the Persian Gulf.

Neritina schlaeflii, Mousson.

1874. *Neritina* (*Mitrula*) *schlaeflii*, Mousson, *Journ. Conchyliol.* XXII, pp. 49, 50.
1874. *Neritina crepidularia*? var. *Schlaeflii*, von Martens, *Vorder Asiat. Conchyl.*, pp. 44, 67, 124.
1879. *Neritina crepidularia* (in part), von Martens, in Chemnitz, *Conch.-Cab.*, *Neritina*, pp. 37-45, pl. vii, figs. 9-11.

This species was described by Mousson from shells collected on the island of "Ghaes" in the Persian Gulf. He noted the resemblance between it and the Oriental species, *N. crepidularia* and *N. depressa*, but considered it distinct from either owing to the much smaller size of the shell, the much less convex and laterally compressed dorsal surface, in the spire being more recurved and flattened, the nucleus being more prominent and in having a much smaller though comparatively more elongate mouth-opening. According to von Martens, it is only a variety of *N. crepidularia*, but the two Mesopotamian specimens collected by Dr. Bowell at Basra leave no doubt in my mind that it is specifically distinct.

The Mesopotamian specimens have a purplish background with a large number of irregular white spots resulting in a network of rather broad purple lines surrounding the white spots ; near the margins of the shell it assumes a blackish tint owing to the darkness of the ground colour and absence of the white spots.

Through the kindness of Major Froilano de Mello of the Portuguese Medical Service in Goa, the Indian Museum has received a specimen of this species from near Goa on the west coast of Peninsular India. This specimen is of a uniform dark brown colour. This record greatly extends the range of *N. schlaeflii*.

Subgenus **Neritaea**, Roth.

1879. *Neritaea*, von Martens, *op. cit.*, p. 16.
1899. *Neritina* (*Neritaea*), Kobelt in Rossmässler's *Icon. Land.-u. Süssw.-Moll.* (n. f.) VIII, p. 1.
1913. *Theodoxis*, Preston, *Journ. As. Soc. Bengal*, IX, pp. 470, 471.
1915. *Theodoxis*, Preston, *Faun. Brit. Ind. Freshw.-Moll.*, p. 5.

In his monograph of the genus *Neritina*, von Martens divided it into six subgenera, and included the species dealt with here in the subgenus *Neritaea*, Roth. This subgenus he further subdivided into eight groups according to the shape, sculpture, etc., of the shell. In the synopsis of these groups he included *N. jordani* and the other Mesopotamian species of the genus in the group Pictae, but further on in the descriptive part of his monograph included them in the account of the group Semicirculatae. This is evidently a mistake since the group Semicirculatae is confined to Central America and South Africa, while the Pictae group is found in the tropical and subtropical regions of Asia, Africa and

America. Moreover the structural characters of *N. jordani* and its allies do not justify their inclusion in the group Semicirculatae.

Preston, following Locard[1] and Dautzenberg,[2] assigns these species to the genus or subgenus *Theodoxis* or rather *Theodoxus*, Montfort. This is certainly wrong, since Montfort's name *Theodoxus*, as both von Martens and Kobelt have shown, should be reserved for the Palaearctic species of the *fluviatilis* type; the shells of the *jordani* type being included in the subgenus *Neritaea*, Roth.

Dr. Annandale recorded four species of the genus *Neritina* from Lower Mesopotamia. I have, however, found specimens of another in the collections made by Dr. Bowell at Basra. This form (*N. macrii* var. *michoni*) was only known hitherto from Syria and Palestine.

Neritina mesopotamica (Mousson), Martens.

1874. *Neritina meridionalis*, var. *Mesopotamica*, Mousson, *op. cit.*, p. 36.
1874. *Neritina anatolica*, var. *Mesopotamica*, v. Martens, *op. cit.*, pp. 33, 34, pl. v, fig. 42.
1879. *Neritina mesopotamica*, v. Martens, *op. cit.*, pp. 90, 91, pl. xiii, figs. 20, 21.
1899. *Neritina mesopotamica*, Kobelt, *op. cit.*, p. 4, pl. ccxi, fig. 1325.

Mousson confused this species with the Sicilian *N. meridionalis* and gave a very incomplete description of his new variety *mesopotamica*. The same form was also described in the same year by von Martens under the same name as Mousson's, but apparently in ignorance of his work. Von Martens considered it to be a form of *N. anatolica*, but published a full description and a good figure, and also compared the variety with the species *N. michoni* and *N. bellardii*. Later in his monograph of the genus he considered it to be a species distinct from *N. anatolica* and worthy of specific rank. I have compared the single Mesopotamian specimen before me with specimens of *N. macrii*, var. *michoni*, from Palestine and Mesopotamia and with those of *N. anatolica*, var. *bellardii*, from Damascus, and am of opinion that the species, as von Martens decided, is distinct from either.

The single Mesopotamian specimen was collected by Dr. Boulenger on the banks of the Khandag creek, Basra. The spire of this specimen is not so prominent as is shown in von Marten's figures, but in other respects closely agrees with his figures and description. The inner lip is straight and has minute denticulations on its inner border.

Neritina macrii, var. michoni (Bourg.).

1879. *Neritina Macrii*, var. *michoni*, von Martens, *op. cit.*, pp. 88–90, pl. iv, figs. 11–13 and pl. xiii, figs. 27–29.

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[1] *Arch. Mus. Hist. Nat. Lyon*, III, p. 231 (1883).
[2] *Rev. Biol. Nord. France*, VI, p. 349 (1894).

1883. *Theodoxis michoni*, Locard, *Arch. Mus. Hist. Nat. Lyon*, III, pp. 232, 233.
1894. *Neritina (Theodoxia) michoni*, Dautzenberg, *Rev. Biol. Nord. France*, VI, pp. 351, 352.
1913. *Theodoxis michoni*, Preston, *op. cit.*, p. 471.

There has been a great deal of confusion in literature as to the exact status of this form. Von Martens, who gives complete references to previous literature, was the first to recognize its relationship with *N. macrii*, Recluz, but in later works Locard, Dautzenberg and Preston have treated the species as distinct, and as belonging to the subgenus or genus *Theodoxis*. This view, as I have pointed out above, is not correct and the species should be assigned to the genus *Neritina* and the subgenus *Neritaea*. Kobelt[1] in his account of *N. macrii* says, "Martens hat *Neritina karasuna* und *michonii* mit *macrii* vereinigt, und zwar mit Recht," and therefore includes *michoni* only as a synonym of *N. macrii*. However, owing to the differences between the typical *N. macrii* and the form *michoni* I consider the latter as a distinct variety of the species.

The shells of this variety are less ovate than the typical form, have the spire a little more pronounced, the suture more impressed, the outer lip of the aperture extending much further over the columellar region, a relatively broader and more flat columellar region and the mouth shorter but broader.

In the Mesopotamian collections there are five specimens of this form, four collected by Dr. Bowell at Basra and the fifth from the Khandag creek, collected by Dr. Boulenger.

It may also be pointed out here that some of the specimens, collected by Dr. Annandale from the exit of the R. Jordan, Palestine, were described by Preston as being of an intermediate character between *N. michoni* and *N. jordani*. I have examined these specimens but can find no resemblances between them and *N. jordani* except for their colouration. This point is considered further under *N. jordani*.

Neritina jordani, Sowerby.

1861. *Neritina jordani*, and var. *turris*, Mousson, *Vierteljahrsschr. Naturf. Ges. Zurich* VI, pp. 151-152.
1879. *Neritina jordani*, von Martens, *op. cit.*, pp. 84-86, pl. ii, figs. 14-16.
1883. *Theodoxia jordani*, Locard, *op. cit.*, pp. 231, 232.
1894. *Neritina (Theodoxia) jordani*, with var. *aberrans*, Dautzenberg, *op. cit.*, pp. 349, 350.
1899. *Neritina jordani*, var. *turris*, Kobelt, *op. cit.*, pp. 2, 3, pl. ccxi, figs. 1319, 1320.
1913. *Theodoxis jordani*, Preston, *op. cit.*, p. 470.
1918. *Neritina jordani*, Annandale, *Rec. Ind. Mus.* XV, p. 162.

Dr. Annandale recorded the occurrence of this species in Mesopotamia from specimens sent to him from Nasariyeh. Since then we have received several shells from Basra collected by Dr. Bowell. This large series, together with the Palestine shells

[1] Rossmässler's *Icon. Land.- u. Süssw. Moll.* (n. f.) VIII, p. 5.

already in the Indian Museum, makes it possible to discuss the individual variation in form and colour.

Sowerby [1] figures three shells of what he calls the three varieties of *N. jordani*, without indicating a typical form ; his figures also are very poor. Reeve's [2] figures show a rather ovoid shell with a relatively small and scarcely exserted spire and with the body-whorl nearly smooth or with only a slight constriction on it. Mousson did not figure the shells he examined, but described a new variety under the name *turris*, which he distinguished from the typical form by its much larger size, more elevated apex, which makes the shell almost subcylindrical in shape, and by the body-whorl having a more prominent constriction. The figure of the typical form, the only one illustrated in von Marten's monograph, differs from that of Reeve's in having a comparatively shorter but more prominent spire, the columellar border narrower, the mouth relatively smaller and the constriction on the body-whorl much more pronounced. Dautzenberg, who followed Locard as to nomenclature, added a new variety (*aberrans*), which, according to him, is distinguished by the almost complete absence of the constriction on the body-whorl and by its variable but different colouration. Kobelt has given good figures of the typical form and of var. *turris*, Mousson. His figure of the typical form is quite similar to that of von Martens. Preston does not add any notes on the specimens examined by him, but says in his account of *T. michoni* that some of the specimens of this species link up the two species, *T. jordani* and *T. michoni*, and that these two are probably extreme forms of the same species only. Annandale, however, refers to some of the shells from Palestine and reported on by Preston as belonging to the var. *turris* of Mousson. In view of the above remarks it is clear that we have to deal with three forms. (i) *N. jordani s.s.* which von Martens' and Kobelt's figures may be taken to represent, and which appears to be a true lake-form occurring in the Lake of Tiberias and probably in the Lake of Homs. (ii) *N. jordani*, var. *turris*, described by Mousson and of which Kobelt's figure is a good representation. This form is stated to have been taken in the Lake of Tiberias, but the exact biological conditions under which it was found are not stated by either Mousson or Kobelt. In Dr. Annandale's collections and those of the late Dr. Anderson from those areas the form is only represented in the collections from the exit of the River Jordan. The form is probably a true stream phase. (iii) *N. jordani*, var. *aberrans*, described by Dautzenberg, but of which no figures have been published. The type specimens of this form were collected in the Lake of Homs and all the specimens from Mesopotamia in my opinion belong to it. This form appears to be confined to closed or slow-running waters.

The three phases discussed above may be distinguished by the following key :—

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[1] *Conchological illustrations, Neritina*, pp. 4, 6, fig. 49 (1841).
[2] *Conch. Icon., Neritina*, species 129 (1856).

I. Shell with a distinct transverse constriction on the body-whorl.
  A. Shell not more than 8 mm. in maximum diameter; more or less ovoidal in shape ... *N. jordani typica.*
  B. Shell measuring up to 15 mm. in maximum diameter; almost subcylindrical in shape and with the constriction of the body-whorl better marked than in the typical form ... *N. jordani*, var. *turris.*

II. Shell with the body-whorl almost smooth or with only a faint transverse constriction across it ... *N. jordani*, var. *aberrans.*

The major part of the Palestine collection reported on by Preston and the shells from the Lake of Tiberias from the late Dr. Anderson's collection belong to the typical form (fig. 1*a*). They have the shell of an ovato-conical form with a prominent spire and a distinct though not very deep constriction across the

FIG. 1.—*Neritina jordani*, Sowerby.
a. Shell of the typical form from Palestine.
b. Shell of Mousson's var. *turris* from River Jordan.
c. Shell of var. *aberrans*, Dautzenberg, from Mesopotamia.

body-whorl. The colouration is variable. Most of the specimens have zigzag vertical stripes of a red, chocolate or dark brown colour alternating with white stripes of the same shape, in a few cases the stripes coalesce here and there to produce a reticulate pattern; still further, a few have a uniform dark-brown or black colour with only a few pale spots. The specimens which Preston regarded as being of an intermediate character between his *T. michoni* and *T. jordani* are no more than uniformly coloured specimens of this form of *N. jordani* and have no relationship with *N. macrii*, var. *michoni*.

The var. *turris* of Mousson (fig. 1*b*) is, as I have stated above, represented by specimens from the River Jordan only. These are much larger, of a subcylindrical shape, have a much less prominent spire and the constriction on the body-whorl is much more impressed. In colour the shells show great variation; the stripes are of various colours as in the typical form but are narrower and

much closer ; a reticulate pattern is also formed in some cases by the fusion of the stripes with one another.

I assign all the Mesopotamian specimens to the var. *aberrans*, Dautzenberg (fig. 1*c*.), since the constriction on the body-whorl in most cases is quite absent or only faintly indicated. The specimens are, further, less elongate than the typical form and have a comparatively broader columellar area. The colouration is very variable. In some cases the shells are uniformly dark-brown or black, in others they have purple, red, chocolate or brownish wavy stripes alternating with much broader white stripes, while most of them show a distinct network of white spots alternating with coloured ones, the latter formed by the fusion of the stripes with one another. Most of the specimens are of a smaller size than those of the typical form.

Family HYDROBIIDAE.

Specimens of the genera *Tricula, Bithynia and Amnicola* (*Alocinma*) are represented in the Mesopotamian collections before me. Dr. Annandale (*loc. cit.*, p. 163) assigned an imperfect shell from Nasariyeh to the genus *Lithoglyphus*, Mühl., with some doubt. I have examined this specimen and agree with Dr. Annandale in considering it as possibly belonging to the genus *Lithoglyphus*, but it is too imperfect for a precise diagnosis.

Genus **Tricula**, Benson.

1843. *Tricula*, Benson, *Cal. Journ. Nat. Hist.*, p. 467.
1851. *Bithinella*, Moquin Tandon, *Journ. Conchyliol.* II, p. 239.
1852. *Paludina* (in part), Küster, Mart., Chemn. *Conch.-Cab.*, *Paludina, etc.*, p. 1.
1856. *Bythinella*, Moquin Tandon, *Hist. Moll. Terr.-Fluv. France*, p. 516.
1858. *Tricula*, H. and A. Adams, *Gen. Rec. Moll.* I, p. 306, pl. xxxii, figs. 5, 5a, 5b.
1862. *Tricula*, Benson, *Ann. Mag. Nat. Hist.* X, pp. 415, 416.
1863. *Paludinella* (in part), Frauenfeld, *Verh. Zool.-bot. Ges. Wien*, XIII, p. 199.
1885. *Tricula* and *Hydrobia* subgen. *Bythinella* (in part), Nevill, *Hand-List. Moll. Ind. Mus.* II, pp. 62, and 49 respectively.
1887. *Tricula*, Fischer, *Man. Conchyliol.*, p. 727.
1892. *Bythinella*, Kobelt, Rossmässler. *Icon. Eur. Moll.* (n. s.), V, pp. 36, 37.
1915. *Tricula*, Preston, *Faun. Brit. Ind. Freshw.-Moll.* p. 68.

I have carefully compared shells of the Himalayan species *Tricula montana*, on which Benson founded his genus, with those of certain European species assigned by most recent authors to *Bithinella*, Moquin Tandon, and can find no generic difference. Kobelt's figures of the various species of *Bithinella*, moreover, strongly support the view that the two are identical. A short review of the confusion that has existed in literature regarding the exact status of the genus *Tricula* may be given before considering the question of its synonymy.

Benson in his original description described the genus as belonging to the Melaniidae, basing his argument partly on shell-characters, which according to him showed the same relationships to *Melania s.s.* as "certain Egyptian and Syrian species of *Paludomus*" bore to that genus; and partly on anatomical grounds, the animal being, according to him, *Melania*-like. In this supposition he was followed by Gray and H. and A. Adams, but Brot in his revision of the Melaniidae, differing from them, stated that the genus was probably referrable to the Paludinidae. Benson in his subsequent work slightly elaborated his original arguments, and considered Brot's position untenable owing to the "very fundamental difference between the concentric operculum of *Paludina* and the subspiral one of *Tricula*"; he again laid stress on the resemblance of the animal of *Tricula* to that of *Melania*. Stimpson, Stoliczka, Blanford and Nevill considered *Tricula* to be a Rissoid genus. Fischer in doubtfully placing it amongst the Hydrobiidae compared it with *Acicula*, a genus of land-molluscs, and remarked, "La classification de ce genre est embarrassante." He had, however, come to a nearly correct conclusion. Preston followed him in assigning *Tricula* to the Hydrobiidae, or what he calls Paludestrinidae. I have pointed out above the resemblance between the shell of *T. montana* and that of the various species assigned to the genus *Bithinella*. The resemblance between its animal and that of the genus *Melania*, on which Benson laid so much stress, is only superficial and his own description does not show any differences between the animal of *Tricula* and that of any other Hydrobiid. Assuming, therefore, that the genus is a true Hydrobiid and that there is no difference between it and the genus *Bithinella*, Moquin Tandon, the name *Tricula*, Benson will have priority over Moquin Tandon's.

It may be noted here that the Indian brackish-water species referred to as *Bithinella miliacea* in a recent paper [1] by Dr. Annandale and myself is not assignable to the genus *Tricula*, but has relationships with the genus *Stenothyra*, Benson.

I have here to express my indebtedness to Dr. N. Annandale for pointing out to me the exact status of the genus *Tricula* and for the help he has so generously given me in clearing up its synonymy.

Tricula palmyrae (Dautzenberg).

1918. *Bithinella palmyrae*, Annandale, *op. cit.*, p. 162.

The only specimens of this species are the shells referred to in Dr. Annandale's paper cited above. I have carefully compared them with Dautzenberg's description and figure of the species and can find no differences.

Genus **Bithynia**, Gray.

In the Mesopotamian collection this genus is represented by two species: (i) *B. badiella*, a species common in Palestine and

[1] *Rec. Ind. Mus.*, XVI, p. 248 (1919).

Syria and recently recorded by Dr. Annandale from Mesopotamia and (ii) *B. rubens*, a species widely distributed in Italy, Sardinia, Greece, Algeria, Syria and probably in Upper Mesopotamia.

Bithynia badiella, Parreyss.

1919. *Bithynia badiella*, Annandale, *op. cit.*, p. 162.

In addition to the specimens reported on by Dr. Annandale there is a shell in the collection made by Dr. C. L. Boulenger from the area between Nasiriyeh and Hama Lake, Lower Mesopotamia. These specimens agree closely with the specimens from Palestine and Syria in the Indian Museum collection.

Bithynia rubens (Menke).

1892. *Bithynia rubens*, Kobelt, *op. cit.*, pp. 70, 71, pl. cxxxvii, fig. 866.

Specimens of this very variable species collected by Dr. Boulenger and Dr. Bowell at Basra agree with Kobelt's figures and with the specimens in the Indian Museum collection from Damascus.

Nevill [1] gave names to a number of well characterized forms of the species from various localities and the specimens he marked are in the collection of the Indian Museum. As he did not describe these forms and some of them have since been described by Preston under other names, Nevill's names will have to be taken as *nomina nuda* only, but the whole question is too complicated to be dealt with here.

Genus **Amnicola**, Gould and Haldemann.

Subgenus **Alocinma**, Annandale and Prashad.

1919. *Alocinma*, Annandale and Prashad, *Rec. Ind. Mus.*, XVIII, pp. 23, 24.

1920. *Alocinma*, Annandale *Rec. Ind. Mus.*, XIX, pp. 42, 43.

Dr. Annandale and I recently proposed this subgenus for certain Indian and Persian species hitherto assigned to the genera *Bithynia* aud *Amnicola*. We regarded this subgenus as being of an intermediate character between *Amnicola* s.s. and *Pseudamnicola*, both of which also must be considered as subgenera only. Recently Dr. Annandale has pointed out that "*Bythinia ejecta*," a species described by Mousson from Lower Mesopotamia, also belongs to this subgenus.

Amnicola (Alocinma) ejecta (Mousson).

1874. *Bythinia ejecta*, Mousson, *op. cit.*, p. 46.

A few of the specimens in Dr. Boulenger's collection from the banks of the Euphrates at Nasiriyeh and at Feluja agree with Mousson's description and are, therefore, assigned to his species.

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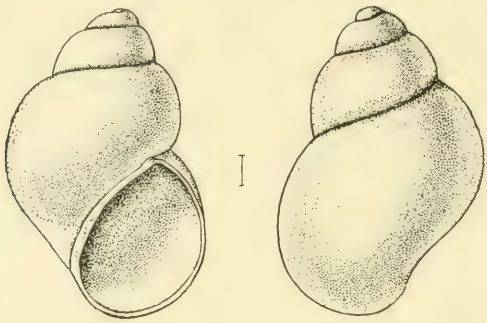
[1] *Hand-List Moll. Ind. Mus.*, II, pp. 40, 41 (1885).

At the end of his description of the species he adds the following: "D'après la forme de l'ouverture et surtout du bord, que est obtus à sa terminaison, je considère cette espèce comme une Bythinie, bien que l'opercule manque et que sa petitesse rappelle plutôt les Amnicoles." It is clear from this quotation that Mousson was not quite definite about the generic position of his form. The specimens before me, however, leave no doubt that the species *B. ejecta*, Mousson, as was considered by Dr. Annandale, is not a member of the genus *Bithynia*, Gray, but belongs to our new subgenus *Alocinma*.



2.

FIG. 2.—*Amnicola* (*Alocinma*) *ejecta* (Mousson) from the banks of the Euphrates at Nasiriyeh.

Family MELANIIDAE.

Genus **Melanoides**, Olivier.

Melanoides tuberculata (Müller).

1874. *Melania tuberculata*, Mousson, *op. cit.*, pp. 47, 48.
1887. *Melania tuberculata*, Schepmann and Snellmann, *Moll. in Veth. Mid.-Sum. Reiz. Ind. Sumatra-Exped.*, pp. 16, 17, pl. iii, fig. 11 (radula).
1919. *Melanoides tuberculata*, Annandale and Prashad, *Rec. Ind. Mus.*, XVIII, pp. 31, 32, pl. vi, fig. 1.

In the paper cited above Dr. Annandale and I have given the diagnostic characters of this widely distributed and very variable species. The radula of the mollusc had been figured by us previously in another paper.[1] Schepmann had previously figured and described the radula of the Sumatran form in the obscure publication cited above. The two differ from one another, but the differences are more apparent than real, being due mainly to different views of the teeth having been figured; other differences in the number of denticulations are only of the nature of a variation exhibited by the species.

[1] Annandale and Prashad, *Rec. Ind. Mus.*, XVI, p. 146, pl. v, fig. 5 (1919).

The species is represented in the Mesopotamian collection by a large number of dry shells from Basra and a few preserved in spirit from the banks of the Euphrates. Most of the specimens are rather small but a few measuring up to 35 mm. in length are also represented.

Melanoides pyramis, var. **flavida** (Nevill).

1919. *Melanoides pyramis* var. *flavida*, Annandale and Prashad, *op. cit.*, pp. 34, 35.

In the paper cited above we referred to a rather dark specimen of this form collected by Dr. C. L. Boulenger from the flooded area near Khandag creek, Basra, Lower Mesopotamia. This specimen agrees in all particulars with the specimens from the Persian frontier and Baluchistan, but is darker in colour. It measures 27·5 mm. in length by 9·9 mm. in breadth, the aperture measures 9·8 mm. by 5·7 mm.

Genus **Melanopsis**, Férussac.

Melanopsis nodosa, Férussac.

1874. *Melanopsis nodosa*, Mousson, *Journ. Conchyliol.* XXII, p. 48.
1874. *Melanopsis nodosa*, Brot, "*Die Melaniaceen*" in Chemnitz, *Conch.-Cab.* (ed. Küster), p. 432, pl. xvi, figs. 17–24 (in part).
1918. *Melanopsis nodosa*, Annandale, *Rec. Ind. Mus.*, XV, p. 163.

The species was recorded by Mousson from the Euphrates and the Tigris below Mosul on the basis of the collections made by Dr. A. Schlaefli in this region, and Annandale has recently recorded its occurrence in Lower Mesopotamia.

In the collections made by Dr. C. L. Boulenger and Dr. E.W. Bowell the species is represented by a large number of shells from Nasariyeh and from Khandag creek, Basra. All the specimens are of the typical *nodosa*-type and none belong to Mousson's var. *moderata*, described in his paper cited above. Most of the specimens are quite fresh and distinctly show the three rows of large tubercles on the body-whorl—a characteristic of this species.

The specimens vary in colour from chestnut-brown to black, except for the subfossil shells which are white and chalky. The largest specimen measures 23·4 mm. in length and 11·3 mm. in maximum breadth; the aperture measures 10·8 mm. by 5·2 mm.

Melanopsis costata (Olivier).

1874. *Melanopsis turcica*, Mousson, *op. cit.*, pp. 48, 49.
1879. *Molanopsis costata*, Brot, *op. cit.*, pp. 426–429, pl. xlvi, figs. 4-7.
1913. *Melanopsis costata*, Preston, *Journ. As. Soc. Bengal*, IX, p. 467.

Melanopsis costata is a widely distributed species throughout Syria, Palestine and Mesopotamia. In the Mesopotamian collections under report, it is represented by shells from the banks of a dry creek connected with Diala River between Baguba and Sharoban, and from the Khandag creek, Basra.

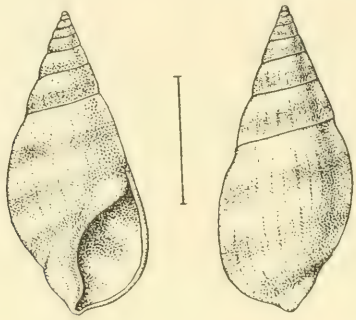
The species, though closely allied to *M. nodosa*, is distinguished from it by the costae on the surface of the shells being more regular and continuous and in having two instead of three rows of tubercles on the body-whorl.

In the large series before me there are shells corresponding to Brot's figures of the *typical* form, var. *B* and *M. turcica bellio*, Parreyss. There are, however, intermediate forms connecting the various varieties and it is therefore not necessary to distinguish them as different forms.

Melanopsis subtingitana (Nevill), Annandale.

1918. *Melanopsis subtingitana*, Annandale, *op. cit.*, pp. 163, pl. xx, figs. 1, 2.

This species has only recently been described by Annandale from two shells in the Indian Museum recorded as *Melanopsis*



3.

FIG. 3.—Type-specimen of *Melanopsis subtingitana*, var. *laevis* from the creek connected with Diala River, Mesopotamia.

costata, var. by the late Mr. G. Nevill, and from two others from Mesopotamia presented to the Indian Museum by Colonel W. H. Lane. Dr. Bowell's collection from Basra also contains a good series of the species. These shells agree closely with the type-shells, except that most of them are a little larger and have the ribs more obsolete.

Var. **laevis**, nov.

Two specimens from Mesopotamia, one from the banks of a dry creek connected with Diala River between Baguba and Sharoban collected by Dr. Boulenger, and the other from Basra by Dr. Bowell, are so different from the typical *M. subtingitana* as to deserve varietal rank. Both the shells are nearly smooth and have the whorls much more regular than in the typical form. In other respects the two shells resemble the forma *typica*.

Type-specimen No. M 11807/2 in the Zoological Survey of India (Indian Museum, Calcutta).

Measurements of shells (in millimetres).

Specimen A is from Basra, and B (the type) from the creek connected with the Diala River.

	A.	B.
Length of shell	16·8	17·6
Breadth of shell	7·4	8·3
Length of aperture	8·2	9·1
Breadth of aperture	3·9	5

NOTES ON LARVAL TREMATODES FROM SEISTAN.

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

The following notes on larval trematodes obtained during our visit to Seistan are admittedly very incomplete. In the field it was not possible to follow out the detailed anatomy of the various forms from living specimens and for this, it is to be feared, no subsequent work on preserved material can compensate. My notes are in the main based on preserved cercariae and on sections of infected livers. As a fixative Schaudinn's solution, used hot, was employed; while for staining haematoxylin followed by eosin gave the best results.

In some instances cercariae were obtained in such small numbers that it has not been found possible to give any account of their anatomical characters. Of these one is a Xiphidiocercaria obtained in *Melanoides pyramis* var. *flavida* at Saindak in the extreme west of Baluchistan and the other a furcocercous form with extremely long tail-flukes obtained in *Gyraulus euphraticus* in the Hamun-i-Helmand. Of each of these only a single infection was discovered. The other three forms of cercariae are partially described below. One of them (Cercaria A) is a leptocercous form with rediae resembling those of *Fasciola hepatica*[1]. The other two (Cercaria B and C) are furcocercous forms; one of these (B) bears a close resemblance to the larva of *Schistosoma japonicum*, but is distinguished by a number of characters.

For the names of the molluscan hosts I am indebted to Dr. Annandale and Dr. Baini Prashad (see page 17 of this volume).

Cercaria A (text-figs. 1 *a–c*).

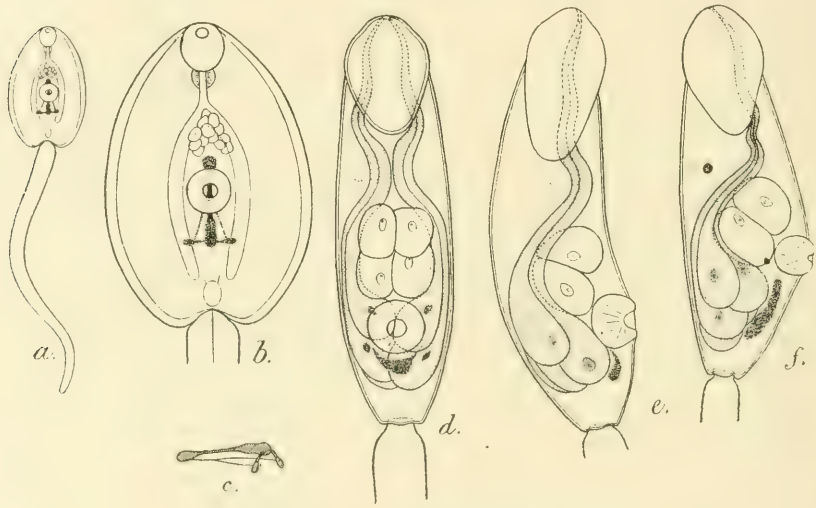
In well-preserved specimens the length of the body is from 290 to 360 μ (average 320 μ) and the breadth 170 to 220 μ (average 200 μ). The tail is twice or more than twice as long as the body, being from 670 to 780 μ in length (average 730 μ).

The body (figs. 1 *a*, *b*) is oval in outline, distinctly excavate posteriorly at the insertion of the tail, and is relatively thick-walled. The oral sucker is about 0·05 mm. in diameter. The acetabulum is approximately the same size and is situated slightly behind the middle of the body. There is a small pharyngeal bulb situated on the undivided anterior portion of the gut close to

1 Erroneously recorded as a monostome on p. 22 of this volume.

the oral sucker. The coeca are long reaching to the distal quarter of the body-length. Near the junction of the coeca there is a cluster of cells which have the appearance of glands, but no ducts leading to the oral sucker were detected in the preserved material. Close to the tail a small bladder can sometimes be observed with traces of a pair of ducts directed anteriorly and one running posteriorly down the middle of the tail.

The most characteristic feature of the anatomy is, however, the partially developed gonad which lies immediately above the acetabulum. The gonad is very conspicuous in stained preparations and in dorsal or ventral view appears T-shaped with a fine strand joining each cross-piece to the stem. In reality the structure is more complex than this view indicates. The principal portion consists of a rod, about twice as long as the diameter



TEXT-FIG. 1.—Cercariae from Seistan.
a-c. Cercaria A. *d-e.* Cercaria B.
f. Cercaria C.

of the acetabulum, which is dilated anteriorly and in its posterior third. At its hinder end a transverse portion, consisting of a slender shaft and swollen head, joins it on either side and each of these portions curves downwards, so that the head itself is on a much lower level than the central rod from which it arises (fig. 1 *c*). From the head of each transverse portion a fine strand runs forward; the two unite and the single strand so formed meets the dilated anterior part of the main axis on its ventral side. The disposition of the parts, as seen obliquely from the side, is indicated in text-fig. 1 *c*. The structure is remarkably constant in form, showing little variations in fully grown and well preserved individuals.

The space between the gut and the body-wall is filled with large cells which lie with their long axes placed transversely.

The cercariae develop in rediae which, as in those of *Fasciola hepatica*, bear a pair of processes near the hinder end; they reach a maximum length of about 2·5 mm.

Cercaria A was found in specimens of *Limnaea bactriana*, Hutton, living in small irrigation channels close to the British Consulate at Nasratabad in Seistan. Of one hundred molluscs which were examined for parasites nine contained this Cercaria.

Cercaria B (text-figs. 1 *d*, *e*).

This is a furcocercous form which appears to resemble rather closely the larva of *Schistosoma japonicum* as described by Cort.[1]

The body in well-preserved specimens is from 167 to 193 μ in length and the mean of a number of observations is 186. Its breadth varies from 41 to 52 μ, the mean being 48. The undivided part of the tail is from 192 to 222 μ, with mean of 208 μ; the furca are from 62 to 67 μ, with mean of 64 μ.

The oral sucker is from 31 to 33 μ in diameter and the acetabulum from 22 to 23 μ.

The alimentary canal appears to be altogether absent and the body is for the most part filled with large gland cells (figs. 1 *d*, *e*). The four anterior gland cells differ very decidedly in character from the remainder, for in preparations treated with eosin the posterior cells are always very heavily stained, while the four anterior remain colourless. No ducts leading forwards from the four anterior cells could be traced in preserved material, though on analogy with similar forms it is probable that they really exist. The ducts from the posterior cells stain readily with eosin and are very conspicuous. The number of posterior cells appears to be six, making five pairs of cells in all; but two are usually concealed by others which overlie them.

On either side of the ducts from the gland cells, in the anterior half of the body length there is a small semitransparent area which perhaps represents an unpigmented eye-spot. Posterior to the acetabulum the beginnings of the gonad are visible, consisting of a mass of cells which is usually crescentic in form when seen in dorso-ventral view.

This cercaria, so far as can be seen from preserved material, seems akin to that of *Schistosoma japonicum* or, more nearly, to the very closely allied form from Bengal recently described by Major Sewell (*loc. cit.*). There are, however, marked differences. In the Seistan cercaria the tail-flukes appear proportionately shorter, the acetabulum larger and unpigmented eye-spots are perhaps present. No trace of the gut could be found, nor of teeth on the anterior sucker.

Cercaria B was found in specimens of *Gyraulus convexiusculus* (Hutton) obtained in the Hamun-i-Helmand, Seistan. Forty-three

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[1] Cort, *Univ. Calif. Publ. Zool.*, XVIII, p. 485 (1919); see also Sewell, *Rec. Ind. Mus.*, XVI, p. 425 (1919).

G. convexiusculus were examined of which three contained examples of the parasite.

Cercaria C (text-fig. 1 *f*).

The cercaria is a furcocercous form, similar in most respects in its internal anatomy to Cercaria B. It is, however, a much larger form and possesses pigmented eye-spots.

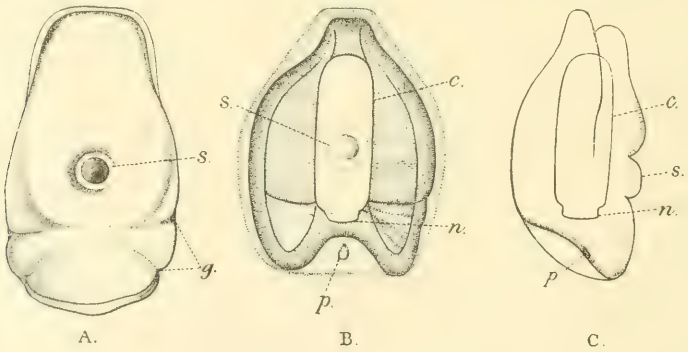
In well-preserved specimens the body is from 188 to 230 μ in length and from 56 to 80 μ in breadth, the mean of a number of observations being 206 by 70. The undivided part of the tail is from 247 to 360 μ, with mean of 305, and the furca are from 106 to 136 μ, with mean of 120.

The internal anatomy, so far as it can be made out, is very similar to that of Cercaria B; the same gland cells are to be seen and in stained specimens the four anterior cells differ in the same way from those placed further back. The gonad, however, is not crescentic in dorso-lateral view, the acetabulum is smaller and the eye-spots are deeply pigmented and black in colour.

This cercaria was found with the preceding in specimens of *Gyraulus convexiusculus* (Hutton) obtained in the Hamun-i-Helmand, Seistan. Two molluscs, out of forty-three which were examined, contained examples of the parasite.

ADDENDUM.

With Dr. Kemp's permission I add here three figures of the parasite of *Schizothorax zarudnyi* referred to by Mr. S. L. Hora



TEXT-FIG. 2.—Parasite from *Schizothorax zarudnyi*.

and myself on p. 173 of this volume. The figures have been placed at my disposal by Major R. B. Seymour Sewell, I.M.S. and represent three views of the animal as seen as a solid object (A) and mounted in glycerine (B & C) after extraction from the cysts in the muscles of the fish. Their magnification is not stated, but it is at least 12 as reproduced. The structure of the organism is so enigmatic that none of us are able even to suggest its taxonomic position. The preservative had apparently failed to penetrate the

peculiar cylinder in the interior of the animal and sections were a complete failure. Major Sewell notes in explanation of his figures that there is a more or less well-defined groove round what appears to be the anterior extremity and sucker-like disc (*s*) in the middle of the (?) ventral surface. The (?) posterior part of the organism is divided by faint grooves (*g*), as shown in fig. A. These are visible only on the (presumed) ventral surface. On the dorsal surface, near the posterior extremity, there is a small aperture (*p*). The outer parts seem to form a kind of test, lined by a thin membrane, and inside this there is a cylindrical body (*c*) with an apparently chitinous investment. At the end nearest the (?) dorsal grooves the extremity of this body is contracted to form a collar (*n*). Though the specimens had been fixed in Schaudinn's fluid and were apparently well preserved, no further structure could be made out.—*N. Annandale.*

THE AQUATIC FAUNA OF SEISTAN.

A Summary.

By N. Annandale, *D.Sc., F.A.S.B., Director, Zoological Survey of India.*

The aquatic fauna of Seistan is a scanty one, fairly rich in individuals, as is usual in a fauna living in abnormal conditions, but poor in species. The most salient fact about it is that it is essentially a mountain fauna acclimatized to live in a swampy depression. Before discussing its geographical and biological relations as a whole I will first consider briefly the different species found in the different bodies of water that exist in the country, *viz.* desert springs, stagnant pools, rivers and other water courses, and the Hamun-i-Helmand or basin into which the Helmand finally drains. An account of these will be found in the Introduction to this volume. I have given in foot-notes references to the species of animals not otherwise noticed in the volume.

THE FAUNA OF SPRINGS IN THE SEISTAN DESERT.

In our hurried journey across the desert of Seistan and the Afghan-Perso-Baluch frontier we had little opportunity to examine many of the springs we passed, but those we did examine were very uniform in their animal life, which did not appear to be much affected by the varying degrees of salinity of water accepted under stress of necessity as potable by man and beast. None of the springs contained fish, but all the larger ones had a small but healthy fauna of molluscs, insects, Entomostraca and leeches.

Mollusca. Only three species of molluscs were found, *Melanoides pyramis* (Benson), *Gyraulus euphraticus*, Mousson and *Corbicula fluminalis* (Müller). Of these the most commonly present was the *Melanoides*. Of this species all our specimens belonged to Nevill's var. *flavida*, a form perhaps peculiar to situations of the kind and originally described from Persian Baluchistan. The shell, though not of the largest size attained by the species, is not dwarfed or in any way distorted. A single specimen of this race is also known from Mesopotamia. The *Gyraulus* is perfectly normal, though found in water distinctly bitter to the taste. It is noteworthy that the species has an extraordinarily wide range (from Mesopotamia to China) and must, therefore, be extremely adaptable. The same is true of the *Corbicula*, which is found practically all over Africa and southern and middle Asia, was originally

described from Mesopotamia and occurs fossil in Great Britain. Shells from the springs are smaller and rather thinner than usual and perhaps a little broader in proportion to their height, but specimens from larger bodies of water exhibit great individual variation in these respects, merging gradually into the thick narrow form called *C. cor* by many conchologists.

The molluscs of the springs, therefore, may be said to show very little response to their environment in structure.

INSECTA. Insect life, even in the middle of winter, is by no means deficient in the springs. The most abundant and the most commonly observed species was the mosquito,[1] *Theobaldia longiareolata*, the larva of which was found in water so saline as to be almost undrinkable, as well as in the excellent spring at Hurmuk, claimed locally to contain the finest water in all Iran. Both larvae and pupae were seen in December and imagines were observed hatching out. The latter, which were common also at Nasratabad, were, however, very sluggish at this season and made no attempt to suck blood.

Small Rhynchota of the family Corixidae were frequently noted in the springs and in that at Hurmuk two species of *Micronecta* (*M. desertana* and *M. biskrensis*) were abundant. The former has been described by Mr. Distant as a new species, while the latter was described by Horvath from the oasis of Biskra in the Algerian desert.

Small Hydrophilid and Dytiscid beetles are not uncommon, and a large species of the latter family was captured in the spring at Hurmuk.

CRUSTACEA. The only Crustacea seen in the springs were Ostracods, which often swarmed on the bottom. In a sample from an artificial tank containing water pumped from a spring in the Baluch desert Mr. Gurney found tests of *Cyprinotus incongruens* and *Ilyocypris bradyi*, both widely distributed species.

HIRUDINEA. So far as I can judge, only one species of leech (*Limnatis nilotica*) occurs in the springs. It is common in all those at which transport animals are watered and is dangerous both to men and animals owing to its habit of entering their mouths while they are drinking and sticking to the tongue or pharyngeal wall.

THE FAUNA OF STAGNANT POOLS.

Under this heading I propose to consider pools connected neither with water-courses nor with small desert springs. Such pools are found occasionally in depressions, probably always of artificial origin, in Seistan and apparently owe their water to percolation. The largest pool of the kind we saw was at the village of Daulatabad towards the south of the country. It formed a fairly large village pond and lay at the base of a low ridge of stiff

[1] For the identification of this mosquito and of the other Nemocera mentioned in this paper I have to thank Mr. Edwards of the British Museum.

clay on which the village was built. Even in December it contained a considerable quantity of water, which was very foul but apparently slightly saline. It was used by the villagers for all domestic purposes. There was no macroscopic vegetation, but much evidence of the presence of a luxuriant growth of microscopic algae was present.

The macroscopic fauna of this pond consisted, so far as we were able to discover, of arthropods only. Cladocera, including large Daphniids and Copepoda, were abundant, but circumstances did not allow of their collection. The most noteworthy features were the wealth of insect life and the large size of some of the species present. This was particularly noteworthy in the Rhynchota, the representatives of which are mostly very small in Seistan. As at other places the only families of this order that we could find were the Corixidae and the Notonectidae, but in the latter family the relatively large and very widely distributed *Notonecta glauca*, which we did not see elsewhere in Seistan, was common, while in the Corixidae *Macrocorisa geffroyi* was also present in large numbers. Dipterous larvae were abundant, the most conspicuous being an exceptionally large Chironomid, the imagines of which were observed hatching out from the pupae on the surface. Water-beetles, including large Dytiscidae and Hydrophilidae of moderate size, were numerous.

The only other pools of the sort in which we collected were those in the parade-ground at Nasratabad. They occupied pits from which clay had been extracted for brick-making. Their water was fouled by the camels and donkeys that frequented them, but not or hardly saline. It was six or seven feet deep in places but blocked up by a profuse growth of the water-weed *Zannichellia palustris*. Insects, Entomostraca and molluscs were rich in individuals, but the number of species was small. No large species of Rhynchota were seen, but several species of Notonectidae and Corixidae were abundant. Mr. Distant has identified the following forms:—*Anisops fieberi* and *Corixa affinis*.

Mr. Gurney found the following species of Entomostraca in the collections made:—CLADOCERA: *Daphnia magna*, *Simocephalus vetulus*. COPEPODA: *Cyclops strenuus*, *C. leuckarti*. OSTRACODA: *Eucypris clavata*, *Ilyocypris bradyi*, *Potamocypris villosa*; all common and widely distributed forms.

The molluscs present were *Limnaea bactriana*, *Gyraulus euphraticus*, *G. convexiusculus* and *Corbicula fluminalis*, all common species in Seistan and found, with the exception of the *Limnaea*, in all bodies of water containing luxuriant submerged vegetation in the country. *L. bactriana*, which appears to be mainly a pond mollusc, was found only in those pools and in small water-courses at the same place.

FAUNA OF IRRIGATION CHANNELS.

The small irrigation channels that form a close net-work over the whole of the habitable part of Seistan have, at any rate in

December, a very poor fauna. This is not altogether surprising, for the water in most of them is at that season intermittent, being shut off for several days each week. Even, however, where the stoppage of the flow does not cause desiccation and where a species of broad-leafed *Potamogeton* flourishes very few macroscopic animals could be found and even insects and Entomostraca were extremely scarce, if not altogether absent. The only crustacean obtained from this habitat was a single specimen of the Conchostracous *Leptestheria tenuis*. A small Tipulid fly (*Symplecta elongata*), the only species in our collection described from Persia proper, was common on the damp mud at the edge of similar channels and probably bred in them.

In the garden of the British Consulate at Nasratabad we examined an artificial water-course which had, however, a much richer vegetation and fauna, probably owing to the fact that it was less liable to desiccation and received the benefit of manure applied to the garden through which it flowed. Its flow was, however, intermittent like that of the irrigation channels outside, from one of which it received its supply. The vegetation consisted mainly of a narrow-leafed species of *Potamogeton* and of *Zannichellia palustris*, but a filamentous green alga forming cloud-like masses was also abundant. The water was fresh or practically so. The fauna was sufficiently rich to be treated group by group.

FISH.—Shoals of the small Cyprinid *Discognathus adiscus* occurred, remaining at the bottom in the day-time but rising to the surface in the evening. Among them was found a single specimen of *D. phryne*. The first species is known only from Seistan, while the second is common in the hill-country of Baluchistan.

MOLLUSCA.—The same molluscs were found as in the pools on the parade-ground hard by, namely *Limnaea bactriana*, *Gyraulus euphraticus*, *G. convexiusculus* and *Corbicula fluminalis*. No difference in the shell of any of these species could be discovered. A few empty shells of *Segmentina calathus*, a widely distributed North Indian species, were also obtained from this channel.

ARTHROPODA.—The insects and Entomostraca of the channel were the same, or practically the same, as those of the pools on the parade-ground.

OLIGOCHAETA.—The little Oligochaete worm *Nais communis* var. *punjabensis* was found in considerable abundance and in interesting circumstances. It inhabited small mucilaginous tubes, probably stolen from a Dipterous larva, in masses of filamentous algae and to each of the tubes a colony of the polyzoon *Lophopodella carteri* was attached. *N. communis* is a cosmopolitan species and the var. *punjabensis* is common in Northern India. Col. Stephenson[1] found among our specimens of this little worm a single individual probably belonging to another species common in North India, namely *Chaetogaster punjabensis*.

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[1] Stephenson, *Mem. Ind. Mus.* VII, p. 196 (1920).

POLYZOA.—*Lophopodella carteri* was the only member of this group observed. Its geographical range is now known to be exclusively Asiatic, but to extend from Eastern Persia to Japan, the Chinese and Japanese race being slightly differentiated. It is not by any means always associated with Oligochaete worms, but a Chironomid larva not infrequently establishes itself at the base of the colony.

DELTAIC FAUNA OF THE HELMAND AND ITS EFFLUENTS.

We were unable to visit the main branches of the Helmand in its inland delta, but collections of fish and molluscs were made in this region by Sir Henry MacMahon and other officers of the Seistan Arbitration Commission. The fish they obtained were:—*Scaphiodon macmahoni*, *Discognathus phryne*, *Schizothorax zarudnyi*, *Schizopygopsis stoliczkae*, *Nemachilus stoliczkae*, *Adiposia rhadinaea* and *A. macmahoni*. Of these only three (*D. phryne*, *Sch. zarudnyi* and *A. macmahoni*) were found in the smaller streams of Seistan.

The molluscs collected by the Commission in the Seistan delta were *Vivipara helmandica*,[1] *Lamellidens marginalis* and *Corbicula fluminalis*. Of the first of these only single empty shells were found by us in other parts of Seistan, except for a number of completely bleached specimens found in a flood-deposit. There is, therefore, some reason to regard the species as peculiar to the estuaries of the Helmand, as it has not been found except in Seistan and the immediate vicinity to the east. The two bivalves are common throughout Seistan, in which the *Lamellidens* has become differentiated into a distinct race (*rhadinaea*). Shells from the Helmand are thinner and smaller than those from other parts of the country. The *Corbicula* is remarkable for its extreme variability.

We examined smaller streams of the deltaic system of the Helmand in the immediate vicinity of Nasratabad, near the ruined city of Jellalabad some 12 miles to the north and at Chilling considerably futher south. Where the water was actually flowing the fauna was very scanty, but the high clay banks were full of bleached shells of *Corbicula fluminalis* and often of *Limnaea gedrosiana* and the different Planorbidae found in the country.

Insect-life is usually scarce in such streams, but a noteworthy feature of those of Seistan is that the Hydrometridae often seen on the surface of the stiller pools are replaced, at any rate in winter, by Diptera of the family Ephydridae, which were often observed in large numbers resting on the surface film. Mr. Brunetti[2] has described a species (*Halmopota viridescens*) from Seistan that "skates" much like *Gerris*.

Near Jellalabad we found the Randa stream practically dry, except for shallow pools left in the bed and completely isolated.

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[1] See Annandale, *Rec. Ind. Mus.* XIX, p. 114 (1920).
[2] Brunetti, *Rec. Ind. Mus.* XVI, p. 300 (1919).

The water in these pools was apparently fresh but very foul as wandering Baluchis watered their sheep, goats and donkeys at them. Most of the fish and other animals were dying in them in large numbers. The fauna was, or had been, fairly rich, but there was no macroscopic vegetation in an active state of growth. Remains of reeds and a few moribund plants of a broad-leafed *Potamogeton* were observed in several of the pools and the nodular roots of some plant were common in the water, evidently in a resting state. The fauna may be dealt with group by group.

FISH.—Four species of fish were found in the pools, viz. *Discognathus adiscus*, *Schizothorax zarudnyi*, *Schizocypris brucei* and *Adiposia macmahoni*. Of the *Schizothorax* only young and half-grown individuals were obtained, although we had the pools netted by Seistani fishermen. Both this species and *D. adiscus* were extremely abundant. The *Schizocypris*, of which we saw only young specimens, were much less abundant. The *Adiposia* was present in large numbers. This fish differs from the others in being a burrowing form. It was the only species in the pools that was in a healthy condition in December, the majority of the others being dead or moribund. Its stomach-contents consisted of the remains of Cyprinid fish and of May-fly larvae.

MOLLUSCA. With the exception of a few dead shells of *Gyraulus euphraticus* and *G. convexiusculus* and one of *Vivipara hilmandensis* found among the remains of reeds in one or two of the pools, the only specimens of Mollusca we obtained from them were shells of *Lamellidens marginalis rhadinacus* and *Corbicula fluminalis*. All those of the former species were empty, but a few living individuals of the *Corbicula* were dug from the mud, in which they were buried four to six inches deep.

INSECTA. The insect-fauna of the pools was scanty so far as most groups were concerned, but the larva of a large May-fly, probably identical with the common European *Palingenia longicauda*, was abundant in the mud and we obtained three species of Rhynchota from the pools, namely *Corixa hieroglyphica*, *C. affinis* and *C. randana*, a new species described by Mr. Distant. *C. hieroglyphica* and *C. affinis* are both Indian.

CRUSTACEA. Numerous specimens of the crab *Potamon gedrosianum* were dug from the mud, in which they were apparently hibernating with *Corbicula*, *Palingena* larvae and the fish *Adiposia macmahoni*. The range of the crab extends from the Punjab Salt Range to Seistan.

POLYZOA. An interesting member of this group [*Plumatella* (*Afrindella*) *persica*, sp.nov.] was found in one of the pools, coating the stems and nodular roots of the plant to which I have referred above. The animal has not as yet been found elsewhere.

Near Nasratabad we visited a number of shallow pools which in the flood season were evidently backwaters of streams or large irrigation channels. In most of them the only traces of vegetation were the roots and dead stems of reeds and dried masses of filamentous algae stranded on land plants growing near the margin.

In drift of fragments of reeds, etc., that surrounded most of these pools, dead shells of *Limnaea gedrosiana* and the other common molluscs of the country, including one of the few endemic species (*Amnicola sistanica*), were abundant, with the statoblasts of *Lophopodella* and the gemmules of the sponges *Spongilla alba* and *S.* (*Eunapius*) *carteri*.

In most of the pools we found no macroscopic life, but in one, in which a broad-leaved *Potamogeton* was common though not in a flourishing condition, *Disocgnathus adiscus* and young specimens of *Schizothorax zarudnyi* were abundant. *Schizocypris brucei* were also found, but in much smaller numbers. A peculiar form of *Limnaea gedrosiana* was also common in this pool. It is distinguished from the *forma typica* of the species by its much greater individual variability and by the fact that the curve of the outer lip of the shell is flattened to a straight line. This mollusc, for which the varietal name *rectilabrum* has been proposed, has been found elsewhere only in the Kushdil Khan reservoir in the north of the hill-country of Baluchistan. The reservoir is a large, shallow artificial lake with a luxuriant submerged vegetation in winter, but liable to complete desiccation in summer. The specimens of the mollusc from Seistan were mostly infected by the common North Indian Oligocheate worm *Chaetogaster bengalensis*, which frequented their pulmonary chamber in large numbers.

THE FAUNA OF THE HAMUN-I-HELMAND.

The Hamun-i-Helmand, or rather that part of it which is permanently filled with fresh or nearly fresh water, may be divided into three zones of life, that of the open lake, that of the reed-beds and that of the bare margin.

The zone of the open lake may be called more appropriately the Central Region. It is that part of the lake which is free from reeds and always, except in abnormal droughts, contains several feet of water. The reed-beds form in winter what is called in Persian the *naizar* or reed-country, but the name *nai* is applied in Seistan particularly to Phragmites, which is the most abundant of the three species of which the reed-beds are composed, namely *Phragmites communis*, *Scirpus littoralis* and *Typha angustifolia*. In the flood-season a great area in the *naizar* is under water and even when the water is low, as it is in December, the reed-beds extend out into the lake for considerable distances. In discussing the fauna of this zone we must, therefore, consider both the species living in pools among the reeds and also those of which remains are found in a dead or dormant condition in the soil of the *naizar*. By the zone of the bare region I mean the shore of the lake at or just below low-water level at places where there are no reeds.

THE FAUNA OF THE CENTRAL REGION. In December this region is very poor in life, both animal and vegetable. The bottom is a stiff, sticky clay which supports but a scanty growth of water-plants. A few beds of *Potamogeton lucens*, none of them at all

luxuriant, were all that were observed. On the bottom, shells of *Lamellidens marginalis* race *rhadinaeus* and *Corbicula fluminalis* were abundant, but no living specimens were obtained. On one of these shells a living colony of the Polyzoon *Fredericella sultana* race *jordanica* was observed. Fish were very scarce, but we saw fishermen catching *Schizothorax zarudnyi* in nets in the open lake, near a reed-bed.

THE FAUNA OF THE REED-BEDS. This fauna is much the richest, or rather the least impoverished, in the lake. It is concentrated in small, comparatively deep pools which are choked even in December with submerged vegetation. In the composition of this, *Potamogeton pectinatus* is the dominant plant, but *P. perifoliatus*, *Nais major* and at least one species of Characeae also occur.

Among the reeds very few fish are found, and of those we caught all belong to one species (*Discognathus adiscus*) and seemed to be in a moribund condition; but the more open channels in the reed-beds are the proper home of *Schizothorax zarudnyi*, the largest fish found in Seistan and apparently the only one caught for food.

Limnaea gedrosiana, *Gyraulus euphraticus* and *G. convexiusculus* were the commonest molluscs in the small pools, but a few small specimens of *Amnicola sistanica* were also found. Shells of this species, in much greater abundance and of a larger size, were dug from the soil of the *naizar*. The *Limnaea* belonged to the typical form of the species but the shells were smaller and a little narrower than those found in ponds at Quetta.

Insect-life was less abundant in this region than might have been expected. Larvae of Chironomid Diptera were fairly common, and so were those of two species of dragonflies. Major Fraser thinks that one of these is probably the larva of the common Palaearctic Agrionid *Ischnura elegans*, while he states that the other "combines some of the features of an Agrionine with those of a Lestine." He remarks that it is unusual to find dragonfly larvae active in winter, as these species were.

Adult insects were less abundant, both in the pools and among the reeds, than larvae. Mr. Edwards has found in our collection several species of *Chironmus*, all allied to, if not identical with European species but unfortunately, owing to an accident, not in sufficiently good condition for specific determination.

The Entomostraca found in this habitat were cosmopolitan species common in similar situations in other countries. None of the higher Crustacea were seen.

A sponge and two species of Polyzoa were fairly common on the stems of *Typha*. The sponge was a phase of the cosmopolitan *Ephydatia fluviatilis* and one of the Polyzoa an equally cosmopolitan species, *Fredericella sultana*. The latter belonged to a race (*jordanica*) hitherto known only from the Jordan and the Volga system, while the other member of the same group [*Plumatella* (*Hyalinella*) *bigemmis*] has been described as new in this volume.

MARGINAL FAUNA. The marginal fauna is very scanty. It includes no molluscs, fish or crustacea, and in winter we found no aquatic insects. The lower surfaces of blocks of clay, however, were covered with a fairly luxuriant growth of *Ephydatia fluviatilis*, in a different phase from that found in the reed-beds, and of *Fredericella sultana jordanica*. The latter were covered with Vorticellid Protozoa. Just above the water-level certain insects were not uncommon in the same position, notably the Tipulid *Symplecta punctipennis*, at least two species of Ephydrid flies, and a cricket (*Achtea bimaculata*) also found in a similar habitat on the shore of the Lake of Tiberias.

COMPOSITION OF THE FAUNA AS A WHOLE.

The composition of the aquatic fauna of Seistan cannot be described as abnormal, but there are certain deficiencies that call for discussion. Some of these are due to geographical cause, which will be discussed later, but others are not so easily explained and evidently depend on some factor in the environment not yet elucidated. The most noteworthy are the apparent absence of Crustacea Amphipoda and of most families of aquatic Rhynchota. Freshwater Amphipods are scarce in the plains of India and as a rule occur only in the large rivers, in which the species are immigrants from the sea.[1] At even moderately high altitudes in the Himalayas, however, species of *Gammarus* and *Talorchestia* occur and in the Quetta district of Baluchistan, between 5,000 and 6,000 feet, at least two species are abundant in every spring and stream. We could find none in Seistan.

The absence of all aquatic Rhynchota except Notonectidae and Corixidae struck us very much in Seistan, particularly in reference to that of the surface-haunting Hydrometridae. It is of course possible that we failed to find these species in winter because they were hibernating, but this is improbable for two reasons, firstly, because we sought for them carefully in spots in which they might have been expected to conceal themselves had they left the water temporarily, and secondly, because they are not uncommon on the water at the same season in adjacent districts. Dr. Kemp found a *Microvelia* abundant on the Zanginawar Lakes in the eastern part of the Baluch desert in December, and I noted a *Gerris* on small streams near Peshawar in large numbers in January. In neither instance was the temperature higher than it was in Seistan in November and December. The line of vegetable debris that marks the flood level on the bare shores of the Hamun-i-Helmand would seem to be an ideal retreat for hibernating Hydrometridae and we found amongst the fragments of reeds, etc., two species of Reduviid Rhynchota, several species of Carabid and Staphylinid and one of Curculionid beetles, at least two species of Diptera, a cricket and an earwig, a wood-louse and a

[1] Cf. Chilton, *Rec. Ind. Mus.* XIX, p. 79 (1920).

toad (*Bufo viridis*), all in a more or less torpid condition; but no Hydrometrid. Indeed, it seemed to us that this family was to a large extent replaced by Diptera, such as *Halmopota viridescens*, Brunetti, which skated on the surface of the water in almost the same way as these Rhynchota do.

The absence of molluscs of the family Melaniidae from the Hamun-i-Helmand and the waters connected with it is another point worthy of note. In the extreme south of Seistan we found one form (*Melanoides pyramis* var. *flavida*) in a desert spring, but neither living molluscs nor empty shells were found at any place in the irrigated part of the country. The absence of species of this genus, one of which is not uncommon in adjacent districts, may perhaps be due to lack of nutriment or the presence of mineral salts in the mud of which they invariably feed.

In other respects the limitations of the fauna seem to be due rather to geographical factors than to any peculiarities of the environment.

GEOGRAPHICAL RELATIONS OF THE FAUNA.

In considering the geographical relations of the aquatic fauna of Seistan five facts must be borne in mind:—firstly, that the country lies well within the limits of the Palaearctic Region and is separated from India not only by several hundreds of miles of desert but also by the great mass of mountains that occupies the more important part of Afghanistan and Baluchistan and juts down southwards almost to the Mekran coast west of the Indus; secondly, that the only waterways that reach it, and probably ever have reached it, come from the east and the north; thirdly, that even these waterways are of recent origin in their present course; fourthly, that it is much depressed below the surrounding districts, and fifthly, that the aquatic fauna, as follows from the third and fourth facts, is composed of immigrants from high mountainous tracts.

These facts account for many of its deficiencies, for example for the absence of aquatic Chelonia and Caridea, both of which are unknown from the higher regions of Central Asia. To the same facts we may trace the paucity of genera in the fish and molluscs, contrasted with the relative wealth of sponges and Polyzoa. It will be interesting to apply these deductions to the different groups of animals that are represented in turn.

Of the three Batrachia known to inhabit Seistan two are perhaps the most widely distributed of all the Palaearctic frogs and toads, namely *Rana esculenta* and *Bufo viridis*. One of these has evidently been stayed in its eastward range by the mass of mountains to which I have already referred. It does not seem to have penetrated beyond the eastern limits of the Baluch desert, or, from the north into the valleys of the western Himalayas, in which the toad has made itself at home. The fact that *Rana esculenta* is represented in Seistan and western Baluchistan by the race *ridibunda* hardly affects the situation, as this race itself has an immense range in

Eastern Europe, Western and Central Asia. The third Batrachian, *Rana cyanophlyctis*, has a much more peculiar geographical distribution—from near Aden to Penang. It is perhaps the commonest and most universally distributed of the Indian frogs, at all altitudes up to nearly 7,000 feet, but east of the Bay of Bengal becomes extremely rare. Throughout the greater part of its range no racial characters have been discovered, but in Seistan it is said to be distinguished by the size of its eyes and tympanum. If this be so—I have seen no specimens of the race *seistanica* of Nikolsky—the race provides evidence of the complete isolation of Seistan from other parts of the range of the species.

The number of fish (9 species in 7 genera) known from Seistan is small considering that the country possesses that rarest of phenomena in Central Asia and Persia, a freshwater lake; but here again the same facts are illustrated. This becomes clearer if we examine the fish-fauna in detail. Of the nine species three belong to the Central Asiatic subfamily Schizothoracinae, which are in a sense anadromous fish though far separated from the sea, three to the Cyprininae, which may be regarded as the dominant group in the great suborder Cyprinoidea, perhaps the most successful and characteristic of all the non-migratory freshwater fish, and three to the Cobitidae, a family of wide range in the Palaearctic and Oriental Regions and modified primarily for life on or in a soft bottom in water of no great speed.

Of the three Schizothoracinae one (*Schizothorax zarudnyi*) is indigenous to Seistan, but is little more than a local race of a species found in mountain streams at much higher altitudes to the north-east, another is identical with a species of similar habitat, namely *Schizopygopsis stoliczkae*, while the third has been known hitherto from Waziristan in the extreme east of the mass of mountains that forms the ultimate barrier between the Oriental and Palaearctic Regions in the Indian Empire. This is *Schizocypris brucei*. The Schizothoracinae are the most characteristic of the fish of the highlands of Central Asia, and particularly of the northern watershed of the Himalayas and Hindu Kush. A few species, including some of the least modified forms, have made their way across the great divide and live in the streams of the southern watershed and even in those on the lower slopes of the Himalayas and in the plains immediately at their base. It is not to these forms that the Schizothoracinae of Seistan are related, but to true Central Asiatic species.

The Cyprininae of Seistan belong to two genera, *Discognathus* and *Scaphiodon*. The latter seems to have its headquaters in Baluchistan and not to be essentially a mountain-dweller, while *Discognathus*, which is replaced in India by the closely allied but more specialized genus *Garra*, occurs in Syria, Mesopotamia, E. Persia, Baluchistan and Waziristan on the North-West Frontier of India. Neither genus is found in the highlands of Central Asia, and though both live commonly in hilly country, neither inhabits high mountainous regions.

The Cobitidae of Seistan, on the other hand, must be associated with the Schizothoracinae in origin. Two of the three species belong to the peculiar genus *Adiposia*, otherwise only known from Turkestan, and are apparently endemic as species. The third (*Nemachilus stoliczkae*) belongs to a group in its genus characteristic of the Central Asiatic highlands, and resembles its namesake of the genus *Schizopygopsis* in geographical range.

The majority of the fish of Seistan are, therefore, without doubt of Central Asiatic origin and can only have reached Seistan from the northern watershed of the Hindu Kush, while a minority have probably arrived in the district from the lower parts of Baluchistan.

From a geographical point of view, the molluscs are perhaps the most interesting group in our fauna except the fish. They differ considerably from the true Eurasian species that have penetrated from Central Asia as far south as the valley of Kashmir, and almost as much from those characteristic of the Persian Plateau. This fact is illustrated equally well by the species and genera that are present and by those that are absent. The Seistan fauna includes none of the widely-distributed Eurasian species found in Kashmir, such as *Limnaea stagnalis* and *Bithynia tentaculata*, nor does it include any representative of the essentially Eastern Palaearctic genus *Melanopsis*, common in Persia proper and Mesopotamia, or of *Bullinus*, one species of which is common in Mesopotamia. The species of *Limnaea* that do occur bear a distinct resemblance to European forms, but at least one of them (*L. bactriana*) also resembles an Indian form, *L. chlamys*. The three species of this genus, one of which (*L. hordeum*) is very rare and is only known from empty and possibly subfossil shells have all been found also in Lower Mesopotamia, though not in Persia proper, but are not dominant in the former country. Two of them (*L. bactriana* and *L. gedrosiana*) also occur commonly in the hill-country of Baluchistan and Afghanistan, but not, so far as we know, at high altitudes. The three Planorbidae have a wide range both in the Oriental Region and in neighbouring districts. That of the two species of *Gyraulus* (*G. convexiusculus* and *G. euphraticus*, extends at any rate from Mesopotamia to Burma and all over the Indian Empire, while the third species of the family (*Segmentina calathus*) is found in Burma and Sumatra as well as in northern India. The occurrence of a species of *Vivipara* in Seistan is an interesting feature. The genus is practically cosmopolitan, but for some unaccountable reason is absent from Syria, Palestine, Mesopotamia, the greater part of Persia and Baluchistan. Among living species the Seistan form (*V. helmandica*) is most closely related to one from Sind (*V. sindica*). It is, however, still more closely related to a fossil (tertiary) species from the Bugti Hills in south-eastern Baluchistan. Indeed, it can be separated specifically from the fossil form only with difficulty. Both *V. helmandica* and the only Unionid known from Seistan afford clear evidence of the existence of an Indian element

in the fauna. The bivalve, indeed, *Lamellidens marginalis rhadinaeus*, is only a local race of one of the commonest Indian species.

The scarcity of endemic species of molluscs of Seistan is noteworthy as providing additional evidence for the recent origin of the fauna. Only two species apparently belong to this category, namely *Amnicola sistanica* and *Vivipara helmandica*.

The aquatic molluscs, therefore, are of more mixed origin than the fish, probably having had better opportunities for immigration, and include a much more distinct Indian element. They provide less evidence, moreover, of derivation from a high mountain fauna.

The only Decapod crustacean found in Seistan is a race of a species widely distributed in south-western Asia and clearly of western rather than eastern origin. The race is not known from higher altitudes than about 6,000 feet, but is common in the Quetta district of Baluchistan and extends its range southwards and eastwards from Seistan to the Punjab Salt Range. The absence of Caridea from the fauna of Seistan, and also of aquatic Isopoda, is noteworthy, but is easily explicable on geographical grounds. That of Amphipoda I have already discussed The Entomostraca have little geographical significance.

The only leech discovered in Seistan (*Limnatis nilotica*) is distinctly south-eastern Palaearctic in range. It is common in Egypt, and in many parts of the Mediterranean basin, but is not known from within the limits of the Indian Empire except in the extreme west of British Baluchistan. The aquatic Oligochaeta are essentially Northern Indian. Two of the three species recorded are known only from India proper, while the third form is an Indian race of a cosmopolitan species.

Four species of Polyzoa have been found in Seistan. Two of these, both species of *Plumatella*, are apparently endemic. One of these [*P.* (*Hyalinella*) *bigemmis*] belongs to a cosmopolitan subgenus, the other [*P.* (*Afrindella*) *persica*] to one of tropical range and strictly Oriental so far as Asia is concerned. Of the other two representatives of the group, one (*Fredericella sultana jordanica*) is a race of a cosmopolitan species, formerly known only from Palestine and the Volga system, while the other is identical with the Indian race of a species (*Lophopodella carteri*) known from India, China and Japan, but represented in the two last countries by a distinct race (*davenporti*).

The only Coelenterate collected is a cosmopolitan species (*Hydra vulgaris*) common in the plains of India.

Three species of sponge were found, viz. *Spongilla alba*, *S. carteri* and *Ephydatia fluviatilis*. The last is a cosmopolitan species common in most parts of the Holarctic Zone but represented by distinct races in the Himalayas and Upper Burma and replaced in Peninsular India by an allied species (*E. meyeni*). *S. carteri* is the commonest of the Indian freshwater sponges and has also been taken in Hungary, Mauritius and the Malay Archipelago. *S. alba* is known from Egypt and from India, where it is usually

found in slightly brackish water. The Seistan form belongs to a distinct race or variety (*rhadinaea*) not found elsewhere.

Our knowledge of the aquatic insects of Seistan is quite fragmentary, being based on a collection made in the middle of winter and only partially worked out. We obtained specimens of a considerable number of water-beetles, but have not succeeded in persuading any coleopterist to name them and our collection of Diptera met with more than one misfortune. The aquatic Rhynchota, as I have already pointed out, belong exclusively to the families Corixidae and Notonectidae. The genera represented (*Micronecta*, *Corixa*, *Microcorisa*, *Anisops* and *Notonecta*) are cosmopolitan and most of the species are known to be Palaearctic. How small our true knowledge about the range of the less conspicuous water-bugs really is, is, however, illustrated by the fact that one of the Seistan species is otherwise known only from an oasis in the Algerian desert. What I have said about the Rhynchota also applies to the Diptera. One species of Tipulid (*Symplecta elongata*) is recorded as Persian and one Ephydrid (*Halmopota viridescens*) has been described from Seistan as new; the other flies are well known European species. So probably is also the May-fly (*Palingenia*) abundant in its larval state on the banks of the Rauda stream.

The aquatic fauna of Seistan is thus, as might be expected from its geographical habitat, mainly Palaearctic. Particularly in the fish, it has affinities with that of the highlands of Central Asia, but the molluscs belong to the geographical association I have recently called the Afghan type—not true Eurasian but belonging to species with both Palaearctic and Oriental relationships. They have, indeed, been introduced, with part of the fish-fauna, into Seistan recently, from the lower mountainous districts of Afghanistan and Baluchistan. It is among the less highly organized invertebrates that the tropical Indian element is most clearly manifest, but although this element is apparently absent in the fish, it appears (to go beyond the groups discussed in this paper) among the birds, of which Mr. Stuart Baker writes:—"The geographical affinities are Indo-Palaearctic, the races of resident birds nearly all belonging to the Palaearctic rather than to the Indian forms..... On the other hand a few sub-species, apparently resident, are typically tropical Indian....."

LIST OF THE AQUATIC FAUNA OF SEISTAN.

Name.	Habitat in Seistan.	Geographical range.	Remarks.
BATRACHIA.			
Rana cyanophlyctis seistanica, Nik.[1]	Reed-beds of Hamún	Seistan	*Forma typica* extends from S. Arabia to Malay Peninsula.
Rana esculenta ridibunda (Pallas)	Probably all over the country ..	S. and E. Europe; S. W. Asia; Central Asia.	Species almost throughout Palaearctic Region.
Bufo viridis, Laur. ..	In winter under lumps of clay and debris at edge of Hamún, etc.	Greater part of Palaearctic Region	....
PISCES.			
Discognathus adiscus, Annand.	Water channels and pools in drying river.	Seistan	....
Discognathus phryne, Annand.	Water channels and reed-beds of Hamun.	Mountains of Baluchistan; Seistan	....
Scaphiodon macmahoni, Regan.	Delta of Helmand	Seistan	...
Schizothorax zarudnyi (Nik.) ..	Delta of Helmand, Hamun, etc. ..	Seistan	Closely allied to *Sch. intermedius* from Hindu-Kush, etc.
Schizopygopsis stoliczkae, Steind.	Delta of the Helmand ..	Northern water-sheds of the Himalayas and the Hindu-Kush.	....
Schizocypris brucei, Regan. ..	Pools connected with rivers and streams in flood-season.	Waziristan, N.-W. Frontier of India; Seistan.	....
Nemachilus stoliczkae (Steind.)	Delta of the Helmand.. ..	Similar to that of *Sch. stoliczkae* but extending further east.	....
Adiposia macmahoni (Chaudh.)	Delta of the Helmand and muddy pools in drying stream-bed.	Seistan	....
Adiposia rhadinaea (Regan) ..	Delta of the Helmand ..	Seistan	....
MOLLUSCA.			
Gastropoda.			
Amnicola sistanica, Annand. and Prashad.	Reed-beds of the Hamun and flooded country generally.	Seistan	....

[1] "A forma typica oculo parvo, oculi diametro longitudinali distincte quam rostri longitudo minore, tympani diametro 4/5 oculi diametri aequante, differt. Habitat in Seistano." Nikolsky, *Ann. Mus. Zool. Ac. Sci. St. Petersburg*, IV, p. 406 (1889).

List of the Aquatic Fauna of Seistan.

Name.	Habitat in Seistan.	Geographical range.	Remarks.
Vivipara helmandica, Annand.[1]	Helmand river and effluents ..	Seistan	....
Limnaea bactriana, Hutton ..	Water-courses and pools with much vegetation.	Afghanistan, Baluchistan, Seistan and Lower Mesopotamia.	....
Limnaea gedrosiana, Annand. and Prashad.	Reed-beds of Hamun ..	Same as last species	....
Limnaea gedrosiana var. *rectilabrum*, Annand. and Prashad.	Pools liable to complete dessication.	N. Baluchistan, Seistan ..	....
Limnaea hordeum, Mousson ..	Only dead specimens found ..	Seistan, Afghan desert; Lower Mesopotamia.	Only known from empty and possibly sub-fossil shells.
Gyraulus convexiusculus (Hutton).	All bodies of water with abundant vegetation.	Mesopotamia to China and Malay Archipelago.	....
Gyraulus euphraticus, Mousson	Similar to last species	Similar to last species ..	....
Segmentina calathus (Benson)	Only dead specimens found ..	Seistan; India; Burma and Sumatra.	....
Pelecypoda.			
Lamellidens marginalis rhadinaeus, Annand. and Prashad.	In all larger bodies of water ..	Seistan and adjacent part of Afghan desert.	*Forma typica* all over the Indian Empire and Ceylon.
Corbicula fluminalis (Müller) ..	Hamun, pools, water-courses and desert springs.	Greater part of Asia and Africa ..	Fossil (Tertiary) in N. Europe.
Insecta.			
Ephemeroptera.			
Palnigenia? longicauda, Oliver	Edge of flooded country on banks of river.	Continental Europe and S.-W. Asia.	The identity of Seistan specimens with European specimens is not completely confirmed.
Odonata.			
Ischnura elegans, Lind. ..	Reed-beds of the Hamun ..	Europe and S.-W. Asia as far east as Kashmir.	Adult among grass round desert springs in W. Baluchistan.
Diptera.			
Chironomus pictulus, Mg.[2] ..	Garden at Nasratabad ..	Europe; Seistan	Larva probably in irrigation channel.
Psychoda bengalensis, Brun.[3] ..	In garden at Nasratabad ..	Probably throughout Palaearctic, Nearctic and Oriental Regions.	....

Culex fatigans, Wied.[4] .	In same garden as last species ..	Widely distributed in S. Asia; Africa; the warmer parts of America, etc.	(In Asia chiefly Oriental.)
Theobaldia longiareolata, Macq.	Larva common in desert springs and in water-courses.	Mediterranean basin; S. Africa; Seistan; W. Himalayas, etc.	....
Symplecta punctipennis, Mg. ..	Adult at edge of Hamun ..	Europe to Himalayas	....
Symplecta elongāta, Lw. ..	Adult common on banks of irrigation channels.	Persia	....
Halmopta viridescens, Brun.[5] ..	Adult on surface of larger water-courses.	Seistan	....
RHYNCHOTA.			
Notonecta glauca marmorea, Fabr.	Village pond at Daulatabad ..	Palaearctic Region; mountains of India.	....
Anisops fieberi, Kirk. ..	....	....	....
Macrocorisa geffroyi, Leach. ..	....	....	....
Corixa hieroglyphica, Duf. ..	....	....	....
Corixa affinis, Dist. ..	....	....	....
Corixa substriata, Uhlet ..	....	....	....
Corixa seistanensis, Dist. ..	Irrigation channels	Seistan	....
Corixa randana, Dist. ..	Pools in drying stream beds and reed-beds of the Hamun.	Seistan	....
Micronecta desertana, Dist. ..	Desert spring	Seistan	....
Micronecta biskrensis, Horv. ..	Same desert spring	N. Africa; Seistan	....
CRUSTACEA.			
Decapoda.			
Potamon (*Potamon*) *gedrosianum*, Alcock.[6]	Pools in drying stream bed ..	Seistan; Baluchistan; N.-W. Frontier of India Punjab, Salt Range.	....

[1] Annandale, *Rec. Ind. Mus.* XIX, p. 114 (1920).

[2] Identified by Mr. F. W. Edwards.

[3] "Only one wing left; but this agrees with *Ps. alternata*, Say, of which *Ps. bengalensis* is probably a synonym." F. W. Edwards. The specimen was identified when still complete by Mr. E. Brunetti.

[4] This and the other Culicidae and Tipulidae identified by Mr. F. W. Edwards.

[5] Brunetti, *Rec. Ind. Mus.* XVI, p. 300 (1919).

[6] Alcock [*Cat. Ind. Dec. Crust.*, part I, fasc. II (Potamonidae), p. 23, 1910] refers this race to *P. fluviatile* with some doubt. This opinion was accepted by Dr. S. W. Kemp and myself in *Journ. As. Soc. Bengal* (N.S.) X, p. 250 (1913); but as Alcock refers the race to alternately to *fluviatile* or to *ibericum*, which elsewhere he also refers to *fluviatile* as a subspecies, it seems simpler to call it merely *gedrosianum*.

List of the Aquatic Fauna of Seistan.

Name.	Habitat in Seistan.	Geographical range.	Remarks.
OSTRACODA.			
Eucypris clavata, Baird ..	Pools of foul water, amongst *Zannichellia*.	All these are probably cosmopolitan species.	....
Ilyocypris bradyi, Sars. ..	Same pools; also in spring in Baluch desert.		
Potamocypris villosa, Jur. ..	In same pools		
Herpetocypris reptans, Baird ..	In pools of clear water in Hamun, amongst *Potamogeton pectinatus*.		
CLADOCERA.			
Daphnia magna, Straus. ..	In pools of foul water with *E. clavata*.		
Daphnia longispina var. *rosea*, Sars.	In pools in reed-beds with *H. reptans*.		
Simocephalus vetulus, O. F. M.	In pools of both types already mentioned.		
Ceriodaphnia pulchella, Sars. ..	In pools in reed-beds with *D. longispina* var. *rosea*, etc.		
Ceriodaphnia reticulata, Jur. ..	In same habitat as the last ..		
Bosmina longirostris, O. F. M.	In same habitat as the last ..		
COPEPODA.			
Cyclops strenuus, Fischer-Sars.	In foul-water pools		
Cyclops leuckarti, Claus. ..	With the last		
Cyclops viridis, Jur. ..	In pools of reed-beds with *D. longispina* var. *rosea*, etc.		
CONCHOSTRACA.			
Leptestheria tenuis, Sars. ..	In irrigation channel	Palaearctic Region.	....
ANNELIDA.			
Oligochaeta.			
Chaetogaster bengalensis, Annd.	In *Limnaea gedrosiana* var. *rectilabrum* in flood-pool.	Northern and Peninsular India; Seistan.	....

Chaetogaster punjabensis, Stephenson ?	In irrigation channel amongst filamentous algae.	N.-W. India; Seistan	....
Nais communis punjabensis, Stephenson.	In same channel associated with the Poyzoon *Lophopodella*; also in pools in reed-beds.	....	....
HIRUDINEA.			
Limnatis nilotica (Sar.) ..	Desert springs	....	....
POLYZOA.			
Fredericella sultana jordanica, Annand.	In reed-beds and at bare margin of the Hamun.	Volga system; Palestine; Seistan.	....
Plumatella (*Afrindella*) *persica*, Annand.	In muddy pools in drying stream-bed.	Seistan	....
Plumatella (*Hyalinella*) *bigemmis*, Annand.	In reed-beds of the Hamun ..	Seistan	....
Lophopodella carteri (Hyatt) ..	Amongst filamentous algae in irrigation channel.	Seistan to Japan	The Chinese and Japanese race is subspecifically distinct (*davenporti*, Oka).
TREMATODA.			
Fasciola gigantea, Cobbold ..	In sheef from edge of Hamun ..	Probably all over Africa and S. Asia; S. America (? introduced).	Found in Rangoon by Dr. H. H. Marshall, in cattle imported from Calcutta.
HYDROZOA.			
Hydra vulgaris, Pallas. ..	In irrigation channel with *L. carteri*	Cosmopolitan	The common Indian species.
PORIFERA.			
Spongilla alba var. *rhadinaea*, Annand.	In reed-beds of the Hamun ..	Seistan	The *forma typica* known from Egypt and India.
Spongilla (*Eunapius*) *carteri*, Carter.	Gemmules amongst flotsam in flooded country.	E. Europe; (?) Central Africa; Mauritius; Malaysia, India.	....
Ephydatia fluviatilis, auct. ..	In same habitats as *F. sultana jordanica*.	Holarctic, including W. Himalayas	....

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