# THE AQUATIC FAUNA OF SEISTAN

## A SUMMARY.

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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 longi-areolata*, 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 Annadale, *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 rhadinaeus* 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 Randa 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 elongata*, 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*.

| 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 | .... |