THE FISH OF SEISTAN

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(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

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[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 37-39⅞, 2 barbels; diameter of eye 4 to 4½ times in length of head, depth of body 3⅗ to 3⅘ 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. stolickae.*

b. Lateral scales present.

i. Mouth terminal or subterminal, lower jaw blunt; ventral scales present; 4 barbels ... ... *Schizothorax.*

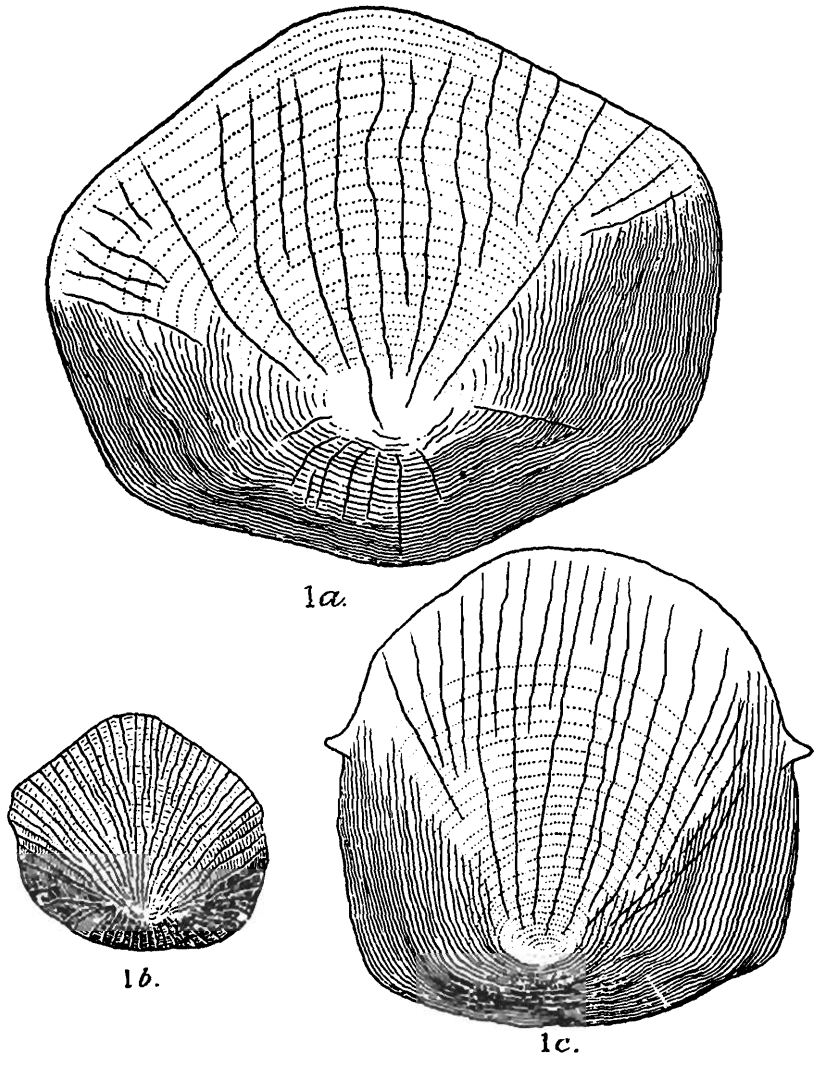
Scales at base of fins slightly enlarged; anal sheath rather poorly developed; lips normal ... ... *S. zarudnyi.*

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 $\frac{5}{7}$ 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

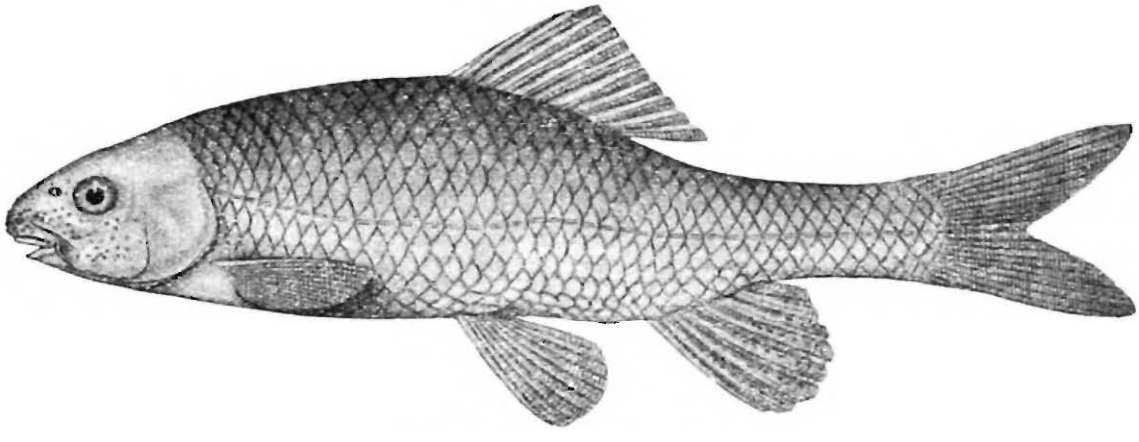
[1] Cockerell, *Bull. Bur. Fisheries* (Washington), XXXII, p. 138, pl. xxxiii, fig. 10 (1912).

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.	$\frac{4}{7}$,, ...	*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 :—

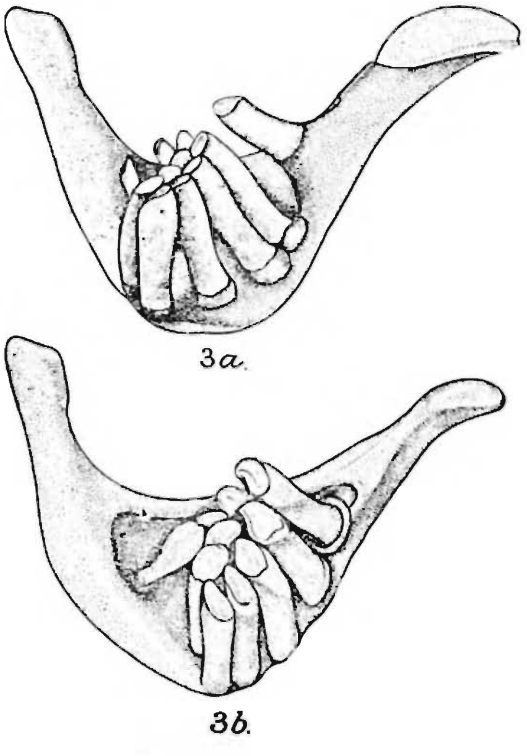
Cyprininae with a ventral mouth situated only a short distance behind the tip of the snout, with exposed cartilaginous jaws without horny covering, a fringed membranous, tuberculate upper lip, a vestigial lower lip ; situated behind the mouth a more or less well-defined adhesive disk less than half as 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*

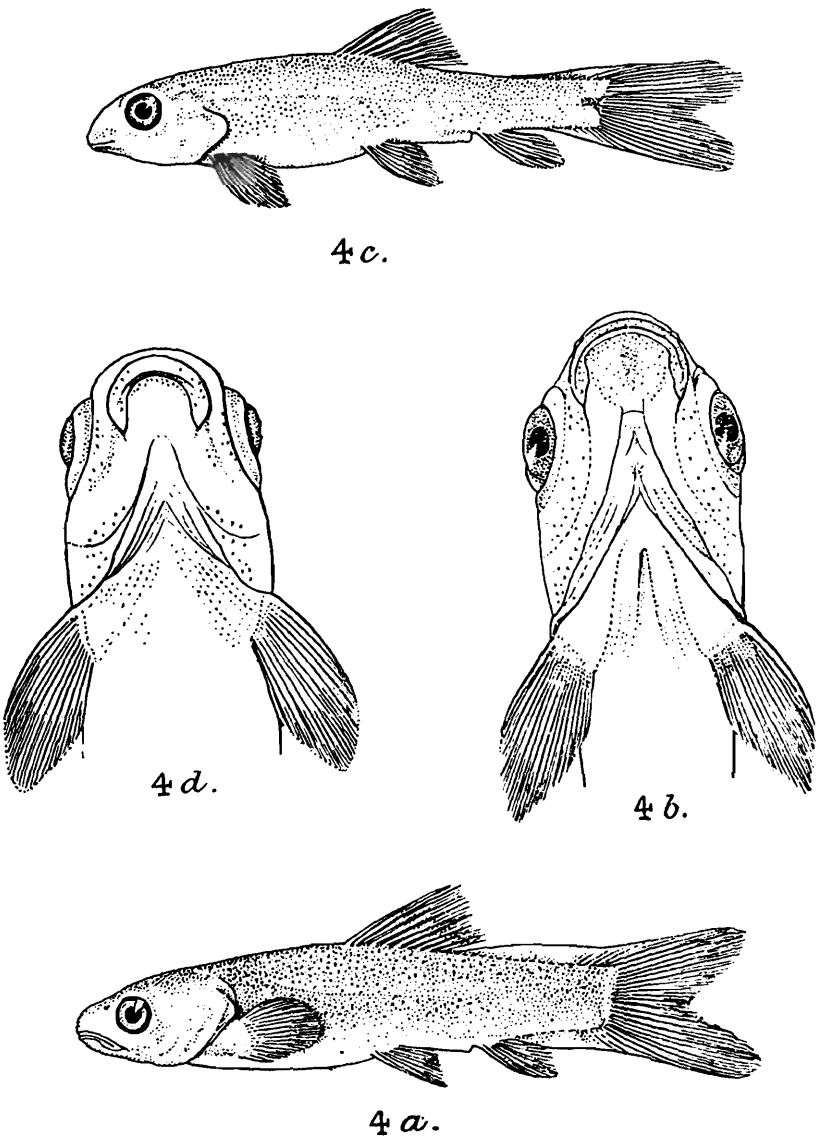


TEXT-FIG. 3.—Pharyngeal teeth of *Discognathus*.
a. D. adiscus.
b. D. phryne.

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 Russegger, *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	$\frac{1}{7}$	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	$\frac{\text{1-Caudal}}{2}$, ..	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	$\frac{\text{1-Caudal}}{3}$, ..	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	$\frac{\text{1-Caudal}}{4}$, ..	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	$\frac{1}{7}$	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.*

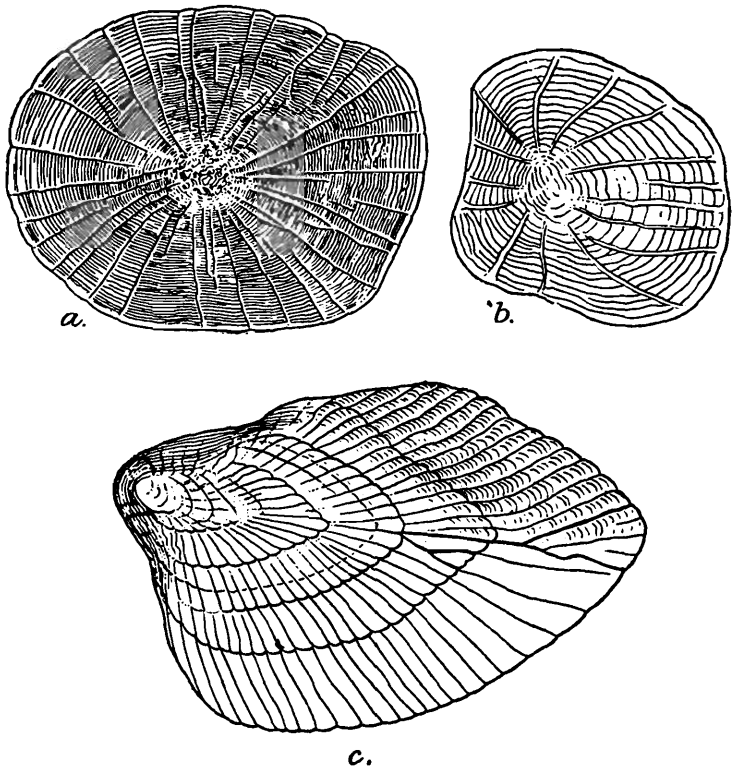
This subfamily is distinguished from the Cyprininae by the Salmonoid facies of the species, their small or degenerate lateral scales and the presence of an anal sheath consisting of folds of skin covered with greatly enlarged scales arranged in two parallel longitudinal rows.

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*, × 17½.
b. Dorso-lateral scale of *Schizocypris brucei* (adult specimen), × 37½.
c. Anal scale of *Schizopygopsis stoliczkae* from Siestan, × 17½.

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.

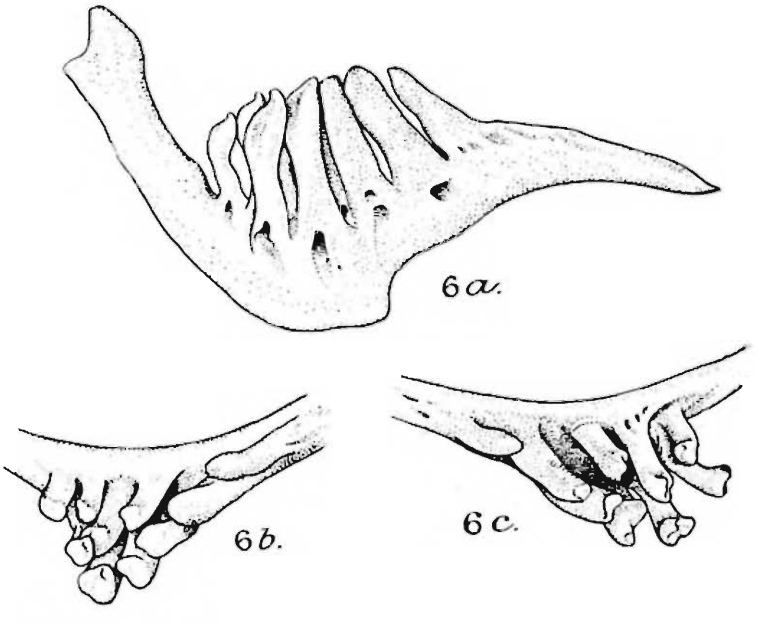
The colouration varies with the environment. In muddy water the back and fins are pale olive-green, the sides faintly

[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.

1	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	$\frac{1}{7}$ ..	3·2	2·82	3·68	3·86	4·75	7·7	7·8	8·0	7·43
23	$\frac{\text{1-Caudal}}{4}$, ...	3·85	3·66	3·88	3·74	3·9	3·76	3·87	3·7	3·77
24	$\frac{\text{1.Caudal}}{2}$, ...	3·9	4·0	3·9	4·0	4·08	5·78	6·6	5·1	4·8
25	$\frac{\text{1-Caudal}}{3}$ ..	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.

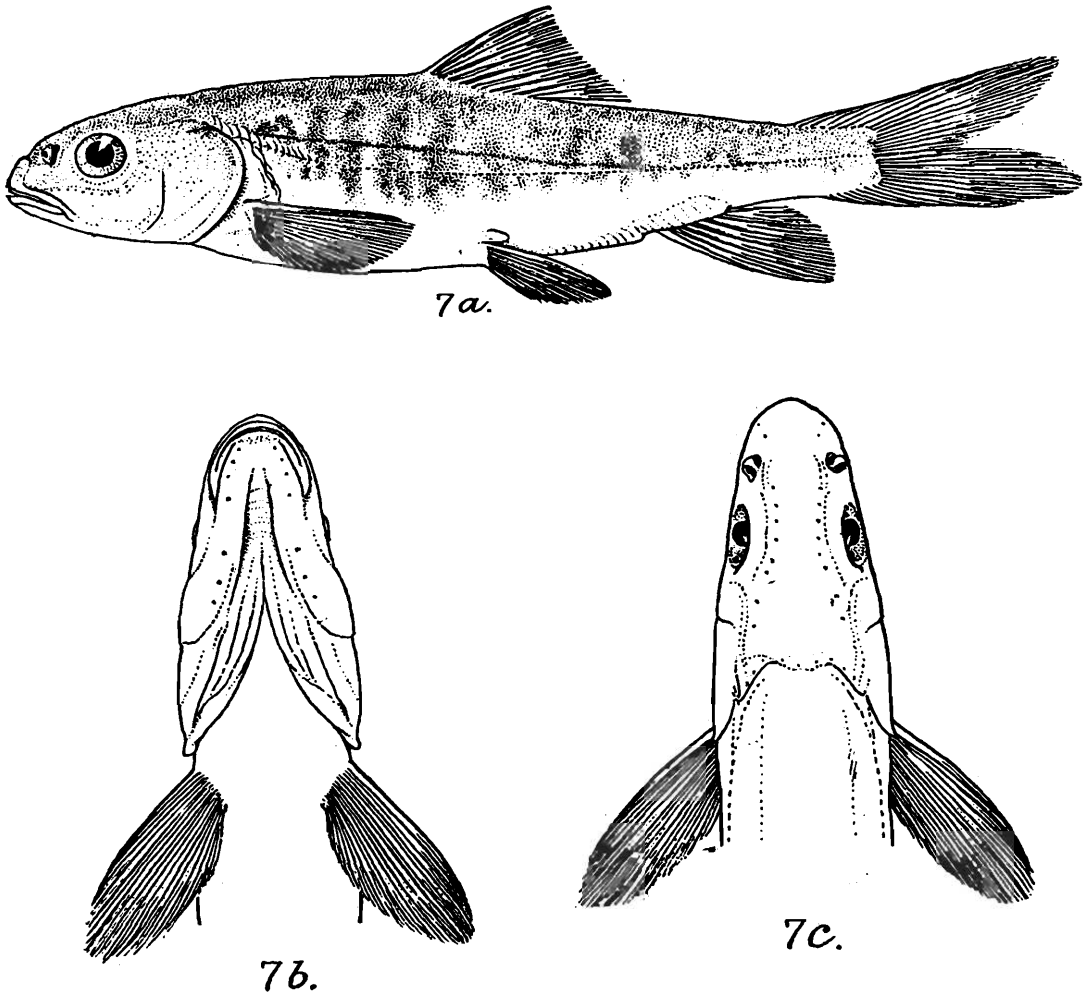
1888. *Schizopygopsis stoliczkae*, Herzenstein, *op. cit.*, p. 191, pl. xvi, fig. 3.

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 sioliczkae* (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	5·67	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	$\frac{1}{7}$	3·3	3·6	3·4	5·0	4·6	5·07	4·56	5·3	4·3
20	$\frac{\text{1-Caudal}}{4}$,	4·1	4·1	3·88	5·83	4·4	4·95	4·25	4·05	4·37
21	$\frac{\text{1-Caudal}}{2}$, ...	4·66	4·56	4·5	6·2	4·35	5·09	4·66	4·2	5·05
22	$\frac{\text{1-Caudal}}{3}$, ...	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	$\frac{3}{0}$	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 headwaters 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.

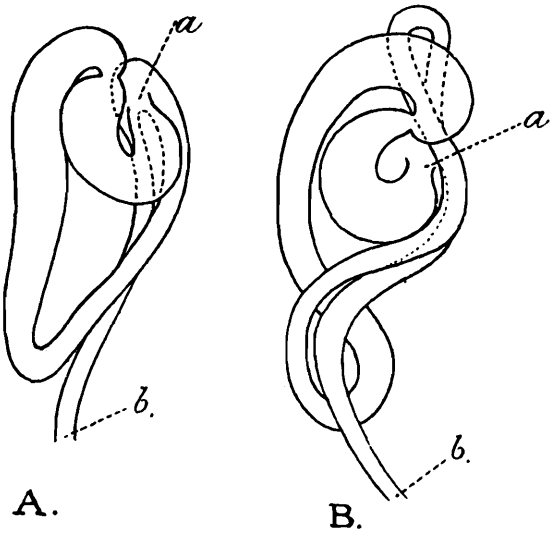
The one Seistani species (*N. stoliczkae*) of this genus belongs to a little group of Central Asiatic forms in which the Tibetan *N lhasae*, Regan, and *N. yarkandensis*, Day, from Turkestan must also be included. This group is distinguished by the elongate form of the body and especially by that of 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.

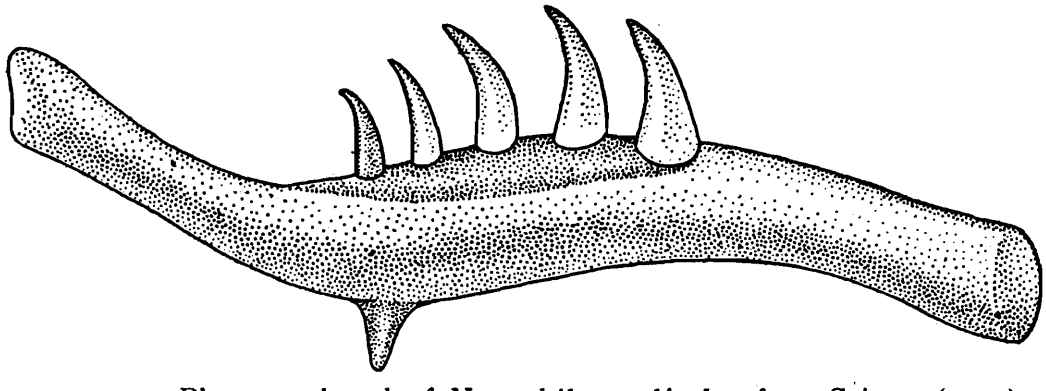
The first specimens we examined were those from Seistan labelled *N. stenurus*. The existence of two forms among them was visible on inspection and was on the whole confirmed by measurements. There were seven specimens in this series, as to four of which we had no hesitation in accepting Mr. Regan's 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	$\frac{1}{7}$	*4·8*	*5·31*	*5·31*	*5·51*	*5·11*	*5·0*
20	$\frac{\text{1-Caudal}}{2}$, ..	*5·53*	*5·04*	*4·67*	*5·53*	*5·18*	*4·44*
21	$\frac{\text{1-Caudal}}{3}$, ..	*6·7*	*6·19*	*5·49*	*7·0*	*6·35*	*6·53*
22	$\frac{\text{1-Caudal}}{4}$, ..	*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	$\frac{1}{7}$		3·86	3·9	4·1	4·14	4·47	4·43
20	$\frac{\text{1-Caudal}}{2}$, ...		5·53	5·96	4·81	5·97	5·35	4·75
21	$\frac{\text{1-Caudal}}{3}$, ..		6·63	6·68	6·83	6·54	6·29	5·81
22	$\frac{\text{1-Caudal}}{4}$, ...		4·3	4·17	3·85	3·95	4·14	3·67
23	$\frac{9}{10}$		6·3	6·07	5·77	6·0	6·3	5·91

Genus **Adiposia** nov.

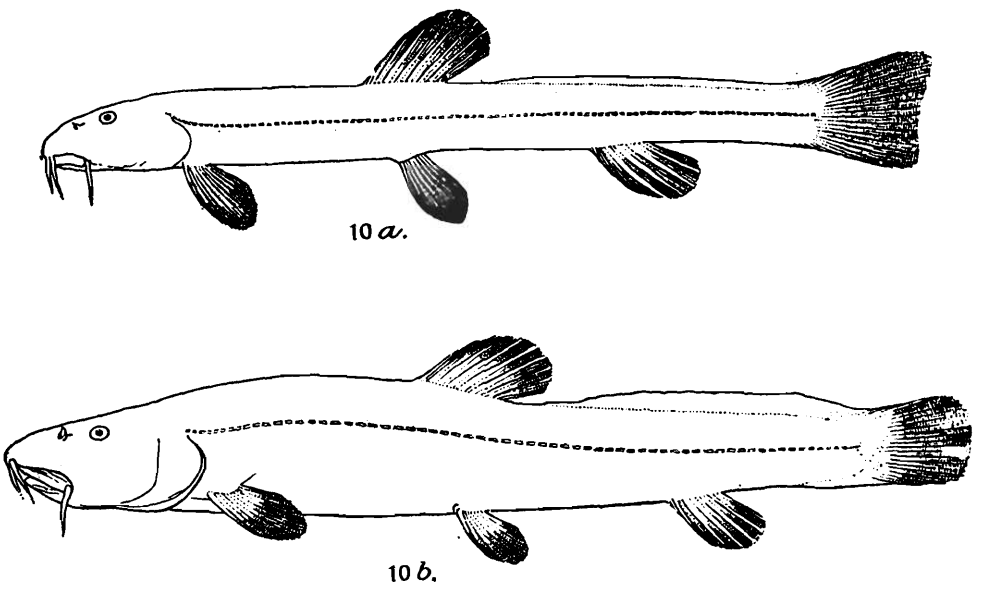
The genus may be described as follows :—

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

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[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.

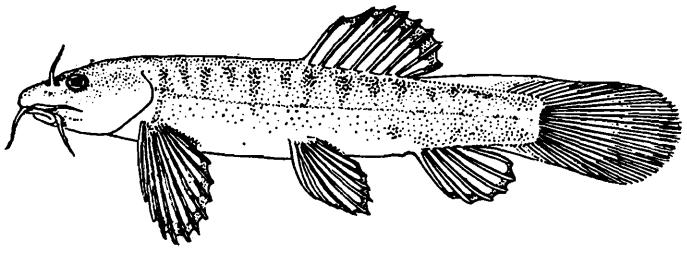
Comparatively large blood-vessels make their way obliquely upwards from the body into the central core of the soft fin at intervals and ramify in it. We have not been able to trace any connection between them and the smaller lateral and basal vessels.

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 all 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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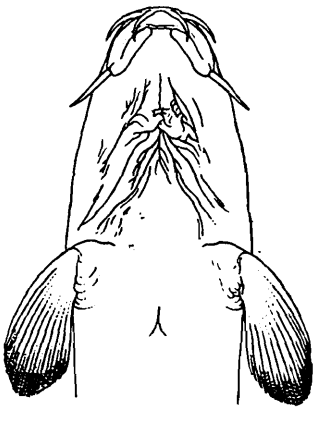
[1] A recent investigation of well-preserved specimens of *Acanthophthalmus pangia* proves the existence of a similar structure in that species.

Adiposia macmahoni (Chaudhuri).

(Plate XV, fig. 4; Plate XVI, figs. 1 & 2.)

1909. *Nemachilus macmahoni*, Chaudhuri, *Rec. Ind. Mus.*, III, p. 341.

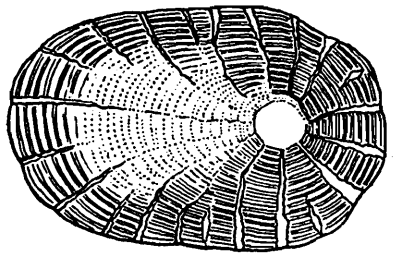
As Dr. Chaudhuri's description was based on a single specimen not in the best condition and bleached by exposure to light, we give a fuller account of the species here, based on numerous well-preserved examples.



TEXT-FIG. 12.—Lower surface of head of *Adiposia macmahoni* (× ¾).

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 6⅖ to a little over 8 times in the total length without the caudal, 7½ 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 4½ 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 5⅖ to 8⅖ 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,

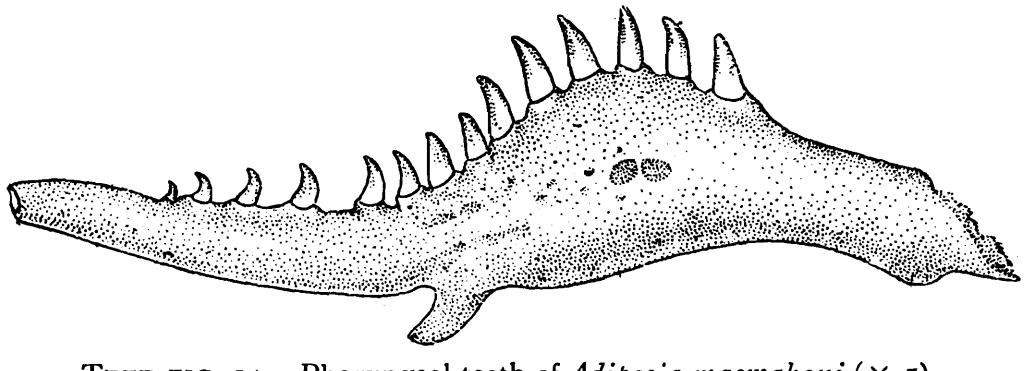
rounded, truncate or slightly emarginate at the tip. The caudal peduncle is compressed and from $1\frac{3}{5}$ to $2\frac{1}{2}$ times as long as deep.



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."

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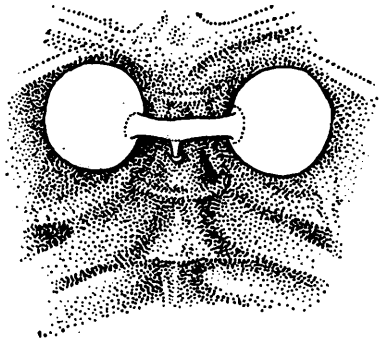
[1] See Gravely, *Rec. Ind. Mus.* XVIII, p. 137 (1920).

"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	$\frac{\text{1-Caudal}}{2}$, ..	4·35	4·95	5·5	5·65	6·18	5·7	5·71	5·41	8·1	6·1
19	$\frac{\text{1-Caudal}}{3}$, ..	8·07	7·94	7·3	6·41	6·8	6·41	7·13	7·75	6·66	10·87
20	$\frac{\text{1-Caudal}}{4}$, ..	4·57	4·86	4·93	4·18	4·43	4·2	4·39	5·07	4·21	5·51