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Edited by the Director, Zoological Survey of India

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IN MEMORIAM¹

THOMAS NELSON ANNANDALE

On the 10th April, 1949, some past and present members of the Zoological Survey of India assembled at the Scottish Cemetery, Calcutta, to pay their respectful homage to the sad and loving memory of Dr. Thomas Nelson Annandale, the founder-Director of the Survey, who died on the 10th April, 1924, twentyfive years ago. Wreaths, flower bunches and loose flowers were laid on the grave and those present stood in silence for some time remembering his brilliant career in India, his erudite learning, his love for the staff and his manifold kindnesses and courtesies to many. It was decided by those, who knew Annandale personally, that every year on this day they should assemble and pay their homage to his memory with floral tributes.

The Royal Asiatic Society of Bengal, with which he was closely associated throughout his period of service in India as anthropological Secretary, Vice-President, and as its President in 1923, perpetuates his memory by a triennial award of the Annandale Memorial Medal on a person who has made the most important contribution, during the previous five years, to Anthropology in Asia and the first award was made to Dr. Fritz Sarasin in 1928 in honour to Dr. Annandale's life work in physical anthropology. Thereafter, the award has been made alternately for physical and cultural anthropology. The Society has also a sepia portrait and an oil painting of Annandale in its rooms. In appealing for funds to perpetuate the memory of Annandale, the Council of the Society paid to him the following tribute :—

“Dr. Annandale occupied the foremost place in the ranks of Indian Zoologists. His scholarly research work earned for him meritorious recognition from the premier scientific Society in the world. His enthusiasm for the cause of scientific education in India was abiding. In him was combined the rare distinction of a scholar, erudite and industrious, and a personality, modest but engaging.

It is also in the programme of the Society “ that the balance of income of the Annandale Memorial Fund be suitably invested until the accumulated amount is sufficient, after paying for the triennial award, to provide Rs. 250 a year, to be utilised for a biennial Anthropological Lectureship”

Annandale was the last Superintendent of the Indian Museum and this office he held from 1907 to 1916. He succeeded Col. Alcock and relinquished the office on becoming the first Director of the Zoological Survey of India. The Trustees of the Indian Museum have also perpetuated his memory by putting up a brass tablet in the premises, the inscription on which reads as follows :—

“ In memory of Thomas Nelson Annandale, C. I. E., M. A., D. Sc., Director, Zoological Survey of India, Superintendent and Secretary to the Trustees, Indian Museum. Born 1876, died 1924. Erected by the Trustees as a token of their esteem ”.

¹An Obituary Notice of Nelson Annandale by the late Dr. S. W. Kemp appeared in the *Records of the Indian Museum* Vol. XXVII, pp. 1-28 (1925).

Lt.-Col. R. B. S. Sewell, C.I.E., F.R.S., Cidevant Director, Zoological Survey of India, at the request of the undersigned wrote a review of Annandale's work in India which is reproduced here. It brings out very clearly how Annandale was far ahead of his times, for to him any taxonomic work involved correlation of the fauna "with the climate, the geographical position and geological formation, the vegetation and the composition of the water of each district surveyed" He was of the opinion that "No one formula can express, much less explain, evolution" He very often told the writer that it was his intention to write a book on "Evolution" during leave which he intended to take when death snatched him away from us. His later writings show the magnitude of the loss suffered by the scientific world through his early death, for he had intended to incorporate the whole of his investigations and wide experience in his contemplated publication on "Evolution".

*Indian Museum,
Calcutta.
10th April, 1949.*

S. L. HORA.

DR. THOMAS NELSON ANNANDALE'S WORK IN INDIA.

Thomas Nelson Annandale was born in Edinburgh on the 15th of June, 1876 : he was the son of Thomas Annandale, Professor of Clinical Surgery in Edinburgh University, and as he once told me, it was probably in consequence of this and the fact that his father was of such eminence in the Medical Profession that he was able to enlist the services of the very best doctors in the City, that Annandale survived his infancy. He was educated at Rugby, where he rose to be head of the school, and later at Balioll College, Oxford, graduating in 1898. From early life he had a keen desire to travel and while still an undergraduate he paid visits to the Faroe Islands and Iceland. From Oxford he proceeded in 1899 to the Malay Archipelago as a Member of the Skeat Expedition. During this period his chief interest was centred in Anthropology, and with Skeat he tried to contact a small jungle tribe of Pagans but failed to do so, though he was able to photograph their dwelling places and graves. He was, however, also able to make a number of valuable contributions to our Zoological knowledge : in a temple at Ban Nah he noticed that one of the small figures of Buddha that had been deposited there contained a fossil shell, and this clue being carefully followed up led to the discovery of the quarry from which the fossil had been taken. This geological formation proved to be of Cretaceous age and it is noted in the account that "well authenticated finds of fossils in the Malay Peninsula have been of the rarest possible occurrence" He also made a close study of the adaptations to its surroundings of a species of Mantis, *Hymenopus bicornis*, and he took part in dredging in the Inland Sea—a chain of Lakes—partly fresh and partly brackish-water, some 60 miles long and thus commenced his study, in later years one of his most outstanding contributions to our knowledge, of the fauna of the inland lakes of Asia. In 1901 Annandale was appointed to a Research Fellowship in Edinburgh University and he held this appointment till 1904 ; during these three years on more than one occasion he revisited the Malay Peninsula, usually in company with Mr. H. C. Robinson, and his main interest seems still to have been centred on Anthropology ; but his published work in the three volumes of *Fasciculi Malayenses* already showed that great breadth of outlook that later became such a characteristic feature of his Zoological work, for he wrote on pure Ethnography, physical Anthropology, Folk Lore, Religion and Magic. In later years, in spite of the prior claims of Zoology, he continued during his travels in Asia to make observation on Ethnology, while for several years he devoted much of his time on holidays and Sundays, when in Calcutta, to obtaining data for an Anthropological study of the Anglo-Indian population, the results of which were submitted to statistical analysis by Prof. P. C. Mahalonobis, of Calcutta University ; as Annandale pointed out in his Introduction to this series of Reports (published in Vol. XXIII of the *Records of the Indian Museum*, 1922-1940) he admits

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to having had doubts as to the value of bodily measurements taken on the living person and, when the opportunity arose, he determined to see whether these doubts were further justified by the investigation of a race known to be of recent origin. Throughout his period of service in India Annandale was very closely associated with the Asiatic Society of Bengal and especially with the Anthropological side of the work of this Society. Almost immediately after his arrival he was appointed Anthropological Secretary to the Society and he continued to hold this appointment, with only an occasional break when he was away on leave or when he was President of the Society, till the time of his death. His first term of office was from 1904 to 1911 and his next from 1915 to 1920. For many years he was a Vice-President of the Society and was elected President in 1923, after which he again became the Anthropological Secretary. The Society showed its appreciation of his work by making him a Fellow of the Society in 1910 and awarding him the Barclay Memorial Medal in 1919.

In 1904 Annandale was appointed to the Staff of the Zoological and Anthropological Section of the Indian Museum under Colonel Alcock, who was the Superintendent, and three years later he succeeded Alcock as Head of the Section. At this time the Section was hopelessly understaffed and Alcock's retirement was very largely due to the fact that he was unable to persuade the Government to increase the number of scientists. Annandale was, however, more fortunate and in 1908 the Staff was increased to four by the appointment of the late Dr. S. W. Kemp, of the Irish Fisheries Department, Dr. F. H. Gravely from Manchester University and Dr. B. L. Chaudhuri : also attached to the Section was the Surgeon-Naturalist to the Marine Survey of India. Annandale was a bachelor and permitted, and indeed encouraged, other scientists and friends to make use of his official quarters in the Museum House as a "Chummery" I was appointed Surgeon-Naturalist in 1910 and first met Annandale in September of that year, when I stayed as his guest in the Museum House for some days before joining the R. I. M. S. "Investigator" in Bombay. Annandale was generous almost to a fault. He used to get seriously perturbed if the credit balance due to him at his bank showed signs of increasing and he would at once cast round to see in what way he could profitably expend his savings, either by undertaking a tour in some distant land or in helping some of his friends. During the 1914-18 war he equipped young Anglo-Indian Officers at his private expense and he used to give a series of short lectures to the troops stationed in Calcutta on some of the Museum Exhibits and at the end entertained his audience to a sumptuous tea.

In 1906 when Annandale became Superintendent of the Indian Museum, touring for the scientific staff had become an obsolete practice, but, although he was the only gazetted officer of the Zoological Section, he persuaded the Trustees to allow him to go on tour, at first surreptitiously and then openly and officially. In the same year he persuaded the Trustees to institute the publication of two Journals, namely the *Records* and *Memoirs of the Indian Museum*. Previous to this the Trustees had published at irregular intervals a series of Monographs, for the most part dealing with the fauna of the deep seas round India

but Annandale realised that a number of shorter papers, published in various Journals and especially in the *Journal and Proceedings of the Asiatic Society of Bengal*, did not receive the attention to which they were entitled from Zoologists in other parts of the world. As a direct result of the institution of these periodicals the Indian Museum was enabled to acquire by exchange the Journals of a large number of Scientific Societies all over the world : in 1920 these numbered 120 and by 1926 the number had increased to 157. As he has himself pointed out, at this time, thanks very largely to the work of Col. Alcock and the R. I. M. S. "Investigator", our knowledge of the fauna of the deep waters of the Bay of Bengal was considerably more advanced than that of the fresh and brackish-waters of the continent itself and he at once set himself to remedy this defect. As a result, in the course of a very few years he had established himself as a recognised expert in several groups of the Animal Kingdom. Most Zoologists are satisfied to be regarded as an expert in a single group. In a country such as India, apart from the study of such "popular" groups as are of interest to the amateur naturalist or the sportsman, such as the Mammals, Birds, Fishes and Butterflies, very little work had been carried out on the fauna ; and anyone who takes up the more obscure groups very quickly realises that most of his time, especially at first, must be devoted to systematic and taxonomic studies, in order to discover what species are present, and only at a later stage is it possible to extend one's researches into Ecology and Geographical Distribution. Annandale commenced his work in India by taking up the study of the fauna of fresh or brackish-water and especially of the Sponges, Polyzoa and *Hydra*, and he very rapidly built up a reputation as an acknowledged expert on these groups, so that by 1909 he had been entrusted with the work of identifying and reporting on collections that had been made by several other Institutions and Expeditions, and he published papers on the Fresh-water Sponges from such widely-separated regions as Japan, New Guinea, the Philippine Islands, Australia, South Africa, North and South America and the Lake of Geneva in Europe.

In 1912 Annandale defined his attitude towards his work as Superintendent of the Zoological and Anthropological Section of the Indian Museum in the following words :—“ Since I became Superintendent of the Indian Museum a little more than five years ago it has been my ambition, without neglecting marine work, to do for the study of the fresh-water fauna of India what my predecessor, Col. Alcock, did for the abyssal fauna”: so, in addition to his work on the fresh-water Sponges and Polyzoa, he took up the study of the Barnacles, and especially of the stalked Barnacles ; and here again in a few years he had established himself as an expert on this group and his published work includes not only a number of papers on the Indian species but also Reports on Barnacles from the Malaysia, New Zealand, the Gulf of Siam and the Irish Seas.

In 1916 Annandale persuaded the Government of India to promote the Zoological and Anthropological Section of the Indian Museum to the status of the Zoological Survey of India and the Department was thus placed on an equal footing with the Geological and Botanical Surveys. As the late Dr. S. W. Kemp wrote in his Obituary Notice of

Annandale in 1924, "To many the change must have seemed purposeless, for it brought no improvement in the conditions of service of the Staff and no increase in their numbers ; and it was absurd to suppose that any comprehensive survey of the fauna of so vast a territory as the Indian Empire could be effected by a department with only four scientific officers. But Annandale showed himself far-sighted in this, as in many less important administrative matters. He saw the advantages that would ensue if Zoology were given equal recognition with her sister sciences, Geology and Botany: above all, that the change would sweep aside all possibility of restricting the activities of the department (at one time a very real danger) and would establish it firmly as an institution with research as its main object and the entire Empire as its field of work "

In the same year Annandale put forward a scheme for the appointment of Research Assistants to the Zoological Survey and on receiving the sanction of the Government for these appointments he selected Mr. Sunder Lal Hora, now the Director of the Survey, and Mr. Gautam Sondhi, both of whom were M.Sc. graduates of the Punjab University and pupils of Lt. Col. J. Stephenson, who was Professor of Zoology in Government College, Lahore and who had built up a flourishing school of research. Mr. Sondhi only held the appointment for a few months and then had to give up in consequence of ill health and was succeeded by Mr. Amin-ud-Din, also from Government College, Lahore, and an M.Sc. graduate of the Punjab University.

From the inception of their appointment, Annandale intended that these Research Assistants should not function merely as glorified Laboratory Attendants and he encouraged them to undertake independent research: he collaborated with them in working out collections and in writing reports on those groups to which their attention had been assigned, and he was meticulously careful to give full credit for all the work done by these young colleagues. It would be hard to find a better training for Zoological Survey work than participation in one or more tours that were undertaken by Annandale. He was very scornful of those Zoologists who deliberately confined their interests and studies to Taxonomy alone. Adopting a term coined by the American Philosopher, Oliver Wendell Holmes, he remarked in his Presidential Address to the Asiatic Society of Bengal in 1923, "Almost all of us 'learned men', as we are called, must admit ourselves to be 'Scarabees', each in his own narrow sphere. But I cannot admit that this is an ideal state of mind, though it be rife in all branches of learning" He took a very wide view of the necessity for including in studies of the fauna of any area, not only the animals themselves but also their ecology and relationships to other animals and plants in the environment, as is clearly indicated in his studies, for example, of the fauna of Barkuda Island in the Chilka Lake, for which he enlisted the help of Officers of the Botanical and Geological Surveys in elucidating the Physiography and Vegetation of the island and of myself in studying the Salinity and Temperature of the surrounding water of the Lake. Annandale's outlook is summed up in his own words, "that Taxonomy is an equal partner with morphology, bionomics and embryology in elucidating the problems of life,

laying a firm path for their progress and consisting not only of the examination of specimens in the laboratory and of reading what has been written but also of the consideration of organisms in relation to other organisms, to evolution, environment and geographical range" This view, he tells us, "has come to me by inheritance as the successor of a long line of broad-minded taxonomists in the Asiatic Society of Bengal and the Indian Museum.. In Calcutta we have always maintained that a taxonomist should be a Zoologist before he is a specialist" and he goes on to point out that "in the Indian Museum with our much smaller staff (than in most other museums) we have the great advantage that when one of us undertakes an important investigation the others know almost as much about it by the time it is finished as the worker himself"

He always insisted on the great importance of field-work and in his Triennial Report for 1917-1920 he writes, "It is impossible to separate Field-work from the more detailed taxonomic work in the Laboratory.. Observations made in the field are as much research as those made in the Laboratory" He aimed at allowing each officer in the Survey to spend about half the year collecting and observing in the field and the other half in the Laboratories of the Indian Museum. It was also part of his policy that areas that had already been surveyed should subsequently be visited again from time to time in order to check the conclusions that had been arrived at and to carry on investigations on particular points, the importance of which only became evident as the material, which had been collected, is worked out. In 1918 in his Report on the Molluscs of the Inlé Lake (*Rec. Ind. Mus.*, XIV) he remarks, "It seems very doubtful whether the peculiar modifications of the shell observed in so many of the aquatic molluscs of the Inlé Lake can have any bearing on the more highly specialised modern theories of evolution, which, even if sound in certain instances, are perhaps of less general application than their rival exponents are willing to admit. None of these theories have been put forward with the same wealth of natural illustration that Darwin gathered together in his *Origin of Species* and it is just as important that observations should be continued in the field on as large a scale as possible and without reference to any one preconceived theory, as that experiments should be conducted in the laboratory or garden-plot with a theory to support"

During his service in India he travelled very widely, visiting different parts of the Indian Empire, and during his periods of leave he extended his travels to far distant lands. In 1912 and again in 1921 he visited Palestine ; in 1916 he toured from the Malay States to China and Japan and in 1921 he visited Morocco. Between 1913 and 1920 he put into effect a wide scheme for the study of the macroscopic fauna of the lakes of Asia. These studies extended from Lake Biwa in Japan, through the Tai Hu in China, the Talé Sap in Siam, the Inlé Lake in Burma, the Chilka Lake in India, and the Hamun-i-Helmand in Persia, to the Lake of Tiberias in Palestine : he divided these lakes into four main types :—

- (a) Maritime Lakes (Chilka Lake, Talé Sap and Tai Hu)
- (b) Inland River Basins (Hamun-i-Helmand)
- (c) Normal Inland Lakes (Lake Biwa and the Lake of Tiberias)
- (d) Specialised Lakes (The Inlé Lake)

and in each of these Lakes he made a detailed study of the molluscs. Although he had published a few short papers on mollusca in previous years, Annandale's study of this group really began towards the closing period of the 1st World War. Several years earlier, in 1912, he had in a lecture to the Asiatic Society of Bengal put forward the view that "some day the Government of India may be forced to realise that the real problems which a civilised government must tackle are not political problems but sanitary ones. .Some day perhaps the medical profession will also realise, as some of its members already do, that sanitary problems are fundamentally biological and chemical, not medical at all" It was not until the concluding stages of the war that Annandale's suggestion was translated into actual fact. At this time Indian troops who had been serving overseas in Egypt and Mesopotamia were being invalided back suffering from the disease Schistosomiasis, and the Government of India and the Medical Department were seriously perturbed at the possibility of this disease being introduced into India, where it had previously been unknown. The parasite that causes the disease passes a stage of its life history in certain fresh-water mollusca, and it was therefore of the greatest importance to know whether any possible mollusc host existed in this country. They therefore requested Annandale to put his department at their service, and this he did with alacrity and his usual energy. The problem was tackled from several angles ; Annandale himself and Baini Prashad took up the study of the mollusca, in order to discover whether any possible host-species existed in India ; Kemp and Gravely attempted to infect the more common molluscs with the early stages of the parasite, obtained from infected individuals ; and on my return from active service at the beginning of 1919 I was transferred temporarily to the Zoological Survey and carried out investigations into the ' cercaria ' stage of the parasite's development, that lives in the snails, in order to discover what species of allied Trematodes were already present. It was during this period that Annandale investigated the Hamun-i-Helmand in Persia. These investigations enabled Annandale to inform the Government that the results obtained were entirely negative ; there was no known host of this parasite in India, no other mollusc seemed to be capable of harbouring the parasite and, although allied species of Schistosomes were present and infected goats and cattle, the human-infecting species was absent.

A survey of this nature necessarily entailed a close study of the taxonomy and systematics of the Mollusca and so Annandale added this group to the number of those of which he was already an acknowledged expert.

From his faunistic studies Annandale was enabled to put forward evidence that clearly indicated that in any given area the fauna may be the result of changes that have taken place in the geology of the region in times past. In his summary of the origin of the fauna of the Lake of Tiberias he points out that the conspicuous African element consists of Vertebrates, rather than Invertebrates, and, moreover, of Vertebrates that are known to be abnormal in their capacity to resist unfavourable conditions. The origin of the Ethiopian element he attributed to the existence in Pleistocene times of a river flowing southward from the Jordan Valley through the Red Sea and discharging into the Indian

Ocean. The Palaearctic element, he suggests, is of relatively recent origin and most of the species came in either from the east or west ; and he calls attention to the fact that the Nile, while serving as a high-way for certain Ethiopian species, has actually acted as a barrier and has separated some forms living to the west of the delta from those found on the east side. In Seistan, he points out, the majority of the fish can only have reached this region from the watershed of the Hindu Kush, while a minority seem to have come in from the lower areas of Baluchistan : but as regards the aquatic molluscs and the Oligochaetes the origin is more varied and includes a more distinct Indian element. His work on the fresh-water sponges of the Malabar zone showed that the majority of the forms found in this area are either African or else are closely related to African forms ; he further indicated that a relationship, though less definite, exists between the Malabar fauna and that of countries to the east of India, namely Sumatra, the Philippine Islands and even China, and he emphasises that this distribution cannot be attributed to either wind or marine currents and demands a true geographical and geological explanation ; he remarks, " No more satisfactory explanation has as yet been put forward than that of a former land connection between Africa and the Malaysia through Malabar at a period (probably late Cretaceous) when the Western Ghats were much higher than they now are " That even a change in the humidity of the atmosphere may be a more important factor in the distribution of reptiles and insects than actual temperature is suggested by him as an explanation of the presence of a lizard, *Lygosoma sikkimense*, in the eastern Himalayas and on Paresnath Hill : the geological history of this region suggests that this lizard " once lived on the plains as well as, or instead of, in the hills but that a fall in the atmospheric humidity of the former, perhaps due in part to movements of glaciers in the Himalayas, drove it up into the Eastern Himalayas on the one hand and the summit of Paresnath on the other or confined it to comparatively high altitudes " (Annandale : The fauna of Paresnath Hill, *Rec. Ind. Mus.* VI, 1912).

At the time of his death in 1924 Annandale was still occupied with the study of the mollusca, but he had practically concluded his systematic and taxonomic work and had just commenced to write up a summary of his work, in which he proposed to incorporate the whole of his investigations and experience gained during his many tours not only in India but throughout the whole breadth of the Asiatic continent. His method of work was most unusual : he had little or no interest in ordinary social intercourse and when he had finished his day's work in the laboratory he used after dinner in the evening to ascend to the roof of the museum and there walk up and down, thinking over the various problems in which he was interested. Late at night he came down and went to his room, and then sat down and put on paper the results of his contemplations. At times it seemed as though he forgot that he had already done so and when he woke the following morning he would get up and again write them down. After his death the writing table in his room was piled with a series of these rough notes, some of them almost word for word identical. Most unfortunately Annandale's handwriting was at the best of times extremely difficult to decipher and even

those who were best acquainted with it found that it was impossible to make head or tail of a great deal of this material. Both Kemp and I attempted the task but had to abandon it in despair. The loss of these notes is of a magnitude that it is impossible to estimate.

From a study of Annandale's published work and especially from his later papers we are able to see the direction in which his thoughts were shaping. The trend of his work had led him to a consideration of the effect that climate, environment and geographical distribution have had on the evolution of the species. As he himself remarks (*Museums and Taxonomy, The Museum's Journal* Vol. XXI, 1922), "Every new piece of faunistic work I undertake I am more impressed with the need for regarding the taxonomy of the groups I describe, not as a thing apart, but in correlation with the climate, the geographical position and geological formation, the vegetation and the composition of the water of each district surveyed" From his earlier studies of the Fresh-water Porifera and Polyzoa he had showed that the effect of environment might be quite different even in related species of the same genus : he gave evidence to show that in Europe species that occur both in that country and in India have developed different reactions to the climatic conditions. In Europe these animals produce statoblasts, gemmules or resting buds in Autumn, which lie dormant during the winter and develop in the following spring ; but in India in the Bengal area they produce these asexual resting buds at the approach of the hot weather and flourish during the cooler winter season, while others reach their maximum development during the rainy period in July-September and die down during the winter months.

He had a firm belief in the effect of environment on the species through a modification of the germ-plasma : from his studies of the adaptations to local conditions that are present among the fishes and tadpoles of hill streams he concluded, "we have thus evidence that these particular structures (*i.e.* adhesive discs) have come into existence, not through mutation and not by any Mendelian segregation of characters, but through a gradual accumulation of small changes. The close correlation, especially in *Garra*, between these change and differences in the flow of water in which species and even individuals live is at any rate suggestive. Whether we are witnessing the survival of the fittest in the Darwinian sense or must accept a frankly Lamarchian explanation only experiment can prove" (Annandale and Hora : *Parallel Evolution in the Fish and Tadpoles of Mountain Torrents, Rec. Ind. Mus.* XXIV, 1922). Among the Mollusca, Annandale concluded that plasticity is a more common phenomenon than individual variability and that the two are not necessarily connected, but that both are specific characters and may be acquired or be lost in the course of evolution and that the moulding forces or the causes of plasticity of greatest influence are not the same in all species and apparently slight differences in environment are sometimes of greater practical moment than changes which seem to be much greater (Annandale : *Aquatic Molluscs of the Inlé Lake and connected waters, Rec. Ind. Mus.* XIV, 1918). In connection with his studies of the species and varieties of the genera of the Family Viviparidae he remarks, "in certain regions of the earth's surface there is or has been

some influence at work which has produced a similar collective peculiarity in the shells of the Viviparidae on diverse occasions and in different parts of the world. What the influence is or was we do not know. I would hazard the suggestion that it had something to do with a peculiar chemical stimulus in the water which exerted its influence for long periods and from generation to generation, ultimately affecting the germ-plasm as well as the soma of the molluscs." Since the future sculpture of the shell can also be seen in embryonic shells he concludes that, "this would seem to prove at any rate that the sculpture cannot be due merely to the direct effect of the environment on the individual. Once the tendency has been implanted in the race, however, it can have full play only in favourable environment. Details must have been different in the various forms but the conditions in which these forms lived or live would seem to have been more or less parallel", and he remarks, "My explanation of the phenomena discussed in this paper implies an acceptance of the doctrine of the survival of the fittest and at the same time a firm belief in the inheritance of one kind of acquired character. Mendelism is true in some cases ; some species produce mutations, but gradual changes also take place under the influence of environment and are perpetuated. In some circumstances these changes are utilised and become more strongly developed, in some they produce harmless by-products ; in others the result is harmful and the race perishes. No one formula can express, much less explain, evolution" (Annandale : *The Evolution of the Shell-Sculpture in Fresh-water Snails of the Family Viviparidae*, *Proc. Roy. Soc.*, B, Vol. 96, 1924).

In 1923 the Government of India showed their appreciation of the splendid work that Annandale had been doing during his twenty years of service by conferring on him the honour of C. I. E., and in 1924 his name was on the list of those scientists who had been selected for the honour of being awarded the Fellowship of the Royal Society of London. Unfortunately he did not live to receive this recognition of his work, for he died during the short interval that has to elapse between the selection of the Candidates by the Council of the Society and the actual award of the honour by the Fellows at their subsequent meeting.

Annandale firmly believed that Indians were capable of carrying out Zoological research of the highest standard, if they were given a full and thorough training in the subject, and it is worth noting that after the selection of the two British scientists, Kemp and Gravely, in 1906, all subsequent appointments to the Survey were filled by Indians, for my appointment by the Government to succeed him as Director, in 1925, was not a new appointment to the Survey, since the Surgeon-Naturalist to the Marine Survey of India had been incorporated in the Zoological Survey as an Hon. Assistant Superintendent in 1906 and I had been connected with the Survey since 1910, first as Hon. Assistant Superintendent and later as Officiating Superintendent. That this belief and trust was fully justified has been amply confirmed in the past and I cannot do better in closing this summary of his work than by quoting the words of Dr. S. W. Kemp in his Obituary Notice in 1925, "His name will endure as an inspiration to his successors who will feel

that the memorial he would most have desired is the steady progress of the Institution, which he served with such devotion ”.

*The Zoological Laboratory,
Cambridge, England.
March 24, 1949.*

R. B. SEYMOUR SEWELL.

SILUROID FISHES OF INDIA, BURMA AND CEYLON.

XIII. FISHES OF THE GENERA *Erethistes* MÜLLER & TROSCHEL, *Hara* BLYTH AND OF TWO NEW ALLIED GENERA.

By SUNDER LAL HORA, D.Sc., F.R.S.E., F.Z.S., F.R.A.S.B., F.N.I.,
Director, Zoological Survey of India, Calcutta.

(PLATES I, II.)

An examination of the material in the collection of the Zoological Survey of India referred to the genus *Erethistes* Müll. & Trosch. has revealed that, as recognised at present, it is a composite genus in which several allied forms have been lumped together. Confusion has also been observed with regard to the precise specific limits of the various species so far described in this genus. It is proposed to elucidate here the systematic position of the Indian forms.

Genus *Erethistes* Müller & Troschel.

1845. *Erethistes*, Müller & Troschel, *Horae Ichthyol.* III, p. 12, pl. i, fig. 3.
1864. *Erethistes*, Günther, *Cat. Fish. Brit. Mus.* V, p. 263.
1870. *Hara* (in part), Day, *J. Asiat. Soc. Bengal* XXXIX, p. 40.
1872. *Erethistes* (in part), Day, *Proc. Asiat. Soc. Bengal*, p. 122.
1877. *Erethistes* (in part), Day, *Fish. India*, p. 452.
1883. *Erethistes* Günther, *Ann. Mag. Nat. Hist.* (5), XI, p. 139.
1889. *Erethistes* (in part), Day, *Faun. Brit. India*, Fish. I, p. 209.
1911. *Erethistes*, Regan, *Ann. Mag. Nat. Hist.* (8), VIII, p. 564.

The genus *Erethistes* was established by Müller and Troschel in 1845 to accommodate a small species of Cat-fishes from Assam. They characterized the genus as follows¹ :—

Gill-openings narrow. Head large, broad, roughened and anteriorly pointed. Besides occipital process, similar cubital processes, one on each side. Pectoral girdle provided with long bony process both above and below the pectoral fin. Snout small. Spike-shaped teeth in both jaws. Palate edentulous. Dorsal and pectoral spines strong and serrated. Dorsal fin situated over pelvic fins. Anal fin small.²

Without examining any specimen, but evidently relying on the original descriptions and figures (Plate XII, figs. 5, 6), Günther in 1864 elaborated the description and added, "Body with minute tubercles arranged in longitudinal series. Eyes small. Mouth small, inferior, with small teeth in both jaws; palate toothless. Apparently a small barbel to each maxillary; no other barbels"

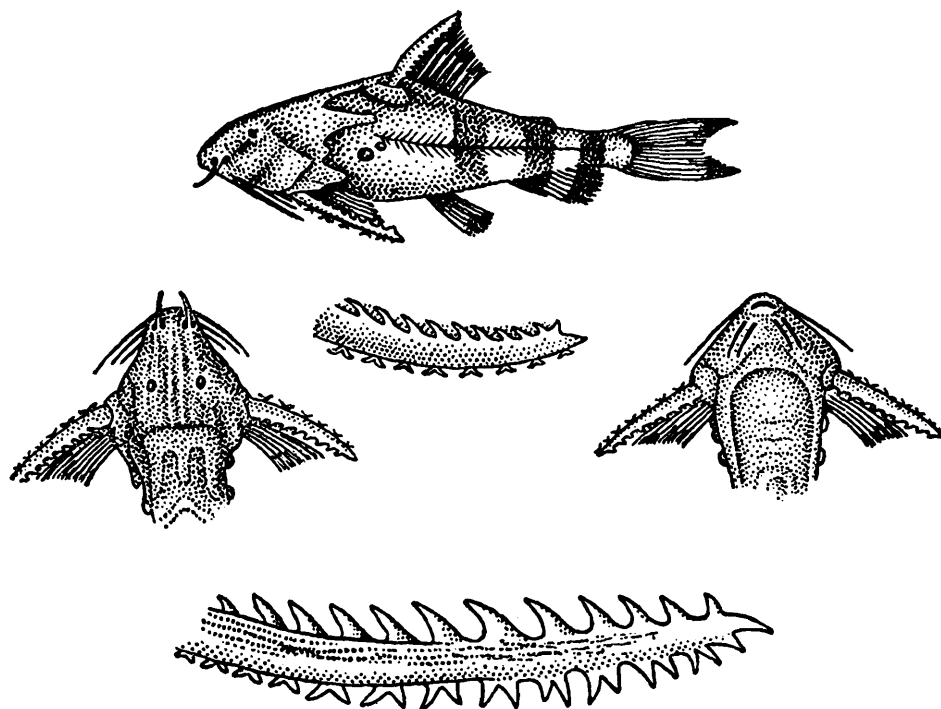
In 1872, Day referred to this genus and stated :

"Having a few months since obtained a copy of 'Horae ichthyoiologicae' from Berlin, I found that the figure of *Erethistes* (excepting in the absence of barbels) corresponded with specimens of *Pimelodus hara*, H. B., not only in the long processes about the nape and in the humeral region, but also in the pectoral spine and the number of fin rays".

¹ I am indebted to Dr. Trewavas of the British Museum for supplying me with copies of the original descriptions and figures of the genus *Erethistes* and of the species *E. pusillus* Müll. & Trosch.

² This is a free translation of the German description.

Hara buchanani (= *Pimelodus hara*) of Day's conception had pairs of divergent denticles along the outer edge of the pectoral spine, a feature very characteristic of *Erethistes pussilus*. It will be shown below (*vide infra*, p. 199) that in Hamilton's *Pimelodus hara* all the denticles on the outer edge of the pectoral spine are directed backwards. However, Day caused great confusion regarding the specific limits of these two species, as is evident from the figures of *Erethistes hara* published by

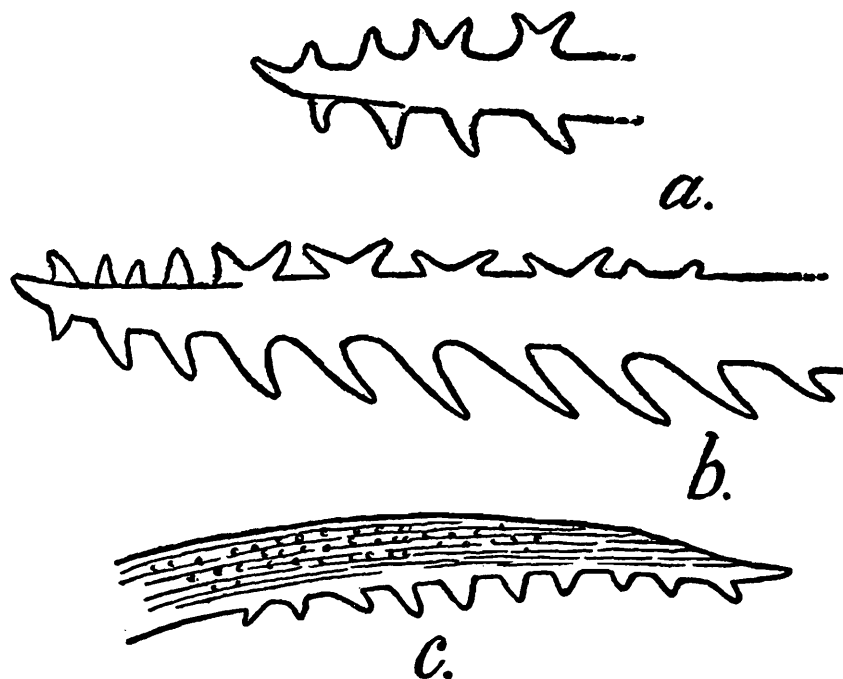


TEXT-FIG. 1.—Day's four drawings (upper) of a specimen wrongly identified as *Erethistes hara* (Ham.), with $4\frac{1}{2}$ times enlarged drawing (lower) of the pectoral spine of specimen No. Cat. 585 to indicate that Day may have used this specimen for his drawings.

him in his *Fishes of India* (pl. cii, figs. 1 & 2). His larger figure based on a specimen from Suddya in Assam shows *Pimelodus hara* whereas his smaller figure of a "half grown" specimen shows *Erethistes pussilus*. The original of the latter figure is probably Cat. No. 585 from Tenasserim collected by Major Berdmore. It is a ripe female and not a half grown specimen.

In 1883, Günther gave a fresh description of the genus *Erethistes* and stated that "These characters are taken from specimens of *Erethistes hara*" Dr. Trewavas has very kindly informed me that there are two specimens (81.4.29. 1-2) from N. Bengal in the British Museum stated to have been "presented by A. Günther" These were first labelled as *Hara buchanani* and then *Erethistes hara*. One of the specimens (81.4.29.1) is 46+4 mm. in length with the caudal incomplete and the second is 45 mm. in standard length. In both of them, the outer margin of the pectoral spine is provided with divergent denticles characteristic of *Erethistes pussilus*. Dr. Trewavas very kindly sent me figures of the dorsal and pectoral spines of these specimens which are reproduced here for future reference.

In 1911, Regan gave the osteological characteristics of the genus. Dr. Trewavas informs me that there is no prepared skeleton of *Erethistes* but the specimen No. 81.4.29.1 has been dissected and is evidently the one used by Regan. It will thus be seen that both Günther and Regan were referring to the true *Erethistes* in their characterisation of the genus though both had confused *Erethistes* and *Hara* as one and the same genus.



TEXT-FIG. 2.—Pectoral and dorsal spines of specimens of *Erethistes pussilus* Müll. & Trosch. in the collection of the British Museum, London.

a. End portion of pectoral spine of specimen No. 81.4.29.2 ; b. Left pectoral spine of specimen No. 81.4.29.1 ; c. Dorsal spine of specimen No. 81.4.29.1.

In view of the above discussion, I propose to restrict the generic name *Erethistes* to the forms in which the denticles on the outer edge of the pectoral spine are divergent. The genus may, therefore, be redefined as follows:—

The genus *Erethistes* comprises small, ugly-looking, spider-like fishes in which the superficial bones of the head are granulated and form a strong armature. The dorsal and lateral surfaces of the body are also granulated, while the ventral surface is covered with short spines directed backwards. The occipital, cubital and scapular processes are well developed ; in continuation of the scapular processes there are two bony nodules on each side ; the humeral processes are elongate and protect the abdomen on each side. The ventral surface of the head and body is flat and horizontal. There are two dorsal fins ; the anterior with a strong spine and the posterior adipose, rather short and placed above the anal. The pelvic fins are six-rayed and are inserted below the dorsal. The pectoral fins are more or less horizontal ; the pectoral spines are strongly indented along both margins, *the indentations along the outer edge being arranged in the form of divergent spines*. The mouth is small and is situated on the ventral surface a short distance behind the tip of the conical snout. There are minute teeth in both jaws while the palate is edentulous. The teeth in the upper jaw are arranged in 3 or 4 series, those of the inner series are elongated and lie flat on the

jaw with their bases ensheathed in muscular pads. The teeth in the lower jaw are minute and scattered. There are eight barbels; the nasal barbels are small and are attached to the flap covering the posterior nostrils; the maxillary barbels are of moderate size and are provided with short, basal flaps; the bases of the two pairs of mandibular barbels are placed in a more or less horizontal line. All the barbels are annulated with black rings. The two nostrils on each side are close together. The eyes are small and devoid of free orbital margins. The gill-membranes are confluent with the isthmus opposite the roots of the humeral processes. The air-bladder (Plate I, fig. 4) is divided into two globular, lateral lobes which are connected by a median, transverse tube; the two lobes come in contact with the skin externally and are protected by the cubital and scapular processes.

Distribution.—*Erethistes* is a monotypic genus so far. It was originally described from Assam but the material in the collection of the Zoological Survey of India and of the British Museum shows that it occurs in Burma, N. Bengal and Bihar also. Day described a similar form from Orissa but the specimens from Orissa examined by me are not referable to *Erethistes* as restricted here. The extension of the range of the genus to Orissa, though probable, needs confirmation.

***Erethistes pussilus* Müller & Troschel.**

(Plate I, figs. 1-6.)

1845. *Erethistes pussilus*, Müller & Troschel, *Horae Ichthyol.* III, p. 12, pl. i, fig. 3 (Assam: one specimen not quite 2 inches long).
 1864. *Erethistes pusillus*, Günther, *Fish. Cat. Brit. Mus.* V, p. 264.
 1869. *Hara buchanani*, Day¹ (*nec* Blyth), *Proc. Zool. Soc. London*, p. 369 (Orissa).
 1870. *Hara buchanani*, Day² (*nec* Blyth), *J. Asiat. Soc. Bengal* XXXIX, p. 40.
 1877. *Erethistes hara*, Day³ in part (*nec* Hamilton), *Fish. India*, p. 452, pl. cii figs. 1 and 2.
 1889. *Erethistes hara*, Day in part (*nec* Hamilton), *Faun. Brit. Ind. Fish.* I, p. 209.

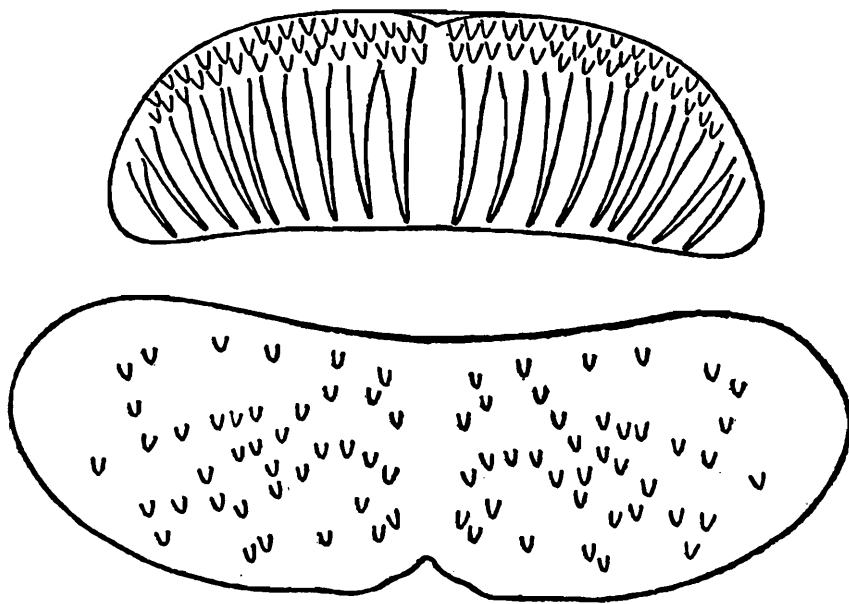
Erethistes pussilus comprises small fishes rarely exceeding two inches in length; the ventral surface of the head and body is flattened but the dorsal profile rises sharply to the base of the dorsal fin and thereafter slopes down to the base of the caudal. The head is sharply pointed anteriorly; its length is contained from 3.6 to 4.3 times in the standard length. The head is almost as wide as long. The depth of the body is almost equal to or slightly greater than the length of the head. It may be mentioned that Müller and Troschel also found "Head as broad as long, its length being equal to the height of the body, and one-third

¹ Day described pectoral spine as "serrated internally, and with finer serrations externally but arranged in a very peculiar manner, each alternate tooth being directed anteriorly or posteriorly". There is a small specimen, 29 mm. in standard length, in the Asiatic Society of Bengal's collection (A. S. B. Cat. 583) from Orissa presented by Day in which the serrations on the outer edge of the pectoral spine are directed in one direction only. In fresh specimens from Orissa, the pectoral spine is not of the type so characteristic of *Erethistes*. This reference has, therefore, been included in the synonymy to invite attention to Day's description. It is likely, however, that the specimen in the Calcutta Museum with which he compared his Orissa specimens had the spine of the *Erethistes* type.

² In characterising *Hara buchanani*, Day stated that the external serrations of the pectoral spine are "alternately directed forwards and backwards".

³ As explained above, the two figures published by Day clearly show that he had confused the two types characterised by the nature of the pectoral spine. He also noted that divergent denticles are present "in many, especially small specimens".

of the total" in the type-specimen (*vide* Günther, *loc. cit.*, p. 264). The snout is almost as long as the postorbital part of the head. The interorbital distance is one-third the width of the head. The maxillary barbels are generally shorter than the head. The gape of the mouth is about one-fourth of the width of the head. Both the dorsal and the pectoral fins are longer than the head; their spines are well developed and strong. The base of the adipose dorsal is considerably shorter than the length of the snout. The caudal peduncle is 3 times as long as its least height.



TEXT-FIG. 3.—Dentition of *Erethistes pussilus* Müll. and Trosch. $\times 40$.

The drawing was made from specimen No. F. 862 from the Jharahi River, Siripur, Saran District, Bihar.

The commencement of the dorsal fin is distinctly nearer the tip of the snout than the base of the caudal fin. The distance between the vent and the base of caudal is two-thirds of the distance between the vent and the tip of the snout. The alimentary canal is short with one loop only.

The other characters are as given in the generic description. Owing to the inaccessibility of the original description of *Erethistes pussilus*, particularly for Indian students, I give below a free English translation¹ of it for convenience of reference in future :

The head is triangular and is as broad as long; its length is contained more than three times in the total length. The height of the body is equal to the length of the head. The eyes are small and are situated in the middle of the length of the head; they are three diameters apart and four diameters from the end of the snout. The head is very coarsely roughened and uneven and the ridge on it ends in a point over the snout. There is a shallow groove from behind the tip of the snout and between the eyes; posterior to this are two median fontanels one behind the other, the last being situated at the base of the occipital process. The occipital process is narrow with parallel margins and is three times as long as broad; it extends to the basal bone of the dorsal spine which is semicircular and roughened. The cubital processes run parallel to the occipital process and are longer than it. The crested scapular processes are also roughened. The mouth is narrow and pointed and is provided with narrow bands of velvet-like teeth in the upper and lower jaws. The gill-openings are narrow and are

¹ I am obliged to Dr. A. K. Mitra of the Anthropological Survey of India for the English translation of the German descriptions of the genus and of the species *Erethistes pussilus* Müll. & Trosch.

separated from each other by a distance which is greater than the distance between the mouth and the gill-openings. There are six branchiostegal rays. Filiform maxillary barbels appear to have been present, but others cannot be recognised. Below the tip of the snout, the lower jaw forms two sharp, posteriorly directed, hook-shaped processes. The pectoral girdle is roughened, and the pointed pectoral process has in the middle of its lower margin a strong indentation. Behind this process, there are two bony, roughened tubercles in the skin which are formed by the ends of the transverse processes of the compound vertebra. The humeral processes are longer than the pectoral ones; they are narrow and extend as far as two-thirds of the pectoral fins. Posterior to these processes, the broad body becomes narrow. The dorsal fin is situated above the pectoral fin and is provided with a spine characteristic of Cat fishes; the dorsal spine is roughened anteriorly and laterally but is denticulated posteriorly. There are six rays in the dorsal fin besides the spine. The adipose dorsal is low and as long as the anal fin above which it is situated. The caudal fin is truncate. The anal fin has 11 rays. The pectoral fins are provided with strong spines; the denticulations along their anterior margin consists of teeth alternately directed forwards and backwards, only the last on the tip is directed backwards; the denticulations along the inner border are still more pronounced and directed forwards. The pectoral fin extends to the pelvic fin which is provided with 6 rays. The body is covered with four to five rows of tubercles which appear to be similar to those found in Bloch's *Platystacus verrucosus*, which is now not to be found in Bloch's collection. It has a large air-bladder.

B. 6; D. 1/6; A. 11; v. 6.

Colour.—Brown.

Size.—1 inch 10 lines.

Locality.—Assam. In the Zool. Museum of Berlin. Presented by Walker.

Erethistes pussilus is represented in the collection of the Zoological Survey of India from the following localities:—

Reg. No.	Locality.	Donor.	Remarks.
Cat. 585	Tenasserim.	Major Berdm re.	Mixed up with 5 other specimens of <i>Hara filamentosa</i> Blyth. Probably the original of Day's figure in the <i>Fishes of India</i> .
Cat. 584	?	?	Of the 3 specimens under this number, two belong to <i>E. pussilus</i> .
F 6982-6989 1	Bijli Hill, Kamrup Dist., Assam.	L. W. Middleton.	
F 86/2	Jharahi River, Siripur, Saran Dist., Bihar.	M. M. Mackenzie.	
F 816/2	Lakhmidi River near S i t a m a r i Rly. Station, Bihar.	P. N. Mitter.	

Distribution.—Burma, Assam, Bihar and ? Orissa.

Measurements in millimetres.

	Tena- sserim.	Assam.			Bihar.		Locality ?	
Standard length	39.8	26.0	42.4	36.2	37.0	37.1	40.0	40.9
Length of head ..	11.0	6.0	11.1	9.1	9.3	8.9	10.6	10.8
Width of head ..	10.0	6.0	10.9	9.1	9.0	8.7	10.6	10.0
Height of head ..	9.4	5.2	9.0	8.2	8.3	8.3	9.0	9.0
Depth of body ..	11.8	6.4	10.1	9.8	9.6	9.1	10.0	10.8
Length of snout	5.5	3.0	5.0	4.7	4.6	4.5	5.0	5.3
Interorbital width	4.0	2.0	4.0	3.0	3.0	2.9	3.8	4.0
Length of maxillary barbels.	D.*	6.2	11.1	8.8	8.4	7.6	7.5	9.0
Gape of mouth ..	D.*	1.6	2.6	2.3	2.5	2.1	2.4	2.5
Length of dorsal fin	D.*	8.0	11.1	9.7	10.2	9.0	D.*	11.8
Length of dorsal spine	12.2	5.5	9.0	8.1	8.1	6.7	12.0	10.0
Length of pelvic fin ..	D.*	5.0	7.0	6.1	6.3	6.5	6.3	6.0
Length of base of adipose dorsal.	D.*	2.7	3.6	4.5	4.0	3.6	4.0	3.0
Length of pectoral fin	D.*	8.5	1.0	11.1	13.5	11.5	D.*	10.0
Length of pectoral spine.	13.3	7.3	11.6	12.5	11.5	10.4	14.4	12.0
Length of caudal peduncle	6.6	4.8	7.8	6.8	7.1	7.0	7.2	7.2
Least height of caudal peduncle.	2.2	1.7	2.6	2.3	2.5	2.3	2.5	2.6
Distance between com- mencement of dorsal and tip of snout.	18.6	10.5	18.0	15.7	16.0	15.0	17.0	18.2
Distance between com- mencement of dorsal and base of caudal.	21.2	15.5	24.2	20.5	21.0	22.1	23.0	22.7
Distance between vent and tip of snout.	27.2	14.9	26.6	22.5	23.3	22.1	24.2	24.1
Distance between vent and base of caudal.	12.6	11.1	15.8	13.7	13.7	14.9	15.8	16.

*D. = Damaged.

Ecology.—No observations have yet been recorded on the bionomics of *Erethistes pussilus* and an attempt made to study them in the living condition at Siripur (Jharahi River), Saran District, Bihar, has not been fruitful. It is known, however, that *E. pussilus* and *Hara hara* live together in the same habitat. Day¹ referred to their habitat in Orissa

¹ Day, F., *Proc. Zool. Soc. London*, p. 370 (1869).

and Mr. M. M. Mackenzie collected specimens of both the species from the Jharahi River at Siripur.

According to the District Gazetteer of the Saran District (pp. 5, 7 ; Calcutta : 1908), Jharahi River takes its rise from a large swamp and acts as an overflow channel to relieve the lowlands of surplus water in the rains. In the dry season it used to dry up leaving stagnant pools or marshes in the deeper portions of its bed. Though it passed Husepur, the former home of the Hathwa Rajas and Mairwa, it conveyed little or no traffic. Mr. M. A. S. Menon, who was sent to study the ecology of *E. pussilus*, has reported that in October-November (27th October to 1st November) the Jharahi River near the Agricultural Farm at Siripur is 2 to 4 feet deep and the bed consists of soft mud with the marginal area of 40 to 60 feet covered with tall grasses and weeds. The water was clear and the current slow with plenty of floating vegetation. Though no boats were noticed during this visit, the party was authentically informed that when Mr. Mackenzie was Superintendent of the Agricultural Farm, the stream was about 10 to 12 feet deep and navigable throughout the year.

The local people recognised the fish *E. pussilus* as "Tengra" and stated that this variety was found when the river was not so shallow. Day also found in Orissa that *Erethistes* "lives amongst weeds or in very muddy parts of rivers"

It would thus appear that *Erethistes* inhabit sluggish deep waters overgrown with vegetation. In such habitats, their spider-like appearance and strongly pectinated spines presumably provide them with anchorage to the vegetation, among which they live fairly well protected from their enemies.

Relationships.—Müller and Troschel compared *E. pussilus* with *Platystacus verrucosus* Bloch in certain respects, while Günther in his *Catalogue* considered it allied to *Sisor* Hamilton. After examining the specimens of the species in 1883, he regarded *Erethistes* as a "genus most closely allied to *Callomystax*" Regan in 1911, on the basis of osteological characters, referred the genus to the family Sisoridae, which comprises specialised Bagrid fishes in which the pterygoid and post-temporal bones are absent, the head of the hyomandibular is contracted and articulates with the sphenotic only and the air-bladder is divided into two lateral lobes. According to Regan's synopsis of the genera of the Sisoridae, *Erethistes* is closely allied to *Nangra* Day¹ and *Gagata* Bleeker from which it differs in having "Mesopterygoid large, extending to hyomandibular above the reduced metapterygoid; pelvics below the dorsal".

***Erethistoides*, gen. nov.**

The genus *Erethistoides* is proposed for a small species of torrent-inhabiting cat-fishes in which the head and body are greatly depressed and flattened, and the paired fins are horizontally placed. The mouth is distinctly inferior and considerably behind the tip of the snout, the teeth in the upper jaw are visible externally. *The denticles along the*

¹ *Nangra* Day is synonymous with *Gagata* Bleeker, *vide* Hora, S. L., *Rec. Ind. Mus.* XLIII, p. 9 (1941).

outer margin of the pectoral spine are directed towards the base in the proximal half of the spine while along the distal half they are directed towards the tip.

As there are only three examples of the new genus, I have not dissected any specimen. Owing to the small uncovered area between the cubital and scapular processes and thick and tuberculated skin in this area, it would appear that the air-bladder is greatly reduced and possibly enclosed in bony capsules, partially or completely.

The genus is allied to *Erethistes* Müll. & Trosch. in most respects and the main points of differences are noted above. Detailed characteristics are given in the description of the species.

Genotype :—*Erethistoides montana*, gen. et sp. nov. (*Loc.*—Tangla, Darrang District, Assam).

***Erethistoides montana*, gen. et sp. nov.**

(Plate I, figs. 10-12.)

D. 1/5 ; A. 9 ; P. 1/6 V-6 ; C. 13.

In *Erethistes montana* the head and body are greatly depressed and the ventral surface is flattened and horizontal ; the dorsal profile rises only very gently from the tip of the snout to the base of the dorsal fin. The depth of the body is contained from 6.1 to 6.3 times in the standard length. The tail is long and narrow ; the least height of the caudal peduncle being contained 3.4 to 3.7 times in its length. The skin and bones all along the dorsal and lateral surfaces are covered with denticles while the whole of the ventral surface is covered with small backwardly directed spines. The head is broadly pointed in front ; its length is contained from 3.2 to 3.3 times in the standard length ; the width of the head is contained from 1.1 to 1.2 times and its height from 2.1 to 2.2 times in its length. The eyes are small, dorso-lateral in position and situated in the posterior half of the head. The interorbital width is less than one-third the length of the head. The mouth is of moderate width, distinctly inferior, and more or less transverse ; its gape is contained from 2.2 to 2.3 times in the width of the head. The snout projects like a broad hood in front of the mouth. The lips are thin but the surrounding portions of skin are papillated. The nasal barbels are longer than the eye ; the maxillary are longer than the head and are provided with broad bases ; the inner mandibular barbels are almost as long as the gape of the mouth while the outer are considerably longer. The gill-openings extend to the ventral surface for about a quarter of the distance before the gill-membranes become united with the skin of the isthmus ; the portion of the gill-opening in front and somewhat inner to the base of the pectoral spine is modified into a spout-like structure for the passage of the expiratory current.

The head and the anterior part of the body are provided with strong armature of bones, all of which are thick, strong and markedly denticulate. The median groove on the head extends from between the posterior nostrils to the base of the occipital process where there is a median fontanel. Just behind the orbital region there is a transverse ridge in the groove. The occipital bone is long and narrow but just

misses the basal bone of the dorsal fin. The basal bone of the dorsal fin is expanded on the sides into wing-like extensions. The cubital processes are almost as long as the occipital process. The scapular process is short and stumpy and is followed by two bony tubercles between it and the basal bone of the dorsal fin. The humeral processes are long and curved, and are separated from the pelvic bones by a short distance. There are two raised muscular pads inner to and behind the pelvic fins and a median pad in front of the anal opening.

The dorsal fin is situated opposite the pelvics; its commencement is distinctly nearer to the tip of the snout than the base of the caudal fin. The dorsal fin is longer than the depth of the body below it but is considerably shorter than the length of the head. The dorsal spine is strong; it is finely serrated externally and pectinated internally. The adipose dorsal is short and low; its base is almost equal to the interorbital width. The pectoral fins are long and horizontal; they are almost as long as, slightly shorter or longer than the head, and extend considerably beyond the bases of the pelvic fins. The pectoral spine is broad and strong; the skin of its distal end is produced into a filliform process along with similar structures of some of the other outer rays; the outer border is finely serrated and the inner is strongly pectinated. The pelvic fins extend beyond the vent which is situated nearer to the base of the caudal fin than to the tip of the snout, but do not reach the base of the anal fin. The anal fin is short and does not extend to the caudal fin. The rays of the lower portion of the caudal fin are greatly produced but are not filliform.

The general colour is dusky above and dirty white below. The head at the nape is provided with a dark band and the body with three similar bands, one below the first dorsal, one below the adipose dorsal and one in front of the caudal fin. The middle portion of the upper surface of the pectoral fins is infuscated with black. The two dorsals and the caudal are provided with bands near their distal portions.

Locality.—Streamlets round about Tangla, Darrang District, Assam. Two specimens were collected by me on 14th November, 1939.

Type-specimen.—F 314/2, Zoological Survey of India, Calcutta.

Remarks.—*Erethistoides montana* can be readily distinguished by the position of its mouth, long maxillary barbels and the form of the caudal fin. Its *Balitora*-like facies recalls its mode of life in very swift currents.

Measurements in millimetres.

Standard length ]	..	..	..	37.8	33.0
Length of head				11.3	10.2
Width of head	..			10.1	8.1
Height of head	..		..	5.1	4.9
Depth of body				6.0	5.4
Length of snout	..		..	6.0	5.0
Interorbital width				3.2	3.1

Length of maxillary barbels	..	..	..	12.4	11.8
Gape of mouth	..	..	..	4.5	3.5
Length of dorsal fin	..	..	..	8.5	6.0
Length of dorsal spine	..	..	..	8.0	5.8
Length of pectoral fin	..	..	..	12.2	9.5
Length of pectoral spine	..	..	..	10.5	9.0
Length of pelvic fin	..	..	..	6.8	5.9
Length of base of adipose fin	..	..	..	3.8	3.0
Length of caudal peduncle	..	..	..	7.9	7.1
Least height of caudal peduncle		..	..	2.3	1.9
Distance between dorsal and tip of snout	..		..	16.9	14.0
Distance between commencement of dorsal and base of caudal.				20.9	19.0
Distance between tip of snout		..	..	22.0	18.9
Distance between vent and base of caudal	..		..	15.8	14.1

***Erethistoides montana pipri*, gen. et sp. et subsp. nov.**

(Plate I, figs. 7-9.)

The subspecies *pipri* is represented in the collection by a single specimen obtained by Dr. K. S. Misra from the Rihand River at Pipri. Though it is sufficiently distinct from *Erethistoides montana* from Assam, I have considered it expedient to keep them linked together, firstly because both forms are known from three specimens altogether and secondly to bring out the significance of their occurrence in such widely separated localities. Remarks on the zoogeographical importance of these forms have already been made elsewhere¹.

The form is less depressed and the body is not so densely tuberculated as in *E. montana*. The dorsal surface behind the dorsal fin and the ventral surface behind the pelvic fins are smooth along the middle. All the fins are somewhat more elongated and the caudal fin is quite different in shape from that of *E. montana*. In the subspecies *pipri*, the caudal fin is emarginate with the lower caudal lobe slightly longer than the upper. The form, lengths and tuberculation of the occipital and cubital processes as well as of the basal bone of the dorsal fin are also different in the two forms. Differences in proportions and other characters can be made out by referring to the drawings and the table of measurements given below:—

Measurements in millimetres.

Standard length	..	..	..	30.8
Length of head	..	..	..	9.4
Width of head	..	..	..	9.4

¹Hora, S. L., *J. Zool. Soc India* I, pp. 1-7 (1949).

Height of head	..	..	..	5.4
Depth of body ..	..		..	6.0
Length of snout	..	..	..	5.0
Interorbital width	..	..	..	3.0
Length of maxillary barbel ..	..	..	..	7.5
Gape of mouth ..	..	..	..	4.0
Length of dorsal fin	..	..	..	6.6
Length of dorsal spine	..		..	5.4
Length of pectoral fin	..		..	11.0
Length of pectoral spine ..	..	..	..	9.5
Length of pelvic fin	..	..	..	6.0
Length of base of adipose fin			..	3.6
Length of caudal peduncle ..	..		..	6.8
Least height of caudal peduncle	..	..	..	2.3
Distance between dorsal and tip of snout		..		15.5
Distance between commencement of dorsal and caudal fin				15.3
Distance between vent and tip of snout		..	..	19.0
Distance between vent and caudal fin ..	..	..	..	11.8

Locality.—Pipri, Rihand River, Mirzapur District, U. P.

Type-specimen.—F 315/2, Zoological Survey of India, Calcutta.

Conta¹, gen. nov.

1871. *Hara* (in part), Day, *Proc. Zool. Soc. London*, p. 407.

1877. *Erethistes* (in part), Day, *Fish. India*, p. 452.

1889. *Erethistes* (in part), Day, *Faun. Brit. India, Fish. I*, p. 209.

The genus *Conta* is proposed for *Pimelodus conta* Hamilton originally described from North-eastern Bengal (Mahananda River). It differs from the genera *Erethistes* Müller and Troschel, and *Hara* Blyth in the following characters :

1. The form is elongated and subcylindrical and not much depressed and flattened.
2. The humeral processes supporting the edges of the abdomen are short and do not extend beyond the bases of the pectoral fins.
3. The rounded abdominal surface is plaited in the middle forming an adhesive pad similar to that found in the fishes of the genus *Glyptothorax* Blyth.

¹ I am aware of the use of the generic name *Contia* Baird and Girard among Reptilia Ophidia and of the name *Contra* proposed by Boulenger (*Zool. Rec. XLII*, p. 1905) for the same. The name *Conta* proposed here differs from both in spellings and is tautonymous and, therefore, a very appropriate generic name for this species.

4. The dorsal spine is strongly pectinated along both edges and not only along the inner edge as in other genera of the *Erethistes*-group.

It differs from *Glyptothorax* in having a broad isthmus separating the two gill-openings.

Day caused considerable confusion with regard to the specific limits of Hamilton's *Pimelodus conta* and it is, therefore, necessary to fix up its position with reference to its original description and figures. The following are its salient features as taken from Hamilton's description :—

- (i) The head is small, oval and sharpish.
- (ii) The mouth is small.
- (iii) The maxillary barbels are shorter than the head.
- (iv) The back slopes very little towards the head.
- (v) The lateral line is straight and high on the sides.
- (vi) The vent is nearly in the middle.
- (vii) D. 5. The dorsal spine is serrated on both sides.
- (viii) The pectoral spine is indented on both sides.
- (ix) The caudal fin is divided into two unequal lobes ; the upper terminating in a long, slender point.

Keeping in mind the above characters of Hamilton's *Pimelodus conta*, if one studies the species of *Erethistes* recognised by Day in his *Fishes of India*, one will at once come to the conclusion that Day's *E. elongatus* is synonymous with *P. conta*. Further, a large number of specimens collected from the hill-streams of North-east Bengal, including the Mahananda River (Type-locality) near Siliguri, and Assam leave no doubt that these two species are conspecific. Day's *E. conta* is Hamilton's *Pimelodus hara* and his *E. hara* is in part *P. conta* and in part *E. pussilus*. The details concerning the systematics of these forms are discussed under each species.

Genotype.—*Pimelodus conta* Hamilton (Loc.—Mahananda River, North-east Bengal).

Distribution.—Assam and North-east Bengal.

Conta conta (Hamilton).

(Plate II, figs. 4-6.)

1822. *Pimelodus conta*, Hamilton, *Gangetic Fishes*, p. 191. (Mahananda River, North-east Bengal).
 1860. *Hara conta*, Blyth, *J. Asiat. Soc. Bengal* XXIX, p. 152.
 1864. *Hara conta*, Günther, *Cat. Fish. Brit. Mus.* V, p. 189.
 1871. *Hara elongata*, Day, *Proc. Zool. Soc. London*, p. 704 (Garo Hills, Assam. One specimen 2.25 inches long).
 1877. *Erethistes elongata*, Day, *Fish. India*, p. 453, pl. cii., fig. 5.
 1889. *Erethistes elongata*, Day, *Faun. Brit. Ind. Fish.* I, p. 207.
 1921. *Erethistes elongata*, Hora, *Rec. Ind. Mus.* XXII, p. 738.
 1922. *Erethistes elongata*, Hora, *ibid.*, XXIV, p. 45 (Ventral surface figured).
 1929. *Pimelodus conta*, Hora, *Mem. Ind. Mus.* IX, pl. xxi, fig. 8 (MS drawing reproduced).
 1937. *Erethistes elongatus*, Shaw & Shebbeare, *J. Roy. Asiat. Soc. Bengal, Science*, III, p. 98, fig. 99.

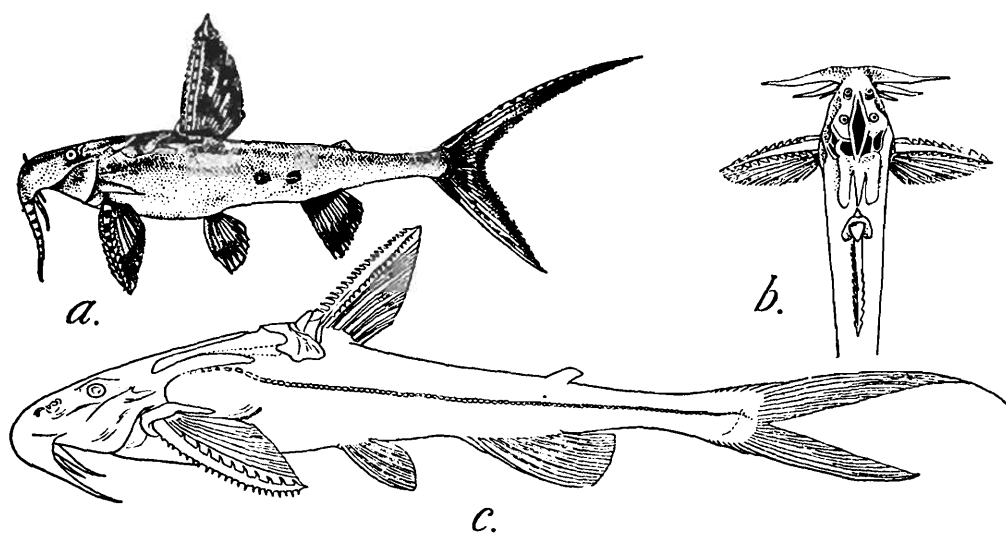
Conta conta is a slender, elongated, subcylindrical, small fish, in which the dorsal profile is but gently arched. The ventral profile is horizontal upto the pelvic fins and thereafter rises to the base of the caudal fin. The head is small, oval and sharpish ; its length is contained from 4.5 to 5.5 times in the standard length. The width of the head is contained

from 1.1 to 1.4 times in the length of the head. The height of the head is greater than its length in one very young specimen otherwise it is equal to or considerably shorter than the length of the head, upto 1.5 times in the length of the head. The eyes are small, dorsolateral in position and situated in the posterior half of the head. The interorbital space is contained from 3.1 to 4.6 times in the length of the head. The nostrils are nearer the tip of the snout than the eye. The nasal barbels are small. The maxillary barbels are generally considerably shorter than the head and extend as far as the gill-openings; they are provided with broad cutaneous flaps at their bases. The mandibular barbels are considerably shorter and fleshy. The mouth is small and is situated on the ventral surface behind the tip of the snout; it is bordered by thick fleshy lips which are papillated and continuous at the angles of the mouth. The anterior lip is interrupted in the middle though the skin in that region is papillated for some distance in the mouth also. It seems probable that the inhaled current enters the mouth through this gap. The gape of the mouth is one-fourth to one-fifth the width of the head. The gill-openings are lateral, extending to the ventral surface only for a short distance; they are provided with spout-like structures in front of the bases of the pectoral spines, these probably serving as exhalent passages for the respiratory current. The groove on the head extends from the nostrils to the base of the occipital process. The occipital process is long and narrow and almost reaches the basal bone of the dorsal fin. The cubital process is somewhat curved, slender and almost as long as the occipital process. The scapular process is short but is followed by another slender bone which is longer than the scapular process. Sometimes this last bone is represented by an ossicle or a chain of ossicles. The humeral process along the lateral abdominal edge is very short and is almost as long as the base of the pectoral fin.

The head and body are tuberculated with the exception of the middle abdominal region which is covered with longitudinal plaits of skin probably performing adhesive function. The depth of the body is contained from 5.3 to 6.5 times in the standard length. The caudal peduncle is long and narrow; its least height is contained from 5 to 8 times in its length. The vent is situated almost in the middle of the distance between the tip of the snout and the base of the caudal fin. There is a small anal papilla.

The dorsal fin is situated somewhat in advance of the pelvics and considerably nearer the tip of the snout than the base of the caudal; it is provided with one spine and five branched rays; it is considerably higher than the depth of the body below it. The dorsal spine is strongly indented along both edges. The adipose dorsal is small and is situated above the base of the anal fin. The pectoral fins are horizontally placed slightly above the ventral profile; they are longer than the head and extend to the bases of the pelvic fins. The pectoral spine is serrated along both edges; the serrations along the outer edge are directed backwards while those along the inner edge are directed forwards. Each fin is provided with one spine and six branched rays. The pelvic fins are six-rayed and are horizontally placed; they extend beyond the vent but are separated from the anal fin by a considerable distance.

The anal fin is short and is provided with 9 to 10 rays. The caudal fin is deeply furcate with both the lobes greatly produced; it contains about 17 rays besides smaller ones at the sides.



TEXT-FIG. 4.—*Conta conta* (Ham.).

a. Copy of Hamilton's drawing of *Pimelodus conta*, lateral view; b. Same as above, a portion of the dorsal view showing nature of pectoral and dorsal spines; c. Outline sketch of a specimen from the Mahananda River, N. Bengal $\times 1\frac{1}{2}$.

The alimentary canal possesses a single loop. The air bladder (Plate II, fig. 6) is divided into two lateral portions which are covered by bony plates posteriorly and are connected anteriorly by a horizontal tube. The lateral line is marked with a series of prominent tubercles.

The colour in the preserved specimens is chocolate dusky all over with the exception of the ventral surface which is dirty white. The barbels are annulated with dark bands. The fins are dark with light patches or bands. The outer rays of the caudal fin are lightly coloured and form a whitish border to the fin.

Conta conta has hitherto been collected from the rocky streams at the bases of the hills and in its general facies, habits and habitat seems very much like the other loach-like cat-fishes of the genera *Olyra* and *Amblyceps*. In fact, fishes of all the three genera have been collected together from the same stream.

Conta conta is represented in the collections of the Zoological Survey of India from the following localities:—

Registered No.	Locality.	Donor.	Remarks.
436	Garro Hills, Assam.	F. Day.	Type of <i>Erethistes elongatus</i> Day.
F 10077/1	Mahananda R., below Darjeeling.	G. E. Shaw & E. O. Shebbeare.	Topotype.
F 82/2	Mahananda R., near Siliguri.	D. D. Mukerji.	(Figured as Plate II, figs. 4, 5, 6).
F 83/2	Laska R., 8 miles from Siliguri.	D. D. Mukerji.	
F 84/2	Eastern Himalayan streams.	Darjeeling Museum.	(Text-figure 4c).
F 85/2	Bhareli River, above Lokra, Balipara Frontier Tract, Assam.	S. L. Hora.	

Distribution.—Assam Hills and Darjeeling Himalayas.

Measurements in millimetres.

	F 82/2	F 84/2				F 85/2					F 10077/1	436	F 83/2				
	Siliguri.	Eastern Himalayas.				Balipara Frontier Tract, Assam.					Darjeeling.	Garo Hills Assam.	Laska R. near Siliguri.				
Standard length	47.5	39.5	49.1	44.6	46.2	28.5	33.6	35.0	35.1	42.9	49.9	45.0	43.9	45.9	46.3	49.0	44.9
Length of head	9.3	8.0	9.6	9.0	8.8	5.6	6.2	7.1	6.9	8.6	9.0	9.3	8.5	8.2	9.0	9.9	8.1
Width of head	7.8	6.0	7.2	6.1	7.0	4.8	5.1	6.0	6.0	6.6	7.2	6.5	6.3	6.9	6.8	7.8	6.1
Height of head	6.3	6.0	6.2	6.0	7.9	5.9	5.0	5.5	5.5	6.0	7.0	6.2	7.0	7.6	7.1	8.0	7.6
Depth of body	7.7	6.8	7.0	7.8	7.4	5.0	5.8	5.9	6.0	8.1	8.0	6.9	7.8	7.1	7.1	8.1	7.3
Length of snout	5.0	4.0	5.0	4.5	5.0	3.1	3.5	4.0	3.3	5.1	5.0	5.0	4.9	4.2	4.2	5.1	4.9
Interorbital width ..	3.0	1.9	2.7	2.2	2.1	1.6	1.9	1.9	1.8	2.7	2.6	2.0	2.0	20.4	2.0	2.5	2.0
Length of maxillary barbel ..	7.2	5.8	6.7	5.0	6.3	4.0	5.7	4.0	6.1	10.6	6.0	6.0	7.0	7.9	7.5	6.3	7.8
Gape of mouth	1.8	1.4	1.4	1.3	1.8	1.0	1.0	1.0	1.1	1.3	1.3	1.5	1.0	1.5	1.1	1.6	1.3
Length of dorsal fin	12.0	8.9	12.0	11.6	12.1	7.8	8.9	D.	9.3	12.0	14.5	12.0	11.6	12.0	10.4	12.5	11.1
Length of dorsal spine	11.0	7.4	10.0	10.5	11.0	6.0	7.8	7.4	8.3	9.9	13.0	10.6	9.5	10.3	9.2	11.0	9.4
Length of pectoral fin	13.0	11.0	13.2	12.8	13.0	7.3	10.1	11.0	11.0	12.3	14.3	11.7	10.9	11.3	11.1	13.0	12.9
Length of pectoral spine	10.8	9.0	11.4	11.3	11.4	6.5	8.4	9.9	9.1	11.2	12.6	11.0	9.9	10.1	10.4	11.8	11.0
Length of pelvic fin	7.3	5.3	7.0	7.0	6.8	4.8	4.9	5.0	5.3	8.0	7.0	6.9	6.4	6.2	7.0	7.4	6.7
Base of adipose fin	2.0	1.4	1.4	1.9	1.9	1.0	1.7	1.6	1.5	2.7	2.0	1.5	1.5	1.5	1.8	2.0	2.0
Length of caudal peduncle ..	11.1	9.0	12.0	11.5	11.8	8.6	8.7	8.6	9.5	10.3	12.2	10.2	10.9	11.2	11.0	12.0	11.0
Least height of caudal peduncle ..	2.2	1.9	2.0	2.0	2.0	1.1	1.2	1.1	1.2	1.8	2.0	2.0	1.9	2.0	2.0	2.0	2.1
Distance between base of dorsal and tip of snout.	18.2	14.8	18.1	16.3	16.8	10.6	14.0	14.9	12.9	17.4	18.0	16.9	16.5	16.3	16.6	18.9	16
Distance between base of dorsal and base of caudal.	29.3	24.7	31.0	28.3	29.4	17.9	19.5	22.9	22.2	25.5	31.9	28.1	27.4	29.6	29.7	30.1	28.1
Distance between vent and tip of snout	26.0	18.0	25.0	22.9	24.0	14.1	16.8	18.0	18.5	23.9	26.5	23.2	24.0	24.2	24.8	26.7	25.6
Distance between vent and base of caudal	21.5	21.5	24.1	21.7	22.2	14.4	16.8	18.0	16.6	19.0	23.4	21.8	9.9	21.7	21.5	22.3	19.3

Ecology.—Reference has already been made to the general similarity in habits and habitats of *Conta conta* to *Amblyceps mangois* (Ham.)¹ and *Olyra longicaudata* McClell.² Whereas *Amblyceps* and *Olyra* live among pebbles and shingle at the bottom of small submountainous streams liable to be cut up into pools and puddles during the dry season and to floods during the rainy season, *Conta*, by virtue of an adhesive apparatus on the thoracic and abdominal regions, probably adheres to rocks in waters flowing through boulders. In such crevices, its strongly pectinated dorsal and pectoral spines probably serve as organs of attachment. They can indeed be very useful in crawling about among stones and boulders which are generally very slippery. The denticulations on the spines are so arranged as to contend both forward and backward thrusts, which are the usual features of turbulent waters.

GENUS *Hara* (Blyth).

1860. *Hara*, Blyth, *J. Asiat. Soc. Bengal* XXIX, p. 151.
 1864. *Hara*, Günther, *Cat. Fish. Brit. Mus.* V, p. 189.
 1870. *Hara* (in part), Day, *J. Asiat. Soc. Bengal* XXXIX, p. 37.
 1872. *Erethistes* (in part), Day, *Proc. Asiat. Soc. Bengal*, p. 122.
 1877. *Erethistes* (in part), Day, *Fish. India*, p. 452.
 1883. *Erethistes*, Günther, *Ann. Mag. Nat. Hist.* (5), XI, p. 139.
 1889. *Erethistes* (in part), Day, *Faun. Brit. India*, Fish. I, p. 209.
 1911. *Erethistes*, Regan, *Ann. Mag. Nat. Hist.* (8), VIII, p. 564.

In 1860, Blyth characterised the genus *Hara* as follows:—

“ With broad maxillary cirri, soft throughout, and annulated with two colours: the pectoral spines short, flat, and pectinated on both edges; the dorsal spine less stout, serrated on both edges or behind only: mouth small, terminal, but opening below: head flattish, with small eyes placed high: a band of card-like palatal teeth. Colouring dark and minutely mottled ”.

“ Type. *H. buchanani*, nobis; *Pimelodus hara*, H. B. ”

The above description appears to have been based on the original description and figure of *Pimelodus hara* Hamilton³, to which Blyth had access in the library of the Asiatic Society of Bengal. Though Hamilton stated that the pectoral spine is “ indented behind ”, Blyth corrected it from the figure and stated “ pectinated on both edges ”. In characterising the dorsal spine as “ serrated on both edges or behind only ”, evidently Blyth had both *P. hara* and *P. conta* under consideration. It is not clear how Blyth came to note “ a band of card-like palatal teeth ”, for in *P. hara*, Hamilton noted “ The only teeth consist in a roughness on each jaw ”, while in *P. conta* the jaws are stated to have “ no perceptible teeth ”. Evidently he took this character from the specimens of *Hara filamentosa*. His diagnosis of the genus *Hara* is, therefore, of a composite nature. The fixing of the characters of this genus should be restricted entirely to the diagnostic features of *Pimelodus hara*.

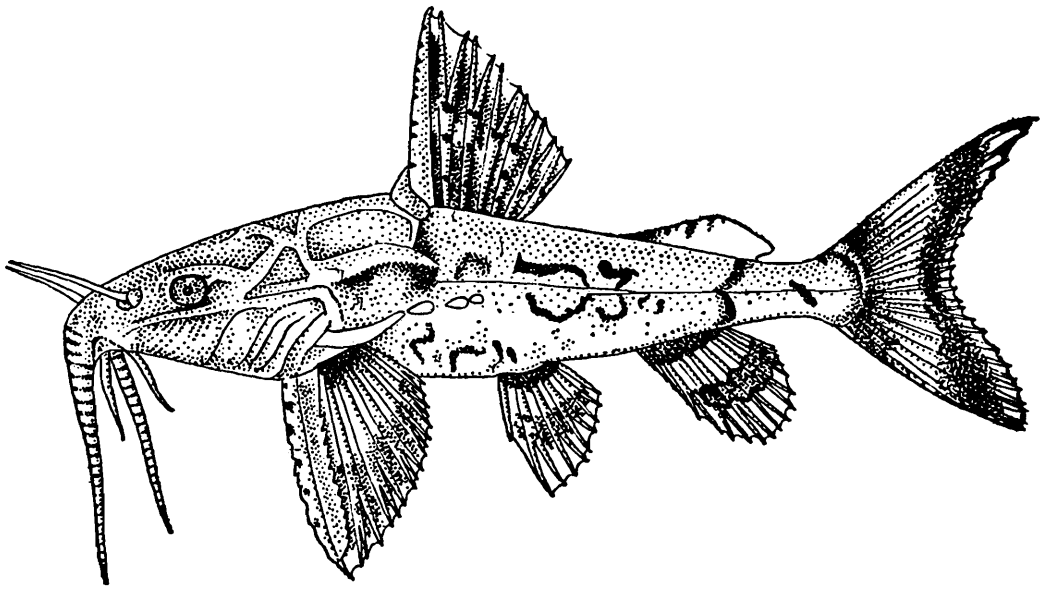
In 1929, I remarked on the controversy regarding Buchanan's (afterwards Hamilton) Zoological Collections and the importance of his fish drawings and concluded that “ *In the absence of any authentic preserved material these drawings are of special interest, for they are the only indications we possess of the different species described by Buchanan* ”. I

¹ Hora, S. L., *Rec. Ind. Mus.* XXXV, pp. 607-621 (1933).

² Hora, S. L., *Rec. Ind. Mus.* XXXVIII, pp. 202-207 (1936).

³ Hamilton, F., *Gangetic Fishes*, p. 190 (Edinburgh: 1822).

wish, therefore, to invite attention to the fact that in the original drawing of *Pimelodus hara*, the indentations along the outer margin of the



TEXT-FIG. 5.—Copy of Hamilton's drawing of *Pimelodus hara* showing the nature of the dorsal and pectoral spines.

pectoral spines are not arranged as pairs of divergent denticles, characteristic of the genus *Erethistes*, but all are pointed in one direction (backwards). Day had caused considerable confusion in mixing up the two types of very characteristic forms readily distinguishable on this character. As both types may sometimes occur together in the same locality and are similar in appearance and colouration, it is all the more necessary to pay particular attention to the nature of the pectoral spine in the two cases.

The genus *Hara* is closely allied to the genus *Erethistes* from which it is principally distinguished by the nature of the pectoral spine as discussed above.

Genotype.—*Pimelodus hara* Hamilton (*Loc.*—Kosi River).

Distribution.—Burma, Assam, Bengal, Bihar, U. P. and Orissa.

Hara hara (Hamilton).

(Plate II, figs. 1-3).

- 1822. *Pimelodus hara*, Hamilton, *Gangetic Fishes*, p. 190 (Kosi River).
- 1860. *Hara buchanani*, Blyth, *J. Asiat. Soc. Bengal* XXIX, p. 151.
- 1860. *Hara filamentosa*, Blyth, *ibid.*, p. 151 (Tenasserim).
- 1864. *Hara buchanani*, Günther, *Cat. Fish Brit. Mus.* V, p. 189.
- 1869. *Hara buchanani*, Day, *Proc. Zool. Soc. London*, p. 369 (Orissa).
- 1877. *Erethistes hara*, Day (in part), *Fish. India*, p. 452, pl. cii, fig. 1.
- 1877. *Erethistes conta*, Day (nec Hamilton), *Fish India*, p. 453, pl. cii, fig. 4.
- 1889. *Erethistes hara*, Day (in part), *Faun. Brit. Ind. Fish.* I, p. 204, fig. 74.
- 1889. *Erethistes conta*, Day (nec Hamilton), *ibid.*, p. 205.
- 1889. *Erethistes conta*, Vinciguerra (nec Hamilton), *Ann. Mus. Civ. Stor. Nat. Genova* (2), IX, p. 122.
- 1929. *Erethistes conta*, Prasad & Mukherji (nec Hamilton), *Rec. Ind. Mus.* XXXI, p. 186.
- 1929. *Pimelodus hara*, Hora, *Mem. Ind. Mus.* pl. xxi, fig. 5 (Hamilton's MS drawing reproduced).

I have referred above (*vide supra*, p. 195) to the salient features of *Pimelodus conta* and concluded that Day's *Erethistes conta* cannot

represent Hamilton's *P. conta*. Under *E. pussilus*, I have shown that Day's *E. hara* must in part be assigned to that species. The above synonymy of *E. hara* shows that Day's classification of the species of this genus was responsible for wrong identifications in the case of later workers.

In describing *Hara filamentosa*, Blyth himself pointed out its great likeness to *H. buchamani* but attached specific importance to the filamentous prolongation of the upper lobe of the caudal fin. It is significant that in several species common to India and Burma, the caudal fin is more markedly bifurcate and the colouration is more gaudy as we go from west to east. In the case of *Amblyceps mangois* (Ham.)¹, it was shown that the form of the caudal fin is very variable. In the case of Siamese specimens of *A. mangois*, the upper lobe of the caudal fin is produced into long filamentous processes exactly similar to the condition described by Blyth in his *Hara filamentosa*. Günther rightly attached no importance to this character but Day in distinguishing his *E. hara* and *E. conta* did take it into consideration.

Of the lot of 6 specimens of *Hara filamentosa* now in the collection of the Indian Museum, one is referable to *Erethistes pussilus*. In these old specimens, the caudal fin is damaged and the colouration has completely faded away so the characteristic features noted by Blyth cannot be made out now. It appears from measurements that Day's figures of *E. conta* in his *Fishes of India* (pl. cii, figs. 4, 4a, 4b and 4c) were made from one of these specimens.

The specimens from Meetan, Tenasserim and Bassein have a smooth ventral surface. The bases of the fins in the Meetan specimens are dark, whereas in the Bassein specimens the pectoral spine is proportionately long. In the examples from Terai and Duars in northern Bengal, the ventral surface is greatly flattened though the body is considerably elevated. It would thus appear that in the material before me, there are probably several races and subspecies, but both in quantity and quality the material is not sufficient for such intraspecific studies.

The species is represented in the collection of the Indian Museum from the following localities :—

Registered No.	Locality.	Donor.	No. of specimens.
Cat. 583	Orissa.	F. Day.	1
	Kudal Darh, Patna State, Orissa.	B. S. Chauhan	3
F7046/1	Lucknow, U. P.	M. M. Khan	1
F11390/1	Terai & Duars, N. Bengal.	G. E. Shaw & E. O. Shebbeare.	2
1454	Sadiya, Assam.	F. Day.	1
1453	Bassien, Burma.	F. Day.	1
Cat 585	Tenasserim, Burma.	Major Berdmore.	5
Cat. 582	Mandalay, Burma.	F. Day.	1
F11049/1	Meetan, Burma.	Genova Museum.	2
F10878/1	Indawgyi Lake, Burma.	B. N. Chopra.	1

¹ Hora, S. L., *Rec. Ind. Mus.* XXXV, p. 618, fig. 5 & p. 620, fig. 6 (1933).

Hara jerdoni (Day)

(Plate II, figs. 7-9.)

1870. *Hara jerdoni*, Day, *J. Asiat. Soc. Bengal* XXXIX, p. 39.1877. *Erethistes jerdoni*, Day, *Fish. India*, p. 453, pl. cii, fig. 3.1889. *Erethistes jerdoni*, Day, *Faun. Brit. India*, Fish. I, p. 206.

Since Day described *Hara jerdoni* from Sylhet, no other worker seems to have recorded this fish from any other locality. Day examined only 3 specimens, the largest being 1.5 inches. In the collection of the Indian Museum, the species is represented by the following specimens :—

Registered No.	Locality.	Donor.	No. of specimens.
Cat. 586	Sylhet, Assam.	Capt. R. Beavan.	1
431	Sylhet, Assam.	Purchased from Day.	1
13873-13902	Jessor Bheels, E. Bengal.	Woodmason & Alcock.	30
F 7150-7153/1	Kowpati, Mangaldai (Assam).	S. W. Kemp.	29
F 317/2	Siripur, Saran (Bihar).	M. M. Mackenzie.	10
F 318/2	Tista River, Jalpaiguri.	N. Annandale & S. W. Kemp.	1

The Asiatic Society of Bengal's specimen (Cat. 586) is registered as *Hara jerdoni* and may have been examined and determined by Day. The specimen No. 431 is undoubtedly one of the three that formed the type-series. The specimens from the Jessore Bheels had been registered as *Erethistes conta*, but there can be no doubt about their specific identity as *H. jerdoni*. This is the only species of the genus in which the skin is smooth and the length of pectoral spine is almost one and a half times as long as the length of the head.

The air-bladder is divided into two lateral circular lobes which are lodged in deep pits and are partially enclosed by bone. They are free on the ventral surface and dorso-laterally they come in contact with portions of translucent skin enclosed by the cubital processes above and scapular processes below. Bony tubercles, two or three in number, enclose the area between the processes mentioned above, thus forming a circular bony rings round the air-bladder. It would appear that air-bladder is a functional organ and receives stimulus from its contact with external factors through the translucent areas of the skin.

Distribution.—From the material listed above in the collection of the Zoological Survey of India, it will be seen that the species is widely distributed from Bihar, north and east Bengal to Assam.

EXPLANATION OF PLATE I.*

FISHES OF THE GENERA *ERETHISTES* MÜLL. & TROSC. *ERETHISTOIDES*, NOV.

Erethistes pussilus Müller and Troschel.

- FIG. 1.—Lateral view of a specimen from Bijli Hill, Kamrup District, Assam. $\times 2$.
- FIG. 2.—Dorsal surface of head and anterior part of same. $\times 2$.
- FIG. 3.—Ventral surface of head and anterior part of same. $\times 2$.
- FIG. 4.—Air-bladder of a specimen from Jharahi River, Siripur, Saran District, Bihar. $\times 4$.
- FIG. 5.—Photograph copy of Müller and Troschel's drawing—lateral view.
- FIG. 6.—Same as above—dorsal view.

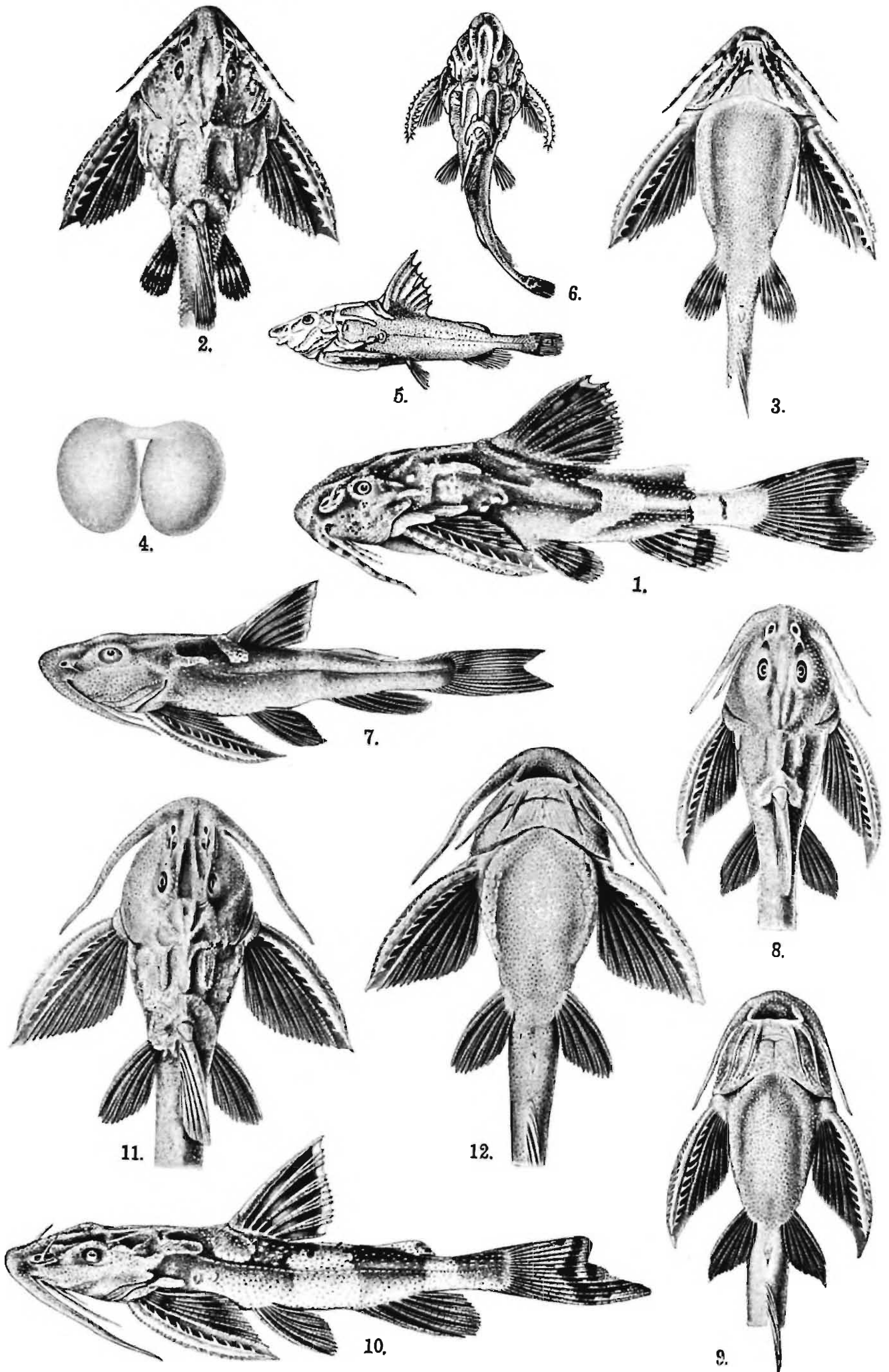
Erethistoides montana pipri, gen. et. sp. et. subsp. nov.

- FIG. 7.—Lateral view of type-specimen (F315/2) from Rihand River at Pipri, Mirzapur District, U. P. $\times 2$.
- FIG. 8.—Dorsal surface of head and anterior part of body of same. $\times 2$.
- FIG. 9.—Ventral surface of head and anterior part of body of same. $\times 2$.

Erethistoides montana, gen. et. sp. nov.

- FIG. 10.—Lateral view of type-specimen (F314/2) from Tangla, Darrang District, Assam. $\times 2$.
- FIG. 11.—Dorsal surface of head and anterior part of body of same. $\times 2$.
- FIG. 12.—Ventral surface of head and anterior part of body of same. $\times 2$.

* To be read correctly as Plate "XII" throughout.



EXPLANATION OF PLATE II.*

FISHES OF THE GENERA *HARA* BLYTH AND *CONTA*, NOV.

HARA HARA (HAMILTON).

FIG. 1.—Lateral view of specimen No. F 11390/1 $\times \frac{15}{16}$.

FIG. 2.—Dorsal surface of head and anterior part of body of the same. $\times \frac{15}{8}$.

FIG. 3.—Ventral surface of head and anterior part of body of the same. $\times \frac{15}{8}$.

Contra contra (Hamilton).

FIG. 4.—Dorsal surface of head and anterior part of body. $\times 2\frac{1}{2}$.

FIG. 5.—Ventral surface of head and anterior part of body. $\times 2\frac{1}{2}$.

FIG. 6.—Air-bladder and associated skeletal structures. $\times 2\frac{1}{2}$.

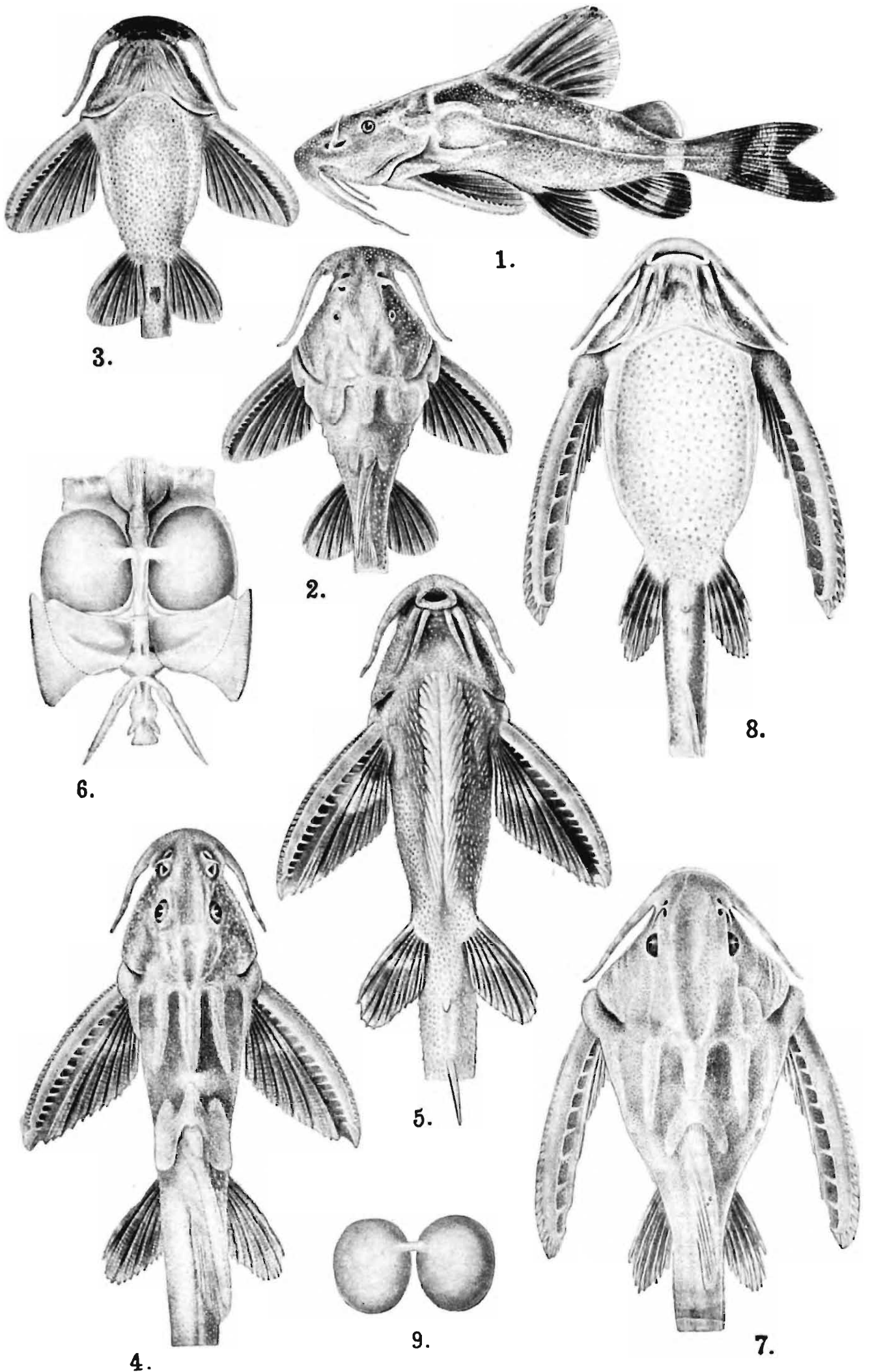
Hara jerdoni Day.

FIG. 7.—Dorsal surface of head and anterior part of body. $\times 5$.

FIG. 8.—Ventral surface of head and anterior part of body. $\times 5$.

FIG. 9.—Air-bladder. $\times 5$.

* To be read correctly as Plate "XIII" throughout.



STUDIES ON THE DEVELOPMENT OF SOME BOMBAY ELASMOBRANCHS.

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INTRODUCTION.

In a previous paper we (1946) gave an account of the Selachian fauna of the Bombay waters and recorded 41 species, of which 39 were either viviparous or ovo-viviparous, the only oviparous forms being *Chiloscyllium griseum* (M. & H.) and *Stegostoma tigrinum* (Forster). Gravid females of a number of viviparous species are landed at Sassoon Dock, Bombay, during the fishing season from September to May, and a study of this material has enabled us to describe the developmental phenomena in some of these viviparous forms which, we believe, are being recorded in India for the first time. These observations have been made on more or less the same lines as have been done previously by Alcock (1890), Woodmason & Alcock (1891), Southwell (1910), Southwell & Prashad (1919) and Mahadevan (1940) on other species of sharks and rays, obtained chiefly off the eastern coast of India.

The terms "intermediate stage" and "advanced stage" used by us to denote different stages of utero-gestation need explanation. The term "intermediate stage" denotes those stages of pregnancy in which the embryonic yolk-sac, while still containing a quantity of yolk within its cavity, displays a rudimentary placental connection with the uterine wall, while the term "advanced state" denotes that the foetal development has advanced to an extent when the yolk-sac no longer contains any yolk and the placental condition has assumed a purely haemotrophic character.

DEVELOPMENTAL STAGES.

Scoliodon acutus (Rüppell).

Intermediate Stage.—(Parent ♀: total length 28" ; app. wt. 3 lb. ; November 11, 1942.) In this specimen only the right ovary was present containing pale rounded ova, 2.0 to 3.0 mm. in diameter, only two eggs being 5 mm. in diameter, with pale yellow yolk. The epigonal organ had an elongated, purplish pink ribbon-shaped structure. Unlike the condition in *S. palasorrah* and *S. walbeehmi* each nidamental gland consisted of two coiled horns apposed against the opposite walls of the uterus. The caudal portions of the oviducts were unusually short. The uteri were elongated, sausage-shaped bags united caudally. The right uterus was divided into two compartments by a central longitudinal partition and contained two embryos, a male and a female, while the left had a single compartment with a single male embryo. The embryos were enclosed in membranous sacs of shell membranes which were devoid of any watery, albuminous liquid. The embryos had already become attached to the uterine walls through their yolk-sac placentae.

One of the male embryos (Text-fig. 1a) had the following dimensions :—

Total length	157 mm.
Length of caudal fin	47 mm.
Length of umbilical cord	162 mm.
Yolk-sac placenta	25 × 10 mm.
Length of clasper	3 mm.

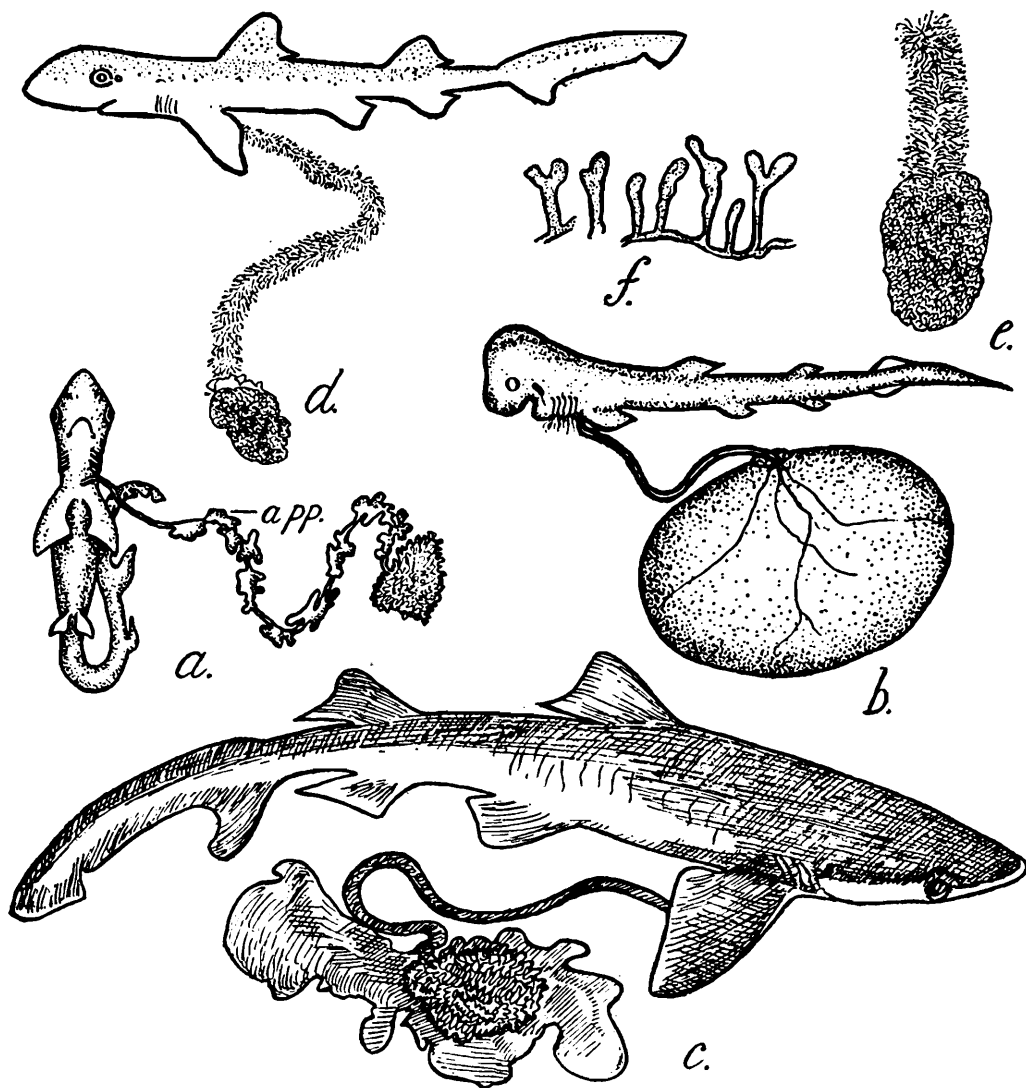
Unlike the adult, the embryo was for the most part cream-coloured, with only very scant pigmentation in the dorsal region and on the edges of the first dorsal and caudal fins. Scales had not yet developed and the branchial filaments had been completely absorbed. The vestigial spiracles devoid of any filaments, were however, discernible behind the eyes just above the angles of the mouth in the form of minute rounded apertures. Eyes are from four to five times as large as the gill-slits, which were comparatively very small, showing in this respect a marked difference from the adult condition.

Yolk-sac placenta.—The foetal placenta is formed by the original yolk-sac, the walls of which were irregularly and densely folded over its entire surface, the folds still containing a considerable quantity of yellowish white yolk. These folds were interdigitate with the vascular villi of the more or less circular trophonema, a ridged, villous and highly vascular patch of the uterine mucous membrane, in the posterior part of the compartment. This constituted the maternal placenta.

The foetal and maternal tissues were not, however, in direct contact, as fold of the shell-membrane intervened between them. The wall of the foetal placenta was fairly vascular at this stage. The placenta closely resembles that of *S. palasorrah* and obviously with the complete exhaustion of yolk in its folds, would give rise to an "entire" placenta.

Umbilical cord.—It consists of a central yolk-duct, accompanied by an artery and a vein enclosed in a sheath of connective tissue. The latter was irregularly folded in a peculiar fashion all along its course to give rise to irregularly-contoured, rather narrow and flattened outpushings

—the appendicula—which were only moderately vascularised on their internal surface.



TEXT-FIG. 1.—Embryonic stages of Bombay sharks.

- a. *Scoliodon acutus* (Rüpp.), embryo in intermediate stages of development with umbilical cord and foetal placenta of the 'entire' variety. Note the characteristic appendicula. b. *Carcharinus temminckii* (M. & H.), embryo in early stages of development (27 mm.—stage). c. *C. temminckii*, foetus in advanced stages of development with placental cord and placenta of the 'discoid' variety. d. *Hemigaleus balfouri* Day, embryo in advanced stages of development with placental cord and placenta of the 'entire' variety. e. *H. balfouri*, magnified view of foetal placenta. f. *H. balfouri*, magnified view of appendicula.

On tracing the umbilical vessels within the body of the embryo, the vein was seen to join the hepatic portal vein before the latter bifurcates into the hepatic lobes, while the artery opened into a branch of the coeliacomesenteric artery, the other branch of which enters the posterior wall of the intestine. The yolk-duct opened into the colon directly and there was no internal *yolk-sac* at this stage.

***Carcharinus temminckii* (Müller & Henle).**

27 mm. Stage.—(Parent ♀: Total length 5'-3"; App. wt. 60 lb.; Aug. 8, 1942.)—This female specimen possessed a single ovary containing small eggs varying from 2 to 7 mm. in diameter. Only the larger

eggs contained pale-yellow yolk. The epigonal organs formed prominent, strap-shaped, purplish-pink structures. Each of the nidamental glands consisted of two coiled horns and was situated nearer the upper pole of the uterus. Each uterus was divided into four transversely placed compartments, each containing a tiny embryo with its umbilical cord and yolk-sac enclosed in a spindle-shaped, water-filled sac of the shell membrane. While the distal end of the shell-membrane sac was folded and compressed into a compact tuft, the proximal end, was only a folded and twisted cord, passing out of the compartment in an irregular course and lying in a tunnel of the submucosa of the posterior wall of the uterus.

Embryo (Text-fig. 1*b*).

Total length		27 mm.
Length of caudal fin		7 mm.
Length of umbilical cord	..	15 mm.
Diameter of yolk-sac	..	31 mm.
Distance between spiracle and first gill-slit ..	..	31 mm.

The embryo was crimson-coloured. Its head region was swollen and quite transparent, the divisions of the brain being distinctly visible. The region of the snout was depressed, rounded in outline and distinctly marked off from the head region. The snouts of some embryos presented a beak-like contour viewed from the side. The rounded outline of the snout contrasts at this stage, markedly with the pointed and triangular outline of the snout in the adult. The eyes were prominent and the pupils large and rounded, there being only a slight pigmentation in front of and behind the pupil. The gill-slits were almost vertical and from each slit emerged a bunch of short crimson-coloured branchial filaments swollen at their tips. A short distance in front of the first gill-slit, situated just above the angle of the mouth, was the prominent, oblique, spiracular slit, possessing a pair of very short spiracular filaments. All the fins had developed in their respective adult positions, though they were in very rudimentary forms of being mere flaps of skin. The sub-caudal lobe had not yet been clearly marked. The sexes were also not yet distinct.

Yolk-sac and umbilical cord.—The yolk-sac was a thin-walled bag enclosing pale yellow yolk. Its walls were interspersed with blood-capillaries which ultimately united to form an umbilical artery and a vein. These vessels passed up into the cord through a gelatinous disc at the upper pole of the yolk-sac. The cord consisted of the usual artery, the vein and the yolk-duct. It was devoid of any appendicula.

The features described above tallied exactly with those of the embryos of a female landed at Sassoon Dock on August 19, 1942, except for the fact that the distance between the spiracular slit and the first gill-slit had greatly increased now. This was because these embryos were bigger (average total length 43 mm.) than those obtained on the previous occasion. All the embryos were not equally developed, but differed slightly, in their total lengths.

Intermediate stage.—(Parent ♀: Total length 4'-9"; App. wt. 60 lb.; October 9, 1943). Each uterus of this female contained four embryos. The uterine compartments were disposed obliquely, each containing an

embryo, with its umbilical cord and yolk-sac enclosed in a thin, transparent water-filled sac of the shell-membrane. The embryos did not lie freely in the compartments but were attached to the uterine wall through rudimentary yolk-sac placentae. In each uterus, two embryos were male and the other two female.

Embryo.

Total length	128 mm.
Length of caudal fin	30 mm.
Length of umbilical cord	120 mm.
Yolk-sac	113 × 100 mm.

Although the various external morphological features of the species had already been developed, there were certain conspicuous differences from the adult condition. The head was thicker and broader than in the adult and the teeth had not yet been formed. The spiracular slits had closed but bunches of crowded branchial filaments still protruded from the gill-slits. The characteristic relative sizes and positions of the various fins were, however, markedly discernible. The process of pigmentation had not yet commenced and the scales not yet made their appearance. The embryos were mostly ivory yellow in colour.

Yolk-sac placenta and umbilical cord.—The yolk-sac formed a spacious, thin-walled sac filled with thin, pale yellow yolk. Its walls were fairly vascular and the folds on its basal region had become firmly interlocked with crypts between the vascular villi of the trophonema, which constituted the maternal portion of the placenta. Folds of the shell-membrane intercepting the foetal and maternal tissues appeared in firm contact with the former.

The structure of the umbilical cord was essentially similar to that of the previous stage. The yolk-duct opened into the colon directly and there was no internal yolk-sac at this stage.

In embryos 205 mm. long, the branchial filaments were no longer present and a minute diverticulum-like internal yolk-sac was seen to have developed between the yolk-duct and the colon.

Advanced stage.—(Parent ♀: Total length 5'; App. wt. 80 lb.; February 5, 1942). Each uterus was divided into four compartments and contained four well-developed embryos enclosed in water-filled sacs of the shell-membrane. The compartments were disposed antero-posteriorly. As in the previous stage, the embryos were connected to the uterine wall through the medium of the yolk-sac placentae. Two of the embryos in one uterus lay in a prone position (mother lying on her back) while two supine. The placental cord in each prone-embryo was seen to twist round the middle of its trunk, and, extending backwards along its dorsal aspect joined the yolk-sac placenta in the posterior part of the compartment. No such twisting of the placental cord existed in the case of the supine embryo and the cord extended directly backwards to join the placenta. Of the four embryos in each uterus, two were males and two females.

Embryo (Text-fig. 1c).

Total length	375 mm.
Length of caudal fin	87 mm.
Length of placental cord	193 mm.
Width of the placental disc	43 mm.
Length of clasper ..	12 mm.

The embryos were completely formed externally and resembled the parent in every respect. The dorsal colouration appeared perfect, but the ventral surfaces of the embryos lacked the characteristic pinkish hue, a feature which develops, we believe, with free life. The embryos possessed placental cords and well-developed yolk-sac placentae.

Yolk-sac placenta and placental cord.—The yolk-sac no longer contained any yolk and had become modified to give rise to a full-fledged yolk-sac placenta of the 'discoid' variety. Its proximal wall was completely devoid of any folding, and extremely thin with a few blood-capillaries, while the distal wall appeared excessively plaited and frayed with the various folds and frills branching and rebranching so as to increase the surface of contact considerably. The result was a more or less compact, crimson-coloured, disc-like mass, roofed over by the proximal unfolded tissue and constituting the foetal placenta which, in the fresh condition, resembled greatly a crimson *Dahlia*. The innumerable crypts between the folds of this foetal placenta were firmly interlocked with the vascular villi on the ridged trophonema—the maternal component of the placenta. Folds of the shell-membrane intervening between the foetal and the maternal tissues, were in firmer contact with the former, having followed it through every fold and frill.

The placental cord consisted of the usual three structures, *viz.*, the artery, the vein and the yolk-duct, though the latter had more or less completely atrophied at this stage, with the absorption of the yolk. The cord was devoid of any appendicula.

Hemigaleus balfouri Day.

Intermediate stage.—(Parent ♀: Total length 32"; App. wt. 4 lb.; October 16, 1942.) This specimen had only the left ovary which contained small, pale, yolkless eggs, even smaller than peas. The right uterus was divided into three compartments and contained three embryos, while the left possessed only a single compartment and a single embryo. All the embryos lay with their heads towards the caudal end of the mother. They were connected to the uterine mucous membranes of their respective compartments through the medium of their yolk-sac placentae. Two of the embryos in the right uterus were female and one male, whereas that in the left was a female.

A peculiar feature in this specimen was that the shell-membranes covering the embryos were not entire, but broken up into small fragments which gave rise to pale yellow, shiny, opaque liquid bathing the embryos. It was thus apparent that the shell-membranes were undergoing degeneration, probably nutritive, and that in this respect the condition resembled that in *Scoliodon sorrakowah* (Setna & Sarangdhar, 1948).

Embryo (Text-fig. 1d).

Total length	135 mm.
Length of caudal fin	32 mm.
Length of placental cord	90 mm.
Yolk-sac placenta	12 × 17 mm.
Length of an appendiculum	5 mm.

The embryo was nearly completely formed and resembled the adult in most of the external morphological features. Unlike the adult its head region was still swollen and sharply depressed in front where it merged into the region of the snout. The embryonic spiracle was circular whereas in the adult it is oval in outline. Branchial filaments had been completely absorbed. The embryo was ivory-coloured, the general process of pigmentation not having yet commenced. The apices of both the dorsal fins were dark and slightly pigmented, whereas in the adult only the top of the second dorsal is blackened. The embryo had an umbilical cord and a yolk-sac placenta.

Yolk-sac placenta.—The yolk in the sac had almost been exhausted and the walls of the sac appeared greatly plaited and folded so as to form a highly wrinkled foetal placenta very much resembling a tuft of wool. Only a few small folds at the umbilical end of this wrinkled mass still contained some yolk. The placental folds were not lax but firm, with a definite tone. Dissection of the placenta revealed ramifications of the umbilical vessels on the internal surface of the folds. The crypts between these folds were firmly interdigitated with the vascular villi on the uterine mucous membrane, thus completing the placental arrangement.

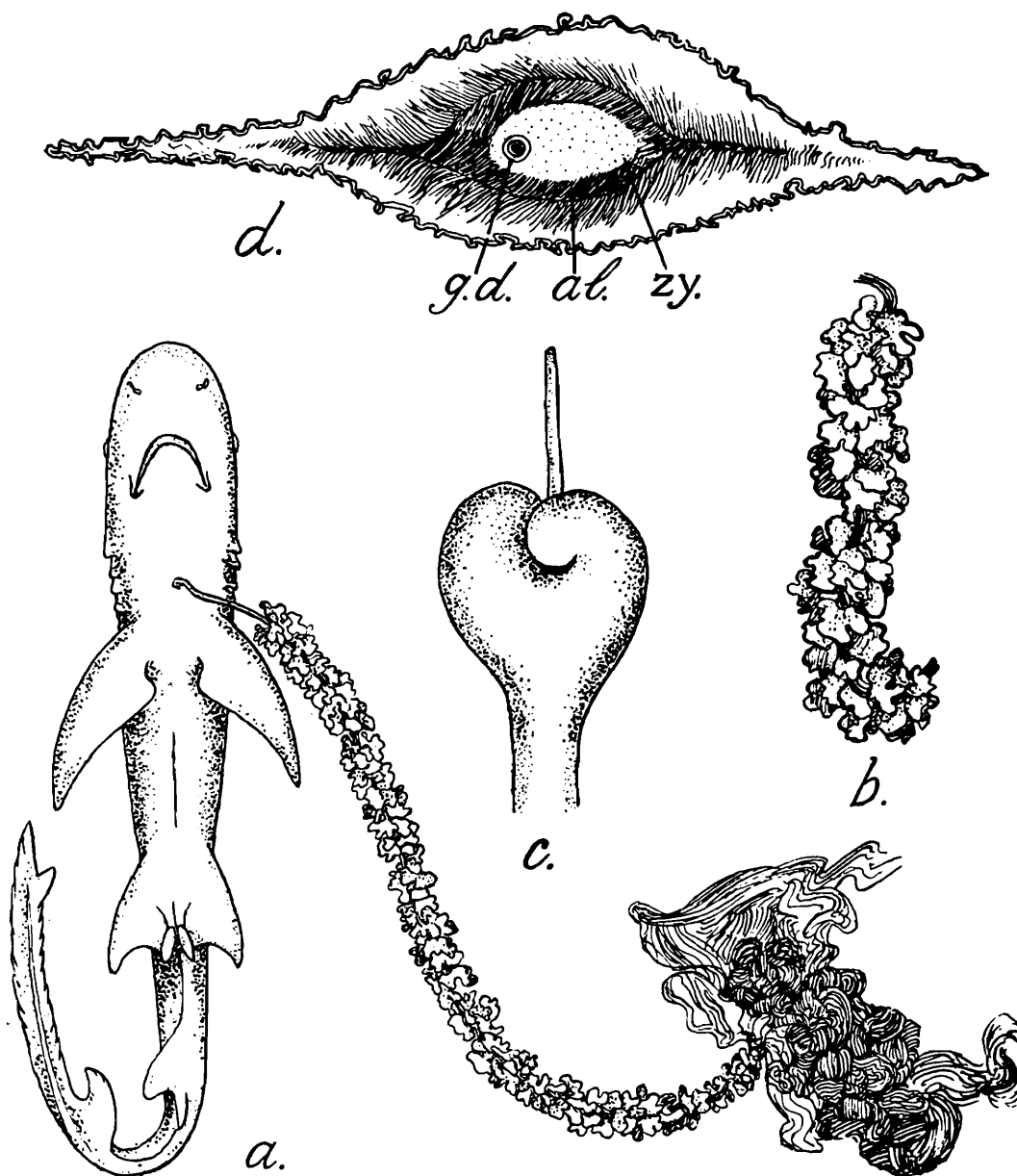
Umbilical cord.—The usual umbilical vessels and the yolk-duct were seen to be enclosed in a sheath of connective tissue which bears innumerable, short, thin, flat and delicate appendicula throughout its entire length giving the cord a very shaggy appearance. The appendicula possessed flat and rounded tips which were occasionally bifid or even trifid. Rarely an appendiculum branched into two terminally (Text-fig. 1f). An internal yolk-sac was not yet present in the embryo.

Advanced stage.—(Parent ♀: Total length 33"; App. wt. 4 lb.; November 24, 1942.) Each of the two uteri of this female contained two well-developed fetuses. Three of these were females and one male. The fetuses measured, on an average, 200 mm. in total length and were perfect replicas of the parent fish. There was no trace of yolk in their placentae and even the yolk-ducts had completely atrophied. The placentae were of the 'entire' variety (Text-fig. 1e).

Hemipristis elongatus (Klunzinger).

Advanced stage.—(Text-fig. 2a).—(Parent ♀: Total length 7' 3"; App. wt. 300 lb.; October 19, 1943.) In this specimen only the right ovary was present as a large, flattened organ studded with small, pale green ova about the size of peas, none containing yellow yolk. The epigonal organ was an elongated, greyish pink band, merged anteriorly into the substance of the ovary. The nidamental glands were large and

situated nearer the upper poles of the uteri. Each measured 40×32 mm. and consisted of two coiled horns, one superposed over the other (Text-fig. 2c). The uteri were long, bag-like structures with thin, spongy, vascular walls. The right was divided into four longitudinal compartments and contained four well-grown embryos, while the left had three



TEXT-FIG. 2.—Embryonic stages of Bombay sharks.

- a. *Hemipristis elongatus* (Klunzinger), foetus in advanced stages of development with placental cord and placenta of the 'entire' variety. b. *H. elongatus*, magnified view of a portion of placental cord showing the peculiarly plaited and frilled appendicula. c. *H. elongatus*, magnified view of nidamental gland. d. *Myrtillo mustelus* (Linnaeus), fertilized egg enclosed in shell membrane sac.
ab. albumen surrounding the zygote; g.d., germinal disc; zy, zygote.

compartments, two with embryos, and the third being an undeveloped compartment containing an unfertilized egg enclosed in a spindle-shaped shell-membrane sac. The embryos were enclosed in shell membrane sacs containing a dirty yellow, opaque liquid, in which were distributed what looked like small bits of coagulated yolk-like matter. Probably this may be a nutritive fluid formed as a result of the mixing up

of the albuminous liquid secreted by the nidamental gland and the secretion of the glandular uterine mucosa, absorbed by the prominent appendicula on the placental cords of the embryos. The latter did not, however, lie freely in the compartments but were attached to the uterine wall through the medium of their well-developed yolk-sac placentae. Three out of the four embryos in the right uterus were males and one female, whereas in the left one was male and one female.

Embryo.

Total length	.	..			387 mm.
Length of caudal fin		..	.	..	115 mm.
Length of umbilical cord		..	..		300 mm.
Yolk-sac placenta		..	..	..	90 × 62 mm.
Appendiculum	.	.	.	..	12 × 10 mm.

The embryo was nearly completely developed at this stage, but differed from the adult form in some important respects. Faint brown pigmentation was apparent, though still very sparse. The length of the preoral snout was slightly greater than the width of the mouth. The teeth were not yet visible externally. The most singular feature in the embryo was, however, its possession of a very prominent and peculiarly appendiculated placental cord and a very well-developed yolk-sac placenta.

Yolk-sac placenta.—The foetal placenta was formed by the original yolk-sac which had now become completely devoid of any yolk. Its walls were excessively folded over its entire surface so as to give rise to a mass of highly wrinkled, crimson-coloured vascular frills and folds, lined very intimately by folds of the shell-membrane. This placenta was very firmly interdigitated with the vascular villi on the maternal trophonema, the villous ridges of which are arranged in more or less circular rows, so that the entire maternal placenta presented a flower-like appearance. A certain amount of force was necessary to pull apart the foetal from the maternal tissues and in this attempt, the foetal tissue withdraws along with it the shell-membrane folds that rub in intimate contact with it. The foetal placenta is of the 'entire' placental variety.

Placental cord and appendicula (Text-fig. 2*b*).—The appendicula were of a unique type, consisting of highly vascular, semi-transparent and sinuously-contoured, broad frills or flaps. These extended in dense clusters almost throughout the entire length of the cord, imparting to it an uncommon anatomical feature, rarely met with in other Elasmobranchs. These appendicula represented undoubtedly a stage of development more pronounced than that of the appendicula in *Scoliodon acutus*, in which the appendicular frills were not so prominently developed. The two types of appendicula appear, however, to be of the same morphological variety and hence comparable. The well-developed appendicula in the present case were, apparently, capable of absorbing the composite nutritive liquid in the shell-membrane sacs.

The placental vessels in the cord had their usual connections within the embryonic body and the atrophied yolk-duct was not seen to be related to an internal yolk-sac.

Myrmillo mustelus (Linnaeus).

Fertilized eggs (Text-fig. 2d).—(parent ♀: Total length 32"; App. wt. 4 lb.; November 2, 1942.) In this specimen only the left ovary was present as a small flattened organ beset with small, pale ova, only a few being as large as peas. The ova were rather flattened and had yellow yolk. The characteristic epigonal organ was merged anteriorly into the substance of the ovary. Each nidamental gland consisted of two coiled horns. The cavity of each of the two uteri was divided into three oblique compartments but these were not yet shut off from one another as the intervening partitions had not yet been completely formed. Each compartment contained a *zygote* enclosed in a spindle-shaped sac of the shell-membrane similar to that described by Sarangdhar (1943) for *Galeocerdo tigrinus*. The zygote was an oval mass of scarlet-yellow yolk having at one of its poles a round dark, opaque speck surrounded by a light halo—the germ disc. The germinal disc was the biggest in the zygote nearest to the cloacal end of the uterus.

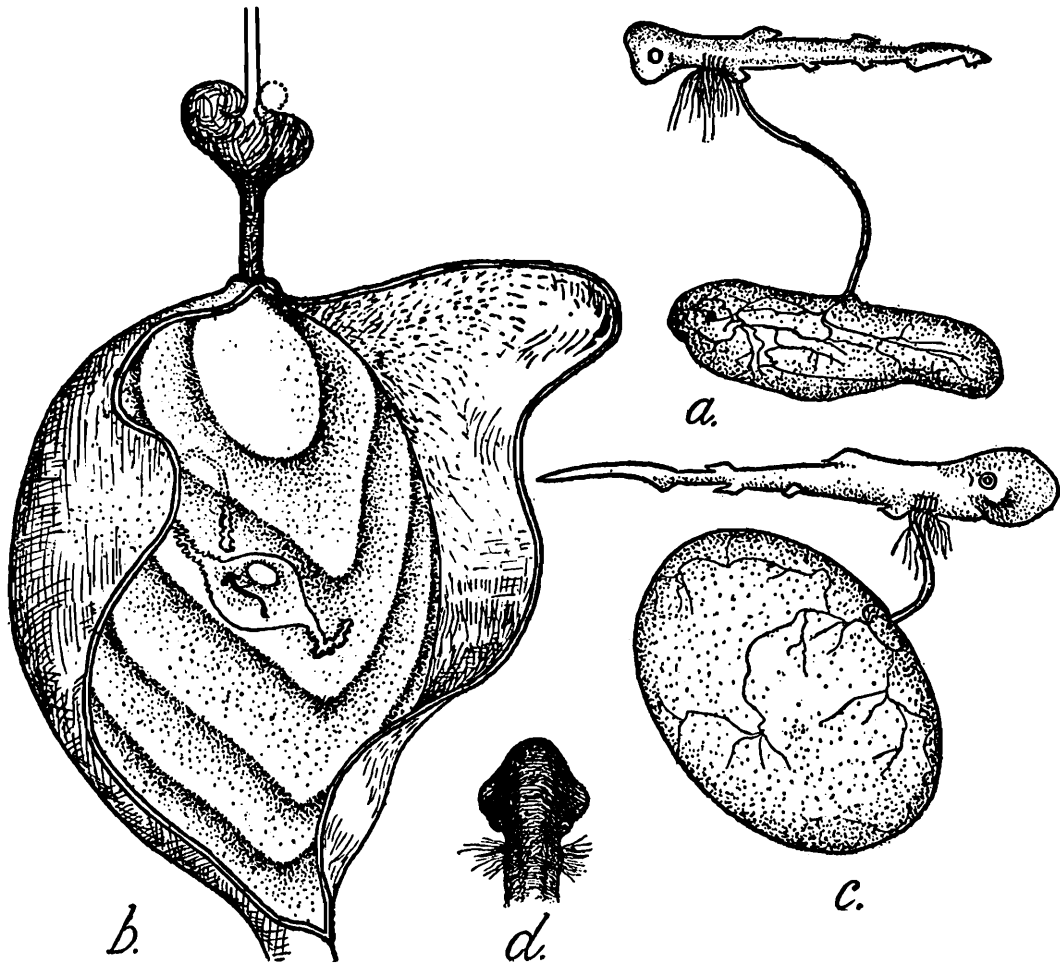
38 mm.—stage.—(Parent ♀: Total length-32"; App. wt. 4 lb.; December 20, 1943). The reproductive organs of this female were quite similar to those described in the previous stage. The uterine compartments were, however, complete at this stage, the right uterus having five compartments but only four embryos and an empty shell-membrane sac, and the left, five compartments and five embryos. The embryos, together with their yolk-sacs and umbilical cords were enclosed in shelly sacs containing thin films of gelatinous albumen which had not yet been liquified. As none of the embryos displayed clasper buds, it is possible that either all the embryos were female or that the sexes had not yet been differentiated externally.

Embryo (Text-fig.3a).

Total length	..	..	..	38 mm.
Length of caudal fin			..	7 mm.
Yolk-sac	..	..	..	47 × 18 mm.
Length of umbilical cord			.	40 mm.
Maximum length of branchial filament				3 mm.

The embryo was cream-coloured suffused with crimson in the region of high vascular activity and the process of pigmentation had not yet commenced. The head region was rounded and swollen and merged almost vertically downwards into a soft broadly-rounded snout. Very minute slit-like nostrils were distinguishable on the ventral surface of the snout. The mouth formed a fairly large pit hardly bounded by jaws but the characteristic prominent labial folds were discernible at the angles of the mouth. The eyes were rounded and prominent with bulging lenses, pigment stripes being noticeable in front of and behind each lens. Small, nearly vertical spiracular slits devoid of filaments were present behind the orbits. Bunches of short vascular, branchial filaments emerged through the gill-slits, which region was rather more inflated than the rest of the body. All the fins had developed in their respective adult positions, but they were more semicircular flaps without the characteristic adult shapes and fin rays.

Yolk-sac and umbilical cord.—The yolk-sac was horizontally ovoid in shape and filled with scarlet-coloured yolk. The blood capillaries interspersed in its walls gave rise to the umbilical vessels, which, together with the yolk duct passed up into the umbilical cord through a gelatinous disc. The umbilical cord was devoid of any appendicula.



TEXT-FIG. 3.—Embryonic stages of Bombay sharks.

- a. *Myrmillo mustelus* (Linnaeus), embryo in early stages of development (38 mm.—stage). b. *Sphyrna blochii* (Cuvier), gravid uterus in early stages of pregnancy opened to show the V-shaped disposition of the compartments. One of the compartments with an embryo enclosed in shell-membrane sac. c. *S. blochii*, Profile of 43 mm.—stage embryo. Note the rudimentary lateral expansion in front of the eye. d. *S. blochii*, dorsal aspect of head of a 43 mm. embryo showing rudimentary lateral expansions and the orbits just behind them.

Sphyrna blochii (Cuvier).

43 mm.—stage.—(Parent ♀: Total length 4'-4"; App. wt. 25 lb.; September 28, 1942.) Only the right ovary was present which was studded with pale ova not bigger than peas. Two or three eggs were about 8 mm. in diameter and contained pale yellow yolk. The cavity of each of the uteri was divided into five compartments, each roughly V-shaped. The greater arm of the V, representing the major portion of the compartment (Text-fig. 3 b), occupied an obliquely transverse position, while the smaller inclined upwards at an angle, lay in a more or less vertical narrow corner of the compartment. In each uterus only three compartments contained embryos while the other two contained

unfertilised eggs. The embryos, together with their appended structures, lay enclosed in shell-membrane sacs, the ends of the membranes being folded into compact tufts. The tufts near the cranial end were invariably more folded than at the caudal extremity. The sacs containing the embryos contained a small quantity of watery albuminous liquid similar to that in other Elasmobranchs. The unfertilised eggs, too, were enclosed in spindle-shaped sacs of shell-membranes. The mucous membrane of each compartment was highly vascular, almost crimson in colour, but did not at this stage, show any modification into trophone-matous ridging.

Embryo (Text-figs. 3*b* and *c*.)

Total length		43 mm.
Length of caudal fin		12 mm.
Length of umbilical cord	..	25 mm.
Yolk-sac	62	× 75 mm.
Length of branchial filament	.	3 mm.

The embryo was nearly completely formed externally but the head region had not yet assumed the characteristic hammer-shaped form (*Sphyrnidae*). Rudiments of the 'hammer' had, however, been formed as very small lateral projections on the lateral borders of the head, immediately in front of the eyes. Due to their presence, the head presented in the dorsal aspect, a rounded outline terminally, with two slight lateral bulges in the ocular region (Text-fig. 3*d*). The head region was soft and swollen, as were also the lateral expansions. Chondrification had not set in at this stage. Each lateral rudiment bore on its ventral aspect a slit-like nostril. The eyes were fully formed and situated immediately behind the lateral rudiments, though on a slightly more dorsal aspect. Their position was exactly similar to that in the corresponding stages of other sharks (*Carcharhinidae*) and did not give any indication that they would subsequently move away from the head and migrate to the tips of the 'hammer' in the fully-formed condition. V-shaped, oblique spiracular slits were discernible immediately behind the orbits. They were however, devoid of any spiracular filaments. The gill-slits had bunches of branchial filaments protruding from them. All the fins had appeared in their respective adult positions but were in a rudimentary state of development, the delicate fin rays not being quite enclosed by the fin-membranes. Also, the caudal fin was not at this stage, quite one-third the total length as in the adult condition. The V-shaped myotomes were visible through the semi-transparent skin. In the caudal region they had not yet assumed the V-shaped character but were in the form of vertical muscle plates only.

Yolk-sac and umbilical cord.—The yolk-sac was a thin-walled oval sac containing thin cream-coloured yolk. Its walls were interspersed with a network of prominent capillaries which joined to form the umbilical vessels. At its upper pole was a transparent gelatinous oval disc through which the umbilical vessels and the yolk-duct passed into the umbilical cord. The umbilical sheath was quite plain and smooth and the characteristic locular appendicula described by Alcock (1890) had not yet made their appearance. Squarish markings on the sheath, in all probability, forerunners of the appendicula, could, however, be distinguished at this stage.

Mobula diabolus (Shaw).

Parturition stage.—Several gravid females measuring 3'-9" to 4' across the disc were landed throughout May, 1943. Their examination revealed the following interesting reproductive features :—

Only the left ovary, left oviduct and the left uterus were developed, these structures being altogether absent on the right side. During pregnancy the uterine mucous membrane was beset uniformly over its entire surface with crowded, thin short, flattened but highly vascular villi—the trophonemata—which secrete a thin yellowish nutritive liquid with which the embryo is bathed. A single embryo was borne at a time and at full term was seen to lie in a supine position (mother lying on her back) with its 'wings' folded backwards and its cephalic horns directed medially so as to meet in the middle line. At term its dimensions are :—

Width across disc	400 mm.
Length of disc	200 mm.
Length of tail	175 mm.
Approximate weight	3 lb.

The foetus was light purple in colour dorsally and white ventrally. It was a perfect replica of its parent. Even the yolk-stalk and sac were completely absorbed at this stage so that even the umbilical scar was no longer visible. There was no caudal spine in the tail but a darkish thickened marking behind the dorsal fin indicated its position of suppression. The foetus was completely formed and ready to be born.

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A NOTE ON THE FISHES FROM THE HELMUND RIVER IN AFGHANISTAN, WITH THE DESCRIPTION OF A NEW LOACH.

By M. A. VIJAYALAKSHMANAN, B.Sc., Assistant, Zoological Survey of India, Calcutta.

The Zoological Survey of India is much indebted to Prof. S. Ali Akhtar of the Faculty of Medicine, Kabul, for the very valuable and interesting collection of fishes from Afghanistan which he kindly presented to the Survey along with his ecological notes. The scientific importance and significance of the collection lie not only in the funistic peculiarities but also in the elucidation of zoo-geographical features and affinities of the area.

The physical features and historical sketch of parts of Afghanistan have been described by McClelland¹, Annandale², and Hora³. For the sake of convenience the former workers on the fauna of Afghanistan divided the country into three systems based on the course of the three main rivers viz., the Oxus in the North, Helmund in the South and Kabul river dividing the former two water-sheds. It is noteworthy, however, that each of these systems has its own indigenous fish fauna, except for a few forms which have a wider range of distribution.

A study of the present collection of fishes from the Helmund river reveals the presence of 4 species viz., *Oreinus sinuatus* var. *griffithii* McClelland, *Schizothorax labiatus* (McClelland), *Schizopygopsis stoliczkae* Steindachner and a new species of *Nemachilus*.

***Oreinus sinuatus* var. *griffithii* McClelland.**

- 1842. *Oreinus griffithii*, McClelland, *Calcutta J. Nat. Hist.* II, p. 581.
- 1842. *Oreinus maculatus*, McClelland, *ibid.*, p. 580.
- 1868. *Oreinus griffithii*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 160.
- 1868. *Oreinus sinuatus*, Günther, (in part) *ibid.*, p. 161.
- 1889. *Oreinus sinuatus*, Day, *Faun. Brit. India*, Fish. I, p. 248.
- 1933. *Oreinus sinuatus* var. *griffithii*, Hora, *J. Bombay Nat. Hist. Soc.* XXXVI, p. 700.
- 1934. *Oreinus sinuatus* var. *griffithii*, Hora, *ibid.*, XXXVII, p. 794.
- 1934. *Oreinus sinuatus* var. *griffithii*, Hora, *Rec. Ind. Mus.* XXXVI, p. 300.
- 1936. *Oreinus sinuatus*, Mukherji, *Mem. Conn. Acad.* X, Art. xviii, p. 347.

In the collection this species is represented by 80 specimens ranging in length from 12.4 to 23.5 cms. Eventhough the specimens show individual variations, the diaganostic features of most of them are quite the same as described by Hora⁴. A few specimens, however, differ from the typical forms and they seem to be hybrids between *Oreinus sinuatus* var. *griffithii* and *Schizothorax labiatus*, as already pointed out by Hora⁵

¹McClelland, J., *Calcutta J. Nat. Hist.* II, pp. 560—573 (1842).

²Annandale, N., *Rec. Ind. Mus.* XVIII, pp. 3—16 (1919).

³Hora, S. L., *J. Bombay Nat. Hist. Soc.* XXXVI, pp. 688—691 (1933).

⁴Hora, S. L., *Rec. Ind. Mus.* XXXVI, p. 303 (1934).

⁵Hora, S. L. *ibid.*, p. 307 (1934).

and Mukerji¹. The character gradients of these forms are enumerated in the following table :—

	<i>Schizothorax labiatus</i>	<i>Oreinus sinuatus</i> var. <i>griffithii</i>	Intermediate forms
Shape of head.	Long and pointed.	Short, broad and broadly pointed.	Various gradations from the former to the latter.
Shape of mouth opening.	Horse-shoe shaped.	Transverse and more or less straight.	In most cases arched but not so much as in <i>Schizothorax</i> mouth. Gradations from the former to the latter can be easily made out.
Posterior lip.	Smooth, trilobate, round and broad.	Posterior half conspicuously papillated from end to end, transverse and straight.	Gradations occur from distinguishably papillated to sparsely papillated only in the middle of the lower lip. The posterior margin of the lower lip also varies in shape from straight to curved.

Any way, in these specimens, the *Oreinus* characters are more predominant than the *Schizothorax* features.

This species was originally described by Hora² from the Chitral river in the Oxus river system and later from the Kabul river and its tributary streams. But this is the first time that *Oreinus sinuatus* var. *griffithii* is being recorded from the Helmund river system.

Locality.—Farakhollum, about 10 miles South of Gardan Diwar.

Schizothorax labiatus (McClelland).

1842. *Racoma labiatus*, McClelland, *Calcutta J. Nat. Hist.* II, p. 578.
 1842. *Schizothorax ritchieana*, McClelland, *ibid.*, p. 580.
 1868. *Racoma labiatus* Günther, *Cat. Fish. Brit. Mus.* VII, p. 162.
 1877. *Schizothorax ritchianus*, Day, *Fish. India*, p. 531 (Foot Note).
 1877. *Schizothorax labiatus*, Day, *ibid.*, p. 532 (Foot Note).
 1934. *Schizothorax labiatus*, Hora, *Rec. Ind. Mus.* XXXVI, p. 292.
 1936. *Schizothorax labiatus*, Mukerji, *Mem. Conn. Acad.* X, Art. xviii, p. 333.

In the collection under report, there is only a single specimen of this species measuring 18.6 cm. in total length. The specific characters of this species are well marked in this single specimen. So there is no doubt about its identity.

In the specimen the lower lip is slightly striated which, however, is only a gradation from the soft to the highly papillated variation already noted by Hora *op.cit.* in this species.

Locality.—Farakhollum, about 10 miles South of Gardan Diwar.

Schizopygopsis stoliczkae Steindachner.

1866. *Schizopygopsis stoliczkae*, Steindachner, *Verh. Zool-Bot. Ges. Wien* XVI, p. 786, pl. xvi, fig. 2.
 1868. *Schizopygopsis stoliczkae*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 170.
 1876. *Schizopygopsis stoliczkae*, Day, *Proc. Zool Soc. London*, p. 791.
 1878. *Schizopygopsis stoliczkae*, Day, *Fish. India*, p. 531, pl. cxxiv.
 1889. *Schizopygopsis stoliczkae*, Day, *Faun. Brit. India*, Fish. I, p. 251, fig. 89.
 1911. *Schizopygopsis stoliczkae*, Stewart, (in part), *Rec. Ind. Mus.* VI, p. 73, pl. iii, figs. 1—3.
 1916. *Schizopygopsis stoliczkae*, Berg, *Poiss. des Eaux Douces de Russie*, p. 290.
 1920. *Schizopygopsis stoliczkae*, Annandale & Hora, *Rec. Ind. Mus.* XVIII, p. 173, fig. 7.
 1935. *Schizopygopsis stoliczkae*, Hora & Mukerji, in *Visser's Karakorum*. I, p. 434, pl. iii, figs. 1—4.
 1936. *Schizopygopsis stoliczkae*, Mukerji, *Mem. Conn. Acad.* X, Art. xviii, p. 351.

¹Mukerji, D. D., *Mem. Conn. Acad.* X, Art. xviii, p. 350 (1936).

²Hora, S. L., *Rec. Ind. Mus.* XXXVI, p. 306 (1934).

The two specimens available in this collection are very small and measure 41.0 and 42.5 mm. without the caudal fin. Since these two specimens are not in a good state of preservation, many of its morphological characters could not be studied in detail.

Annandale and Hora *op.cit.*, who had recorded the species from Seistan, made the following interesting remark in their description of the species—

“The two types of head referred to by Stewart (*op. cit.*) as the *stoliczkae* and the *severzovi* 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.”

And so they concluded that :

“We do not, therefore, consider it advisable to give the Seistan fish a racial name”.

An examination of the two specimens in the present collection shows that the characters of the two species mentioned by Stewart *op.cit.*, are not of any racial value.

Again, a comparative study of the anterior part of the two specimens with the description and figures by Hora and Mukerji *op.cit.* shows, that these two have more resemblance to typical *stoliczkae* rather than to the Seistan forms.

This probably supports Stewart's (*op. cit.*) view that :

“It is not justifiable to separate *Schizopygopsis severzovi* from *S. stoliczkae* as a distinct species, since they can only be distinguished by one character and a complete series of gradations occur from the one extreme type of head to the other. The fish from any single narrow locality appear to incline to one type or the other.”

Locality.—Water channel 8 miles East of Labi Baring, Seistan.

Thus the variation in the shape and form of head of this species correlated with the variation of the same parts noted in the new species of loach (*vide infra*) received from the Helmund river, probably throws some light on the effect of climate and environmental conditions on the fauna of the particular region.

***Nemachilus akhtari*, sp. nov.**

D. 2/7 ; A. 1/6 ; P. 1/10 ; V. 2/7 ; C. 16+.

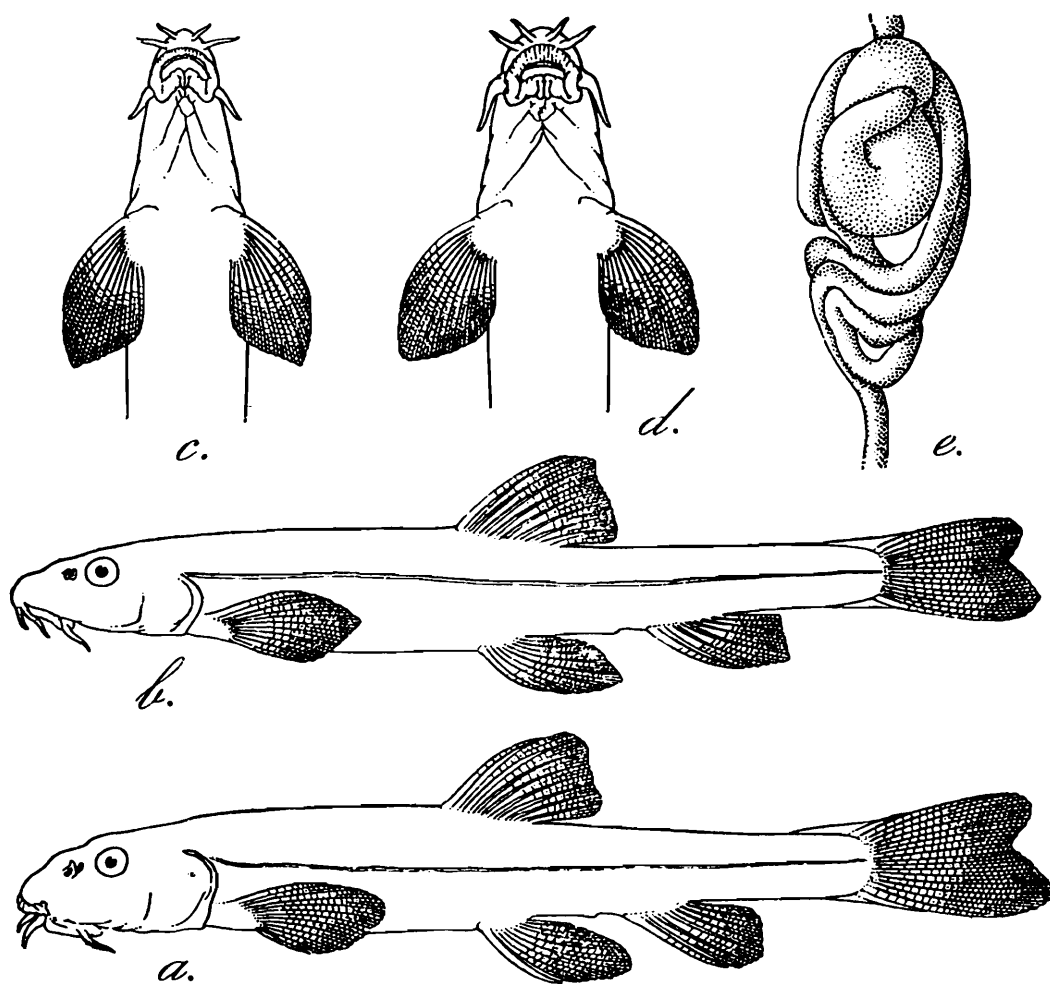
Various authors have recorded a number of species and varieties of *Nemachilus* from the Helmund river basin. But in the present collection there is a species of *Nemachilus* which shows characters that, to my knowledge, have not been described so far in any one of them. I propose to recognize it as a new species and describe it as *Nemachilus akhtari*.

Nemachilus akhtari is a long and slender fish in which the head and anterior part of the body are depressed, while the tail region, though compressed, is not whip-like. The dorsal profile is slightly arched and the ventral profile is almost horizontal throughout, except in gravid females in which the abdominal region is somewhat convex. The present

collection contains specimens in which the head is broadly pointed and others in which the head tapers rather evenly (Text-fig. 1. *c* & *d*). These differences in the shape of the head are not correlated with differences in sex.

The length of the head is contained from 5.3-5.6 times in the total length and from 4.4-5.0 times in the length without the caudal. The width of the head is contained from 1.3-1.6 times and its height at occiput from 1.8-2.1 times in its length.

In most of the specimens, the eye is situated slightly towards the tip of snout and in a few in the middle of the head. The diameter of the eye is contained from 5.0-6.3 times in the length of the head, from 2.0-2.7 times in the length of snout and from 1.2-1.7 times in the inter-orbital width. The eyes are not visible from the ventral surface.



TEXT-FIG. 1.—*Nemachilus akhtari*, sp. nov. *a* & *b*. Lateral views showing the difference in the shape of the head : $\times 1\frac{1}{2}$. *c* & *d*. Ventral views of *b* & *a* showing the mouth parts : $\times 1\frac{1}{2}$. *e*. Alimentary canal : $\times 2$.

The mouth is inferior, crescentic and situated slightly behind the tip of snout. The posterior lip is reflected backwards so that a fairly large portion of the jaw is left uncovered. The lips are thick, continuous at the angles of the mouth, and greatly striated. The post-labial groove is very narrow and, on either side of the groove, the ridges are prominently enlarged and elongated and extend backwards as two separate ridges. This is very characteristic of the species. The maxillary and outer rostral pairs of barbels are of the same length and are longer than the diameter of the eye. The inner rostral barbels are short and stumpy.

The greatest height of the body below the dorsal fin is contained from 8.6-9.8 times in the total length and from 7.0-8.3 times in the length without the caudal. The body is scaleless and smooth. The lateral line is complete. The caudal peduncle is long and narrow ; its least height is contained from 2.4-2.9 times in its length.

The dorsal fin commences midway between the tip of the snout and the base of the caudal and is inserted slightly in advance of the pelvics. The height of the dorsal fin is almost equal or slightly higher than the depth of the body just below it. Its anterior margin is rounded near the tip and the free posterior border is almost straight or slightly concave. The paired fins are horizontally placed ; they are broad and more or less triangular in shape. The pectoral fin is shorter than the head and extends half the way to the pelvic. In all the specimens the pelvic fin extends beyond the anal opening. In many cases the pelvics do not reach, while in some specimens they just touch the anal fin. In a few cases, however, the pelvics extend beyond the commencement of the anal fin. The anal fin resembles the dorsal fin in form and is separated from the caudal by a distance greater than its own length. Anal fin has a broad base. The caudal fin is almost as long as or slightly shorter than the head. It is slightly emarginate, the lower lobe being better developed and longer than the upper.

Nemachilus akhtari shows sexual dimorphism. The differences noted are similar to the secondary sexual characters described by Hora for *N. tibetanus*¹, *N. choprai*², and *N. kashmirensis*³. But they are not so well marked. Sex cannot be differentiated by the difference in the shape of head or the length of pelvic fin.

The present collection of specimens is several years old and hence the original colouration has faded away in spirit. It is, however, noted that the colouration slightly varies with size and age of the specimen. In all the specimens, the dorsal surface and the sides of the body are darker and towards the ventral surface, pale yellow in colour. On the dorsal surface, there are numerous black bands, which in the caudal region, are five in number. The dorsal and caudal fins are spotted with black while the paired and the anal fins are pale yellow.

Bionomics.—The greatly reduced air bladder enclosed in a bony capsule, the flattened ventral surface, the horizontally placed paired fins, and the well developed lower lobe of caudal fin of *Nemachilus akhtari* indicate the bottom-dwelling nature of the fish. Besides, the unusually developed lips and the highly convoluted alimentary canal⁴ with the intestines full of sand and gravel show the ground and herbivorous habit of life. Rarely, the coils of the alimentary canal exhibit still further complications and coils.

Locality.—Farakhollum, about 10 miles South of Gardan Diwar, Helmund river.

¹ Hora, S. L. *Rec. Ind. Mus.* XXIV, p. 81 (1922).

² Hora, S. L., *ibid.*, XXXVI, p. 313 (1934).

³ Hora, S. L., *ibid.*, XXXVI, p. 318 (1934).

⁴ In the convolutions and the position in which the coils of the alimentary canal lie this species shows some resemblance to *Nemachilus dorsonatus* Kessl., described and figured by Herzenstein in "*Wiss Res. Prezewalski Central As. Reis. Zool.*" III(2), Tab. viii figs. 14—18, (1888).

Measurements in millimeters.

				♂	♀	♂	♂	♀	♀
Total length including caudal	..			118.0	112.0	112.0	108.0	104.0	100.0
Length without caudal	..	..	..	99.0	92.5	92.0	91.5	84.0	84.0
Length of head	..	..	..	22.0	21.0	20.0	18.0	19.0	18.0
Width of head	..	..	..	13.5	14.0	13.0	12.0	13.0	13.0
Height of head	..	..	..	10.5	10.0	10.0	10.0	10.0	9.5
Depth of body	..	..	..	13.0	13.0	12.0	11.0	12.0	11.0
Length of snout	..	..	..	9.5	9.0	8.0	8.0	9.0	7.0
Diameter of eye	..	..	..	3.5	4.0	4.0	3.0	3.5	3.0
Interorbital width	..	..	..	6.0	5.0	5.0	5.0	5.0	4.5
Length of caudal peduncle	..	..	..	22.0	20.0	19.0	20.0	18.0	17.0
Least height of caudal peduncle	..	..	..	7.5	7.0	7.0	7.0	6.5	7.0
Longest ray of dorsal	..	..	..	14.0	14.0	14.0	13.5	14.0	12.0
Longest ray of anal	..	..	..	13.0	13.0	13.5	12.5	13.0	12.0
Length of pectoral	..	..	..	17.0	16.0	16.5	15.0	15.0	15.0
Length of ventral	..	..	..	14.0	14.0	15.0	14.0	14.0	12.0

A study of the specimens in the above collection shows that the Helmund species is allied to *Nemachilus stoliczkae*; *N. farwelli*; *N. griffithii* var. *afghana* and *N. stenurus*, but differ from them in many important characters.

The following table shows the important differences between these related species :—

Character.	<i>N. stolizkae</i> ¹	<i>N. farwelli</i> ²	<i>N. griffithii</i> var. <i>afghana</i> ³	<i>N. stenurus</i> ⁴	<i>N. akhleri</i>
Commencement of dorsal fin.	Conspicuously towards base of caudal.	Nearer tip of snout than base of caudal.	Almost equidistant between tip of snout and base of caudal. (may be slightly nearer caudal).	Nearer to the tip of snout by a distance equal to the length of snout.	Equidistant between tip of snout and base of caudal.
Labial fold.	Thick continuous and papillated post-labial groove interrupted in the middle by a slight ridge.	Well developed fleshy and continuous; lower lip narrowly interrupted in the middle.	Fleshy and continuous at the angles; lower lip is interrupted in the middle.	The lips membraneous feebly wrinkled without any post-labial groove.	Thick continuous and greatly striated; post-labial groove very narrow and on either side of the groove the ridges are prominently enlarged and elongated and extends backwards.
Caudal fin.	Slightly emarginate, lower lobe being longer than the upper.	Slightly emarginate.	Obliquely truncate, the upper lobe slightly longer than lower.	Posterior margin deeply notched, both the lobes are equally long or the upper exceeds slightly the lower.	Slightly emarginate, lower lobe being better developed and longer than upper.
Caudal peduncle-Proportion of least height to length.	3.1—3.6 times.	4 times.	2.0—2.2 times.	7.85—9.2 times.	2.4—2.9 times.
Well marked groove between anus and anal fin.	Absent.	Characteristic.	Absent.	X	Absent.
Proportion of length of head to standard length of body.	4.2—4.8 times.	5.1 times.	4.1—4.2 times.	4.9—5.5 times.	4.4—5.0 times.
Length of alimentary canal to length of fish.	Slightly greater than the length of fish.	X	X	X	Almost 1½ times longer than the length of fish. (Al. canal=165 mm. Total length=117.5 mm.)
Distribution.	Helmund river.	Helmund river.	Helmund river.	Helmund river.	Helmund river.

¹Hora, S. L., *Mem. Conn. Acad.* X, Art. xvii, pp. 306—308 (1936).

²Hora, S. L., *J. Bombay Nat. Hist. Soc.* XXXVII, No. 4, p. 799 (1935).

³Hora, S. L., *ibid.*, XXXVI, No. 3, p. 697 (1933).

⁴Herzenstein, S., *Wiss. Res. Prezewalski Central As. Reis. Zool.* III (2), p. 64, Tab. I, fig. I. (1888).

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I am much indebted to Dr. S. L. Hora, Director, Zoological Survey of India, for affording me the necessary facilities for doing this work and for his benevolent guidance and constant encouragement. My thanks are also due to Dr. Raghun Prasad, Assistant Research Officer, Central Inland Fisheries Research Station, Calcutta, for translating a relevant piece of German literature and to Sri A. K. Mondul, Artist, for making the necessary drawings.

NOTES ON FISHES IN THE INDIAN MUSEUM.

XLII. ON A NEW LOACH FROM POONA.

By A. G. K. MENON, M.A., *Research Scholar, Zoological Survey of India, Calcutta.*

The fish fauna of Poona has received considerable attention in recent years¹ and the systematics of most of the forms described by Sykes² have now been straightened out. It would seem surprising, therefore, that in a small collection made by the writer at Poona in November 1948 in the Moola-mootha river, eight specimens of a characteristic loach were found which, though in general facies, resemble Annandale's *Nemachilus anguilla*³, described from the adjoining district of Satara, differ specifically from it in colouration and several other diagnostic features. I propose to describe it here as a new species and to designate it as *Nemachilus poonaensis*. Including the new loach, the collection contains the following species :—

Family CYPRINIDAE

Subfamily ABRAMIDINAE

1. *Chela phulo* Ham.

Subfamily Rasborinae

2. *Danio aequipinnatus* (McClell.)

Subfamily : CYPRININAE

3. *Barbus (Puntius) kolus* Sykes

4. *Barbus (Puntius) ticto* Ham.

5. *Barbus (Tor) khudree* Sykes

6. *Cirrhina fulungee* (Sykes)

7. *Garra mullya* (Sykes)

8. *Labeo calbasu* (Ham.)

9. *Rohtee virgosii* Sykes

Family COBITIDAE

10. *Nemachilus botia* var. *au reus* Day

11. *Nemachilus denisonii* Day

12. *Nemachilus poonaensis*, sp. nov.

Family BAGRIDAE

13. *Mystus cavasius* (Ham.)

Family XENENTODONTIDAE

14. *Xenentodon cancila* (Ham.)

Family AMBASSIDAE

15. *Ambassis ranga* (Ham.)

Family GOBIIDAE

16. *Glossogobius giuris* (Ham.)

Family MASTACEMBELIDAE

17. *Mastacembelus armatus* (Lacép.)

¹Fraser, A. G. L., *J. Bombay Nat. Hist. Soc.* XLIII, pp. 452-454 (1942); Hora, S. L. and Misra, K. S., *ibid.*, XLIII, pp. 218-225 (1942); Suter, M., *ibid.*, XLIII, pp. 663-664 (1942).

²Sykes, W. H., *Proc. Zool. Soc. London* VI, pp. 157-168 (1838); Sykes, W. H., *Trans. Zool. Soc. London* II, pp. 349-378 (1841).

³Annandale, N., *Rec. Ind. Mus.* XVI, pp. 127, 128 (1919).

Nemachilus poonaensis, sp. nov.

D.12 (4/8); P.11 (1/10); V.7 (2/5); C.19.

In this loach the body is much elongated; the dorsal profile rises very little from the tip of the snout to the base of the dorsal fin beyond which it is almost straight. The ventral surface is flattened, and its profile is almost horizontal. The head is conical and the snout very bluntly pointed. The length of the head is contained from 4.5 to 4.75 times, the depth of the body near the origin of the dorsal fin from 7.3 to 8.3 times, and the length of the caudal peduncle from 3.7 to 4.0 times, in the standard length. The eyes are dorso-lateral in position and are not visible from the ventral surface; they are situated nearer to the tip of the snout than to the hinder end of the operculum. The diameter of the eye is contained from 3.0 to 3.5 times in the length of the head and from 1.0 to 1.25 times in the length of the snout. The inter-orbital width is equal to the diameter of the eye. The nostrils are situated considerably nearer to the eye than to the tip of the snout. There are three pairs of short, thread-like barbels; the rostral barbel is shorter than the maxillary; the barbels of the inner maxillary pair extend backwards as far as the nostrils, while the barbels of the outer pair reach the anterior fourth of the eye. The lips are swollen and corrugated with two short digitiform processes in the middle of the upper lip, and the lower lip is interrupted in the middle line.

The origin of the dorsal fin is nearer to the tip of the snout than to the base of the caudal; it is very much higher than the depth of the body below it, and its upper margin is nearly straight. The pelvics commence slightly behind the origin of the dorsal, and are situated midway between the tip of the snout and the base of the caudal. The pectorals are long and narrow and are almost of the same length as the height of the dorsal. The caudal fin is long and emarginate; its upper lobe is slightly longer than the lower.

The most characteristic feature of the species lies in its colouration. There is a dark lateral stripe extending from the operculum to the base of the caudal fin. The back is marked by three rows of dark olive green patches which more or less coalesce to form a variable number of transverse bands bearing narrow, dull-yellow, interspaces between them. The rest of the body, including the fins, is of dirty yellow colour. There is a black oval blotch at the base of the caudal fin which is also provided with four V-shaped bands across its rays.

Type-specimen.—No. F242/2, Zoological Survey of India, Calcutta.

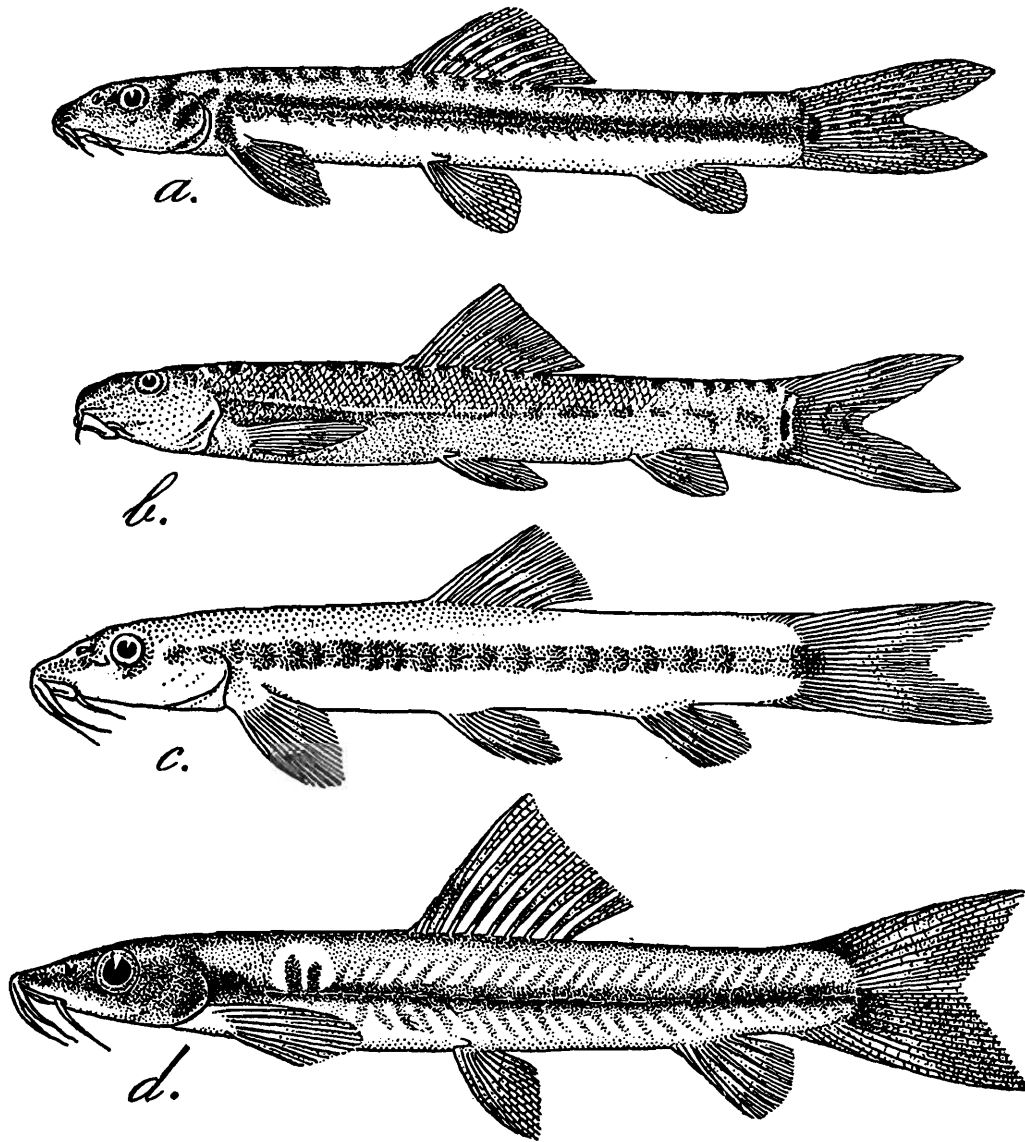
Locality.—Moola-Mootha river at Poona, Bombay Presidency

General remarks.—The general resemblance of this species to *N. anguilla* has already been noted. In the build of its body and colouration, its resemblance to *N. monilis*¹ from the Nilgiris on the one hand and to *N. binotatus*² from Thailand on the other may also be noted. The unmistakable distinguishing feature of these species lies in their body colouration, especially the nature of the lateral band in each. In

¹Hora, S. L., *Rec. Ind. Mus.* XXII, pp. 19-21 (1921).

²Smith, M. H., *Bull. U. S. Nat. Mus.* CLXXXVIII, pp. 328-29 (1948).

N. anguilla (Text-fig. 1b) there is a row of blackish spots or blotches along the mid-lateral line extending to the caudal fin, and not a broad black band as in the case of the other three species. In *N. monilis*, (Text-fig. 1c. as the name implies, the broad lateral band is moniliform, while it is continuous in the new species (Text-fig. 1a) as well as in *N. binotatus* (Text-fig. 1d). These changes in the nature of the lateral bands, exhi-



TEXT-FIG. 1.—A New Loach from Poona, Western Ghats, and certain allied species
a. Nemachilus poonaensis, sp. nov. : $\times 1\frac{1}{2}$; *b. N. anguilla* Annandale : $\times 2$; *c. N. monilis* Hora : $\times 1\frac{1}{2}$, and *d. N. binotatus* Smith.

bited by these otherwise closely allied forms, but occurring in different localities, are significant, and lead to the conclusion that possibly these forms may have evolved from a common ancestral stock, and that their present diagnostic features are the results of isolation in different watersheds. If further material shows that this surmise is correct, then the distribution of these allied species will add further evidence to the hypothesis of the continuity of the Satpura mountains with the hills of Assam and further east on the one hand and the Western Ghats on the other¹.

¹Hora, S. L., *Rec. Ind. Mus.* XXXIX p. 225 (1927).

Measurements in millimetres.

Total length	..	..	..	63.25	40.75	42.0	38.0	34.0	34.25	32.0	31.0
Standard length	..	..	..	50.0	32.5	33.25	31.0	2.0	28.0	26.0	24.5
Length of head	..	..	..	10.5	7.5	7.25	6.75	6.0	6.25	6.05	6.0
Height of head	..	..	..	5.25	4.0	4.05	3.75	3.25	3.25	3.0	3.0
Width of head	..	..	..	6.5	4.75	5.0	4.75	4.0	4.0	3.75	3.75
Diameter of eye	..	..	..	3.0	2.25	2.75	2.25	2.0	2.0	1.75	1.5
Length of snout	..	..	..	4.5	3.0	3.25	3.0	2.75	2.75	2.5	2.5
Inter-orbital distance	..	..	..	3.0	2.25	2.25	2.25	2.0	2.0	2.0	2.0
Depth of body	..	..	..	6.0	4.75	4.75	4.25	3.75	3.75	3.5	3.05
Width of body	..	..	..	5.75	4.5	4.5	3.75	3.0	3.05	3.0	3.0
Length of caudal peduncle	..	..	..	6.5	5.0	5.0	4.0	3.6	3.75	3.5	2.75
Least height of caudal peduncle	..	..	..	5.0	3.25	3.5	3.0	2.75	2.75	2.5	2.5
Length of dorsal fin	..	..	..	8.25	6.5	6.5	6.25	5.25	6.0	5.05	5.0
Length of pectoral fin	..	..	..	8.0	6.0	6.25	5.5	5.0	5.25	5.0	5.0
Length of pelvic fin	..	..	..	7.5	5.5	5.5	5.0	4.5	5.0	4.5	4.5
Length of anal fin	..	..	..	7.5	5.0	4.75	4.25	4.0	4.0	3.75	4.0
Length of rostral barbel	..	..	..	1.5	1.25	1.25	1.25	1.25	1.25	1.05	1.0
Length of inner max. barbel	..	..	..	2.75	1.5	1.75	2.0	2.0	2.0	1.75	1.5
Length of outer max. barbel	..	..	..	2.75	2.0	2.0	2.0	2.0	2.0	1.75	1.5

XLIII. ON A SMALL COLLECTION OF FISH FROM EAST PUNJAB.

In January 1949, Mr. H. Khajuria of the Zoological Survey of India made a small collection of fishes from the districts of Hoshiarpur and Gurdaspur in East Punjab. It was mainly obtained from Naya Pataya and Purana Pataya, two small tributaries of the river Ravi, and also from other brooks which ultimately join either the Ravi or the Chanab. The fish were collected either by netting or, for the most part, by damming smaller channels in the rocky portions of the bed of a stream. The entire collection comprises 304 specimens belonging to the following 19 species:—

Family CYPRINIDAE

Subfamily RASBORINAE

Specimens.

1. <i>Barilius vagra</i> Ham.	33
2. <i>Danio (Brachydanio) rerio</i> Ham.	7
3. <i>Danio devario</i> Ham.	10
4. <i>Esom usdanricus</i> (Ham.)	36

Subfamily *CYPRININAE*

5. <i>Aspidoparia moar</i> (Ham.)	7
6 <i>Barbus (Puntius) conchoni</i> (Ham.)	2
7. <i>Barbus (Puntius) pinnauratus</i> (Day)	4
. . <i>Barbus (Puntius) sophore</i> (Ham.)	33
. . <i>Barbus (Puntius) ticto</i> (Ham.)	28
10. <i>Crossochilus latius punjabensis</i> Mukerji	57
11. <i>Garra gotyla</i> (Gray)	1

Family *COBITIDAE*

12. <i>Lepidocephalichthys guntea</i> (Ham.)	..	22
13. <i>Nemachilus botia</i> (Ham.)		24
14. <i>Nemachilus corica</i> (Ham.)		1

Family *SILURIDAE*

15. <i>Callichrous pabda</i> Ham.	..	5
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Family *BAGRIDAE*

16 ¹ <i>Mystus bleekeri</i> (Day)	..	5
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Family *AMBLYCEPITIDAE*

17. <i>Amblyceps mangois</i> (Ham.)	..	22
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Family *OPHICEPHALIDAE*

18. <i>Ophicephalus gachua</i> (Ham.)	..	4
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Family *MASTACEMBELIDAE*

19. <i>Mastacembelus armatus</i> (Lacép.)		3
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The majority of the species listed above are fairly well known and are widely distributed. Such forms do not call for any special remarks. The presence in the collection of *Barbus (Puntius) pinnauratus* and *Amblyceps mangois* is, however, of special significance from a zoogeographical point of view and accordingly remarks are made below on these two species.

***Barbus (Puntius) pinnauratus* (Day).**

1937. *Barbus (Puntius) pinnauratus*, Hora, *Rec. Ind. Mus.* XXXIX, pp. 336, 337.

Barbus pinnauratus is represented by four specimens, ranging from 60.5 to 73.5 mm. in standard length, in the collection. Of these, three were collected from Purana Pataya at Mangyal in the Hoshiarpur District, and the fourth, the largest, measuring 94 mm. in total length, from Naya Pataya, 2 miles east of Mangyal, in the Gurdaspur district. In their general features, including the characteristic colouration of the species, these specimens agree well with the description given by Day and later workers.

According to Day¹, *Barbus (Puntius) pinnauratus* is found only in the "fresh waters at Coconada down the East Coast of India to Ceylon, and

¹Day, F., *Fish. India*, p. 561, pl. cxxxix, fig. 3 (1878).

inland as far as the Nilgherries, also along the Western Ghats and rivers at their bases" In 1937, Hora (*op.cit.*) recorded this species from the upper Chindwin and remarked on its discontinuous distribution in such widely separated areas. Its present record from the Western Himalayas shows the antiquity of the species and reminds one of the period when the Indo-Chinese fauna was gradually moving westwards along the newly-formed Himalayas, for it was much later that this fauna became diverted along the Satpura trend of mountains to Peninsular India and Ceylon.

Amblyceps mangois (Ham.).

1933. *Amblyceps mangois*, Hora, *Rec. Ind. Mus.* XXXV, pp. 617-621.

Amblyceps mangois is represented by 22 specimens in the collection ranging from 29.5 to 53 mm. in total length. They were collected from Naya Pataya at Pathankote in the Gurdaspur District, and resemble closely the typical specimens obtained in the Eastern Himalayas. There are, however, slight variations in the shape of the caudal fin. Hora (*op.cit.*) has already pointed out the great variety of shape and size of the caudal fin exhibited by the members of this species. In all the specimens under report the caudal fin is deeply forked with lobes of equal size. In specimens from other localities, when the caudal is forked, the upper lobe is generally considerably longer than the lower. This condition reaches its climax in the Siamese specimens, where the upper lobe is produced into a long thread-like process.

Day¹ had recorded this species from the Kangra Valley but no specimens from the Western Himalayas were present in the Museum collections. This species has, however, been collected from several localities along the Satpuras and its present western record is from the Hoshangabad District². It is likely that, if looked for in suitable localities at the foot of the hills, it may be found all along the Western Ghats and even in Ceylon. Its present-day distribution along the Himalayas on the one hand and the Satpuras on the other is, at any rate, very suggestive of its occurrence in Peninsular India and Ceylon from a purely zoogeographical point of view.

¹Day, F., *Fish. India*, p. 490 (1878).

²Hora, S. L. & Nair, K. K., *Rec. Ind. Mus.* XLII, p. 372 (1941).

XLIV. FISHES FROM THE KOSI HIMALAYAS, NEPAL.

INTRODUCTION.

In connection with the economic fishery survey of the Kosi river, sponsored by the Indian Council of Agricultural Research, Mr. K. K. Nair, Superintendent of Fisheries, Bengal, made an extensive collection of fish from the river in the Nepal territory, and particularly from regions above and below the proposed dam site at Barahakshetra. The collections were made at three different times : November 1947, January-February 1948, and April 1948. They were sorted out and provisionally identified by Mr. K. K. Nair, but they were again carefully gone through by the present author and a portion of the collection left unidentified by Mr. Nair was investigated. The collection can thus be regarded as a fairly representative one for the area, and consists of 11 families, comprising 26 genera and 52 species. A complete list of species, with zoogeographical remarks and notes on a few interesting forms are given in this paper.

The Kosi¹ is the most important river of Bihar. It rises in the eastern division of the hill ranges of the Nepal territory. The main river itself is formed of the confluence of seven rivers in a tract which is popularly known as the 'Sapt Kosi' or 'the country of the seven Kosis'. The most important branch is the San Kosi, which runs from west to east. At Barahakshetra the river leaves the mountains in a series of rapids and enters the plain as the Kosi river.

Before the river enters the plain, it is not very broad, the banks are rocky and steep, the water is deep and the current very strong. The collections were made mainly from side streams by damming up shallow portions and by blasting certain regions of the river with dynamite.

The following is the list of the species, with the localities whence they were collected and general distribution.

LIST OF FISHES FROM THE KOSI HIMALAYAS.

Systematic list of species.	Number, size and locality of specimens.	Distribution.
Family CYPRINIDAE		
Subfamily ABRAMIDINAE		
1. <i>Chela argentea</i> Day	19 specimens : 66 to 75 mm. Kokha nullah, Barahakshetra.	Nilgiris, Coorg, Mysore and Calcutta.
2. <i>Chela gora</i> (Ham.)	7 specimens : 60 to 220.8 mm. Chhatra ghat ; Nirmali.	Sind, throughout Northern India and Assam.
3. <i>Laubuca laubuca</i> (Ham.)	1 specimen : 48.5 mm. From a stream about 2 miles west of Bisharia ghat.	" Ganjam, Orrisa, Bengal, Central India, Assam and Burma " (Day).

¹O'malley, *Bengal Dt. Gazetteers*, XXV, p. 3-9 (1911).

Systematic list of species. Number, size and locality of specimens. Distribution.

Subfamily *RASBORINAE*

4. *Barilius bendelisis* (Ham.) 237 specimens: 17.5 to 93.5 mm. Kokha nullah; Chhatra. All along the base of the Himalayas and throughout the sub-continent of India.
5. *Barilius barila* (Ham.) 5 specimens: 67 to 71.5 mm. Kokha nullah, Barahakshetra. Northern India as far as Krishna in the South and Burma.
6. *Barilius shacra* (Ham.) 1 specimen: 63.5 mm. From the confluence of Tamur with the Kosi. "From Hardwar down the valley of the Ganges, North-west Provinces, and Assam" (Day).
7. *Danio aequipinnatus* (McClell.) 1 specimen: 76.5 mm. From a hill stream about 1½ miles from Chhatra, between Chhatra and Barahakshetra. Ceylon, India, Burma and Siam.
8. *Danio dangila* (Ham.) 1 specimen: 67.5 mm. Chhatra Bazar. "Bengal, Bihar, Himalayas at Darjeeling, also hills close Akyab" (Day).
9. *Danio devario* (Ham.) 1 specimen: 61 mm. Chhatra bazar. All over northern India, and Deccan.
10. *Rasbora daniconius* (Ham.) 2 specimens: 60.5 mm. Nilhol, about 26 miles from Chhatra. Widely distributed in the Oriental region.

Subfamily *CYPRININAE*

11. *Aspidoparia jaya* (Ham.) 2 specimens: 78.5-98 mm. Chhatra. "Hardwar on the Ganges and Assam" (Day).
12. *Aspidoparia morar* (Ham.) 14 specimens: 59 to 116.5 mm. Kosi river above the dam site. "Sind, Punjab, Continent of India (except the western coast and localities south of Kistna river) also Assam and Burma" (Day).
13. *Barbus (Puntius) chola* (Ham.) 6 specimens: 67.5 to 89 mm. Nirmali. India, Burma and further east.
14. *Barbus (Puntius) clavatus* (McClell.) 1 specimen: 117 mm. Chhatra Bazar. Northern Bengal and Assam.
15. *Barbus (Puntius) sarana* (Ham.) 3 specimens: 89 to 114 mm. Nirmali (Bihar) (Purchased). India, Burma and Yunnan.
16. *Barbus (Puntius) ticto* (Ham.) 1 specimen: 61.5 mm. From a stream on the track between Chhatra and Barahakshetra. Widely distributed in India, Burma and Siam.
17. *Barbus (Puntius) sophore* (Ham.) 10 specimens: 40 to 64.5 mm. Satpatia ghat about 6 miles from Nirmali. India, Burma and Yunnan.

Systematic list of species.	Number, size and locality of specimens.	Distribution.
18. <i>Barbus (Lissochilus) hexagonolepis</i> McClell.	2 specimens : 117 and 230.8 mm. Kokha nullah ; Tamur river, Tribeni.	Eastern Himalayas, Assam, Burma and Further east.
19. <i>Barbus (Tor) putitora</i> (Ham.)	33 specimens : 34.5 to 123 mm. Kokha nullah ; Chhatra.	All along the Himalayas.
20. <i>Crossochilus latius</i> (Ham.)	24 specimens : 59 to 102 mm. Nirmali market ; the Confluence of the Kosi river with the Tamur.	Peninsular India, along the Himalayas and Burma.
21. <i>Cirrhina reba</i> (Ham.)	9 specimens : 64 to 129.8 mm. Kosi river, Barahakshetra.	India and Siam.
22. <i>Garra annandeli</i> Hora	125 specimens : 25 to 94.5 mm. Kosi river, Chhatra ; Kokha nullah	Darjiling Himalayas.
23. <i>Garra gotyla</i> (Gray)	250 specimens : 49.5 to 72.5 mm. Kosi river, Chhatra.	Along the base of the Himalayas (Kangra, Ravi river, Simla, Chumba, Gharwal, and Mahanadi river in Darjiling district).
24. <i>Garra mullya</i> (Sykes)	1 specimen : 85.5 mm. From a stream $1\frac{1}{2}$ miles from Chhatra, between Chhatra and Barahakshetra.	Vindhyas, Satpuras & Peninsular India.
25. <i>Labeo angra</i> (Ham.)	11 specimens : 119 to 183.4 mm. Kosi river, Chhatra.	Assam, Bengal, Orissa and Burma.
26. <i>Labeo boga</i> (Ham.)	1 specimen : 154.5 mm. Chhatra bazar.	India and Burma.
27. <i>Labeo dero</i> (Ham.)	94 specimens : 80 to 116 mm. Tamur river below its Confluence with Arun and Chhatra.	All along the Himalayas, Sind Hills, Assam and Burma.
28. <i>Labeo dyocheilus</i> (Ham.)	1 specimen : 111 mm. Chhatra bazar.	All along the Himalayas, Sind Hills, Assam and Burma.
29. <i>Labeo sindensis</i> (Day)	4 specimens : 87 to 93.5 mm. Chhatra bazar.	"Sind, Punjab (at Lahore and Hardwar) also the Deccan at Poona" (Day).

Family HOMALOPTERIDAE

30. <i>Balitora brucei</i> Gray	2 specimens : 33 and 34.5 mm. Bhagwanpur, Bagalpur Dt.	Darjiling, Khasi Hills, Assam, Tenasserim and also Mysore.
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Family COBITIDAE

31. <i>Botia lohachata</i> Chaudhuri	111 specimens : 55 to 88.5 mm. Kosi river, Chhatra ; Kosi river at its confluence with Arun river ; Arun river ; and Kosi dam-site.	Bihar.
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Systematic list of species.	Number, size and locality of specimens.	Distribution.
32. <i>Lepidocephalichthys guntea</i> (Ham.)	5 specimens : 47 to 75 mm. Bisharia ghat, 14 miles from Chhatra.	Throughout Northern India.
33. <i>Nemachilus botia</i> (Ham.)	2 specimens : 47 to 63.5 mm. Kokha nullah near its confluence with Kosi at Barahakshetra.	Ceylon, India and Burma.
34. <i>Nemachilus rupicola</i> var. <i>inglisi</i> Hora	57 specimens : 40 to 47 mm. Kokha nullah at Barahakshetra.	Eastern Himalayas, (rivers below Darjiling and Sikkim).
35. <i>Nemachilus savona</i> (Ham.)	4 specimens : 22 mm. From a stream of the Kosi at Bisharia ghat.	Eastern Himalayas.
36. <i>Nemachilus scaturigina</i> (McClell.)	31 specimens : 35.5 to 61.5 mm. Kokha nullah a mile and a half its confluence with Kosi.	Eastern Himalayas and Assam.

Family SILURIDAE

37. <i>Callichrous bimaculatus</i> (Bloch)	4 specimens : 113 to 119.5 mm. Nirmali market.	India, Burma and further east.
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Family SCHILBEIDAE

38. <i>Clupisoma garua</i> (Ham.)	2 specimens : 119-240.5 mm. From the confluence of Tamur with the Kosi.	Sind, Northern India, Assam and Burma.
39. <i>Eutropiichthys vacha</i> (Ham.)	1 specimen : 370 mm. Kosi river about 3 miles from Nepal.	Punjab, Sind, Bengal, Orissa, Burma and Siam.

Family BAGRIDAE

40. <i>Mystus bleekeri</i> Day	39 specimens : 47.5 to 119 mm. Nirmali market.	"Sind, Jumna, upper waters of Ganges and Burma" (Day).
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Family SISORIDAE

41. <i>Gagata nangra</i> (Ham.)	1 specimen : 55 mm. Kosi river at Chhatra.	Kosi and Hoogly river at Nawabgunj "Ganges, Jumna and Indus" (Day).
42. <i>Gagata viridescens</i> (Ham.)	3 specimens : 65 to 73.5 mm. Kosi river at Chhatra.	Bengal and Assam. "Assam northern Bengal, Jumna at Delhi and Poona" (Day).
43. <i>Glyptothorax annandalei</i> Hora	40 specimens : 40.8 to 73.5 mm. Kosi river about 2 furlongs down its confluence with the Arun, Kosi river about a mile and a half down Barahakshetra temple and Kosi river at Chhatra.	Vindhya (Rihand river) Peninsular India and Nilgiris.

Systematic list of species.	Number, size and locality of specimens.	Distribution.
44. <i>Glyptothorax cavia</i> (Ham.)	11 specimens : 94.5 to 124.2 mm. Kosi river, Nepal; Kosi river Chhatra and Kosi river at Tribeni.	Northern Bengal, Assam and Burma.
45. <i>Glyptothorax horai</i> Shaw & Shebbeare	4 specimens : 83.8 to 120 mm. Kosi river, 3 miles down Nepal; Kosi river at Chhatra; Kosi river about a mile and a half down Barahakshetra temple.	Eastern Himalayas. (so far known only from the Tista valley and the Rihand river).
46. <i>Glyptothorax telchitta</i> (Ham.)	1 specimen : 72.5 mm. Kosi river, Nepal.	Northern Bengal, Bihar, and the Vindhya.
47. <i>Pseudecheneis sulcatus</i> (McClell.)	2 specimens : 97.5-89 mm. Kokha nullah about a mile up its confluence with Kosi.	Darjiling Himalayas and Khasi Hills.

Family XENENTODONTIDAE

48. <i>Xenentodon cancila</i> (Ham.)	5 specimens : 130 to 165 mm. Nirmali market.	Ceylon, India, Burma and further east.
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Family GOBIIDAE.

49. <i>Glossogobius giuris</i> (Ham.)	3 specimens : 72 to 104.5 mm. Nirmali market.	Ceylon, India Burma and further east.
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Family OPHICEPHALIDAE

50. <i>Ophicephalus punctatus</i> Bloch	1 specimen : 63.5 mm. Satpatia ghat, 6 miles from Nirmali.	India, Burma, Ceylon and Yunnan.
51. <i>Ophicephalus stewarti</i> Playfair	7 specimens : 113.5 to 147.5 mm. Kosi river at Chhatra, Kokha nullah about a mile up its junction with the Kosi river.	" Cachar and Assam in both running and standing waters " (Day).

Family OSPHROMENIDAE

52. <i>Colisa faciatu</i> s (Bl. Schn.)	2 specimens : 29.5 and 30 mm. Satpatia ghat.	India and Burma.
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ZOOGEOGRAPHICAL REMARKS.

It is well known to geographers and waterways engineers that the Kosi river has been undergoing a steady westerly movement for hundreds of years. It may be mentioned that in the early part of the 18th century, the Kosi flowed below the town of Purnea but it has gradually worked westwards across 75 miles of the country as is clearly evidenced by its deserted channels. The large commercial town of Nathpur, where Hamilton collected several species of fish from the Kosi river, was several miles

to the west of the river even up to 1850 but it has not only been washed away but the site of its ruins lies now many miles to the east of the river.

The westward movement of the Kosi is also strongly marked in its fish fauna. The occurrence in the collection under report of the most highly evolved torrential fishes, such as *Balitora brucei*, *Pseudecheneis sulcatus*, *Glyptothorax annandalei*, *Glyptothorax cavia*, *Glyptothorax horai*, several species of *Nemachilus* and *Lissochilus hexagonolepsis* shows the close affinity of its fish fauna to that of the Tista river, Eastern Himalayas and the Assam Hills. The present day composition of its fish fauna is suggestive of the fact that some of its earlier tributaries must have drained the region of the Darjeeling Himalayas and are now probably the feeder streams of the Tista River. Detailed account of the zoogeography of the Himalayas as evidenced by the distribution of fishes will be discussed when an account of the fish fauna of its various regions is completed.

SYSTEMATIC NOTES ON CERTAIN SPECIES.

Barbus (Puntius) clavatus (McClell.).

1921. *Barbus (Puntius) clavatus*, Hora, *Rec. Ind. Mus.* XXII, pp. 185, 186.

Barbus clavatus is represented by a single specimen measuring 90.5 mm. in total length. In all the important characteristics, the specimen agrees well with Hora's description of the species, except colouration, which is light yellowish on the back and silvery all over the rest of the body.

Barbus clavatus has so far been recorded from northern Bengal and Assam and its occurrence in the Kosi extends its range of distribution westwards along the Himalayas.

Garra mullya (Sykes).

1921. *Garra mullya*, Hora *Rec. Ind. Mus.* XXII, pp. 658-660.

There is a single, well preserved specimen in the collection and it conforms in all details to specimens from Peninsular India.

Garra mullya is a very widely distributed species of the Peninsular India, and has also been recorded from the Vindhya and the Satpuras. Its occurrence in the Kosi river is of considerable interest as this is the first record of the species from the Himalayas.

Balitora brucei Gray.

1932. *Balitora Brucei*, Hora, *Mem. Ind. Mus.* XII, pp. 290, 291.

Two juvenile specimens, measuring approximately 34 mm. each, represent *Balitora brucei* in the collection under report. These specimens agree well with the forma typica (Hora, *loc. cit.*, p. 197, 198 and 199) in all the important features. However, in these specimens the head is slightly pointed which may probably be a juvenile character.

According to Hora (*loc. cit.*, p. 292) this species is found in "India (Khasi Hills, Assam, Darjiling, Eastern Himalayas, and the Chittagong Hill tracts), and Burma (Meekalan and Meelan, Lower Burma; Myitkyina District, Upper Burma and Megla stream on Burma-Siam border)".

Its occurrence in the Kosi is, therefore, of some interest from the point of view of the geographical distribution of the species.

Glyptothorax annandalei Hora.

1923. *Glyptothorax annandalei*, Hora, *Rec. Ind. Mus.* XXV, pp. 14-16.

Glyptothorax annandalei is represented by a large number of specimens in the collection and they agree well with the description of the species by Hora. So far this species is known only from the Peninsular India and the Vindhya, and this is the first record of the species from the Himalayas.

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ON TWO NEW CERIANTHARIAN LARVAE FROM THE MADRAS PLANKTON.

By

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(Plates III-V.)

INTRODUCTION.

The present paper deals with two new species of Ceriantharian larvae, belonging to the genera *Arachnactis* and *Anactinia*, collected for the Madras Plankton during the years 1942 to 1945.

Arachnactis albida, the first larval Ceriantharian to be described, was discovered by Sars in 1846 from the Faroe Island, off the Coast of Norway. Since then many contributions on the developmental stages and anatomical features of this North Atlantic form have appeared of which those by van Beneden (1891 and 1897), Vanhoffen (1895), Carlgren (1906 and 1912) and Bourne (1920) are noteworthy in this field. Subsequently three more species have been discovered from tropical waters. *Arachnactis sibogae* was collected by the "Siboga" Expedition from the Malayan Archipelago and the account of it by McMurrich (1910) is incomplete in several respects. The "Valdivia" Expedition collected *Arachnactis valdiviae* (Carlgren, 1924) from the North West Coast of Sumatra. Recently Panikkar (1947) described *Arachnactis indica* from the Madras Coast together with a detailed account of its developmental stages and morphological features.

The genus *Anactinia* was established by Annandale in the year 1909 for the reception of an interesting pelagic anemone without tentacles collected from Furi on the Orissa Coast of the Bay of Bengal. He described its anatomy and considered it as an adult Ceriantharian. Menon (1914), suspecting them to be larval forms, reared the specimens obtained by him from the Madras Plankton and succeeded in metamorphosing them into the adults and thereby established the larval nature of *Anactinia pelagica*. Carlgren (1924), from a detailed study of the specimens of *A. pelagica* collected by the German Deep Sea Expedition on "Valdivia" and of the material in the Uppsala Museum, made additions to Annandale's account of the structural features. In the same paper, Carlgren, doubtfully, refers *Ovactis superficialis* and *Ovactis indiana*, the two non-acontiated forms of Bamford (1912), to the genus *Anactinia*, on account of the presence of mucus cell patches in the tentacular prominences, particularly in the latter species. But he also suggests the possibility that they may be young ones of *A. pelagica* itself. A clarification of this is possible only if Bamford's material is re-examined in the light of our present knowledge of the morphological features of larval Ceriantharia.

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It is known that the Ceriantharian larvae occur in the Madras Plankton mostly during the colder months of the year (Nair, 1944). The two larvae described in this paper are rare and they occurred in the townet collections made on the following days :—

Arachnactis panikkari, sp. nov.—

3rd Nov., 1944	..	..	..	1 Specimen.
4th Jan., 1945	..	..	..	4 Specimens.
10th Jan., 1945	..	..	..	1 Specimen.

Anactinia carlgreni, sp. nov.—

23rd Nov., 1942	..	..	..	3 Specimens.
16th Apr., 1943	..	..	..	1 Specimen.
16th Feb., 1945	..	..	..	1 Specimen.
19th Feb., 1945	..	..	..	2 Specimens.
21st Feb., 1945	..	..	..	1 Specimen.
16th Apr., 1945	..	..	..	1 Specimen.

Some specimens were allowed to metamorphose into the adults in the Laboratory Aquaria and the remaining ones were utilised for this study. The larvae were narcotised with Menthol and fixed in 10 per cent. Formalin. Serial sections of a few specimens were made at seven microns thickness stained in Delafield's and Heidenhain's Iron Haematoxylin counterstained with Acid Fuchsin.

I have great pleasure in expressing my thanks to Dr. N. Kesava Panikkar for his valuable help and criticisms and to Dr. H. Srinivasa Rao for kindly reading through the manuscript and making useful suggestions.

Family ARACHNANTHIDAE Carlgren, 1924.

Genus *Arachnactis* Sars, 1846.

Arachnactis panikkari, sp. nov.

(Plates III, IV.)

Diagnostic characters.—*Arachnactis* with nine marginal and six labial tentacles without directive tentacle and without an aboral pore on the column in the final pelagic stage. The directive tentacle and the aboral pore develop only after the transformation of the larva into the adult. Actinopharynx one-eighth the length of the column with a hypsulcus of about the same length provided with well developed ciliated tracts. Himisulci extremely short or practically absent. The first pair of metamesenteries is the longest and extends to the aboral end of the column, each ending in a slender, thread-like acontium. All the other metamesenteries shorter than the second pair of protomesenteries.

Orthocraspedon of the second pair of protomesenteries, and the first and the third pairs of metamesenteries of Type II. Orthocraspedon of the third pair of protomesenteries, and the second and the fourth pairs of metamesenteries of Type III. Cnidoglandular craspedonemes present. Metamorphoses into burrowing tube-dwelling adult.

EXTERNAL CHARACTERS.

Arachnactis panikkari is translucent and slightly opaque with the tips of the marginal tentacles brightly pigmented. The extremities of the marginal tentacles are pasture-green in colour with a deep brown pigmented region below this patch. The endodermal portions of the green and brown pigmented regions of the tips of the tentacles are milky white in colour. The labial tentacles and the gullet are light violet. The green tinge of the column in reflected light is more pronounced in the aboral region. The yellowish brown colour of the mesenterial filaments can be made out only in transmitted light. The preserved specimens are white and opaque with the column and the tips of the tentacles coloured light brown. In all the six specimens collected, nine marginal tentacles are present of which five belong to the right side and four to the left side (Pl. III, fig. 1). The fifth marginal tentacle of the left side had not developed, though the corresponding one of the other side had grown to about the same length as the other marginal tentacles. In the expanded condition the marginal tentacles are about one and three-fourths the length of the column and are 12 mm. long with a diameter of 0.4 mm. The directive marginal tentacle is absent with no indication whatsoever of its growth in the larval stage. From observations made in the Laboratory on larvae which have metamorphosed into the adults, it seems that the directive tentacle in this species makes its appearance only after the larvae have begun to metamorphose by burrowing into the substratum of sand. Apart from the interesting nature of this fact, it is an important distinguishing feature of *A. panikkari*. In all the recorded species of *Arachnactis*, the directive tentacle develops after the fourth couple of marginal tentacles has appeared, except in *A. valdiviae* where it appears after the formation of the third couple of marginal tentacles. The marginal tentacles originate as direct continuation of the column without a marked constriction at their bases. The larvae have not been observed to shed their tentacles either in the living or in the preserved condition. All the specimens possess six labial tentacles, three on each side of the oral opening and belong to the second, the third and the fourth pairs of actinocoels. The labial tentacles of the directive and the two adjoining actinocoels are absent in the larva. The very small labial tentacles, 1 mm. long and 0.2 mm. in diameter in the fully expanded condition, arise as direct continuations of the oral disc. The cylindrical column is 7.5 mm. long and 1.2 mm. in diameter and does not show any differentiation.

STRUCTURE OF THE LARVA.

The Tentacles.—In transverse sections the marginal and labial tentacles are rounded, and there is no appreciable difference in the structural features of the two sets of tentacles. The greater part of

the thickness of the tentacle is occupied by the well developed ectoderm composed of columnar supporting cells with numerous interstitial cells (Pl. III, fig. 2). The few cnidae are irregularly arranged. In this respect the present species differs from *A. valdiviae*, where bands of cnidae have been observed by Carlgren (*op. cit.*) on the abaxial side. The dimensions of the thick-walled nematocysts and the thin-walled spirocysts are $18.8 \times 3.3 \mu$ and $9.9 \times 2.2 \mu$ respectively. The spirocysts are more numerous than the nematocysts which are common on the tips of the tentacles. The definite aggregations of cnidae at the tips of the tentacles described by Panikkar (*op. cit.*) in *A. indica* are not present in this species. Large numbers of mucus cells are scattered amidst the ectodermal cells with no trace of the regular grouping of cells on the adaxial side of the tentacle recorded in *A. valdiviae*. The long supporting cells of the inner side of the labial tentacles are so compactly arranged that this region appears to be broader and more deeply stained than the other side of the tentacle.

The musculature of the tentacle is very well developed, the mesodermal folds and the muscle branches being more pronounced than in the anterior region of the column. The homogeneous mesogloal layer is devoid of nuclei. The thin endodermal layer is about a third to half the thickness of the epidermal layer. In *A. indica* the endodermal layer is thicker than the ectodermal layer especially at the basal region of the tentacles. Spirocysts of the same dimensions as found in the ectoderm have been noticed in relatively small numbers in the endoderm of the tips of the tentacles.

The Column.—There is a gradual tapering of the column towards the aboral end. This extremity is rounded and no aboral pore has been noticed in any of the larvae collected, though the ectodermal musculature of the column wall was fully developed in the larvae studied. In *A. albida*, Bourne (*op. cit.*) has shown that the aboral pore appears rather late when the larva reaches the 23 tentacled stage. His suggestion that the appearance of the aboral pore coincides with the full development of the longitudinal musculature does not apply to *A. indica* and *A. panikkari*. The formation of the aboral pore in *A. panikkari*, like that of the directive tentacle, is not a larval feature, for, judging from their metamorphosis soon after a suitable substratum is provided, these larvae seem to represent the final pelagic stage. Metamorphosed adults have, however, an aboral pore indicating that in *A. panikkari* it appears only after the transformation into the adult. The same condition may be expected in *A. indica* also as the 12-tentacled stage without the aboral pore is the final pelagic stage.

Like the tentacles, the column in transverse sections presents a circular appearance, with the wall of uniform thickness at the two extremities, while in the middle region the wall is thicker by two-thirds. There is no histological difference between the regions of the columnar wall except that presented by the ectodermal longitudinal musculature. The musculature is very feebly developed in the anterior end of the column below the tentacles, with the folds and the muscle branches very few in number (Pl. III, fig. 3). These are well developed in the middle region corresponding with the position of the hyposulcus where they form the most prominent part of the body wall (Pl. XIV, fig. 4). The

mesogloal folds here are very high, numerous and compactly arranged containing a large number of muscle branches. The muscle layer at the posterior extremity of the column is better developed than that of the anterior extremity, but not to such an extent as in the region of the hyposulcus (Pl. XIV, fig. 5). The columnar ectodermal cells of the body wall are compactly arranged with numerous interstitial cells (Pl. III, fig. 6). Mucus cells are very common and a gradual increase in their number is discernible towards the aboral extremity. Differently sized nematocysts are very common and the largest measure $21 \times 4.4 \mu$. Curved nematocysts are not rare. Nematocysts are more abundant at the aboral end. Spirocysts and gland cells are almost completely absent from the ectoderm of the body wall. The mesogloal layer, as in the tentacles, is homogeneous without any nuclei. The endodermal layer is thin and contains curved spirocysts, similar to those on the tentacles. Straight spirocysts, which are slightly longer than the curved ones, are very rarely seen in the endoderm. Nematocysts are extremely rare in the endoderm of the body wall.

The Stomodaeum.—The mouth in *A. panikkari* is an elongate slit-like opening, the two sides of which are closely apposed together. The mouth leads into the stomodaeum, extending to about one-eighth the length of the column. The siphonoglyph is clearly differentiated from the rest of the actinopharynx and its lining cells are thin and long with elongated nuclei and provided with very long cilia (Pl. IV, fig. 3). Gland cells and mucus cells are also present amidst the supporting cells of the siphonoglyph. The ectoderm of the remaining portion of the actinopharynx, between two consecutive mesenteries, forms a high ridge with deep furrows on either side opposite the mesenterial attachments. The number of the ridges corresponds to the number of actinocoels excluding those belonging to the siphonoglyph. These ridges are formed exclusively of ectodermal cells without any mesogloal support and thus resemble the condition found in the two adult Ceriantharians, *Arachnanthus oligopodus* and *Arachnanthus sarsi*. Large gland cells with numerous globular secretory granules are the most conspicuous elements in the ectodermal ridges. Cnidae, especially the nematocysts, occur in large numbers in these ridges. The nematocysts, both curved and straight, are of different sizes and the largest measure $20 \times 3.3 \mu$. Spirocysts are rare in the ectodermal ridges. Mucus cells also occur in fairly large numbers. Cilia are uniformly distributed on the ridges and the furrows, but are short when compared with the ciliation of the siphonoglyph.

The aboral continuation of the siphonoglyph, namely the hyposulcus, is very broad and powerfully ciliated with a structure similar to that of the siphonoglyph (Pl. IV, fig. 4). Distinct ciliated tracts are present throughout the entire length of the hyposulcus, and these fade away at its termination (Pl. IV, fig. 1). Only in *A. albida* and in *A. indica*, the ciliated tracts are well developed in the hyposulcus and this tract is continued on to the hemisulci in the latter species. In *A. valdiviae* the ciliated tracts are absent in the hyposulcus. Spirocysts, large nematocysts and gland cells are common at the free curved end of the hyposulcus in the vicinity of the ciliated tracts.

Hemisulci are extremely short and can be regarded as practically absent in *A. panikkari*. Only in *A. valdiviae* the condition of the hemisulci approaches that of the present form. These are present in *A. sibogae* and in *A. indica*, while in *A. albida* they are completely absent.

The Mesenteries.—In the two specimens sectioned serially fifteen mesenteries are present in the anterior region including the directive mesenteries (Pl. XV, fig. 3). Of these, eight belong to the right side and seven to the left side. One specimen was slightly advanced in age and possessed two more mesenteries, the ninth of the right side appearing as a rudiment and the eighth of the left side as an incomplete septum extending half way between the body wall and the actinopharynx. Of these fifteen mesenteries, the last of either side is very short and does not extend below the posterior border of the actinopharynx. All the remaining mesenteries in both the specimens show filament differentiation except the directive mesenteries and the seventh mesentery of the right side of the younger larva. The directive mesenteries are not continued beyond the rudiment of the hemisulci. The second pair of protomesenteries is about the same length as the directive mesenteries. The third pair of protomesenteries is shorter than the other two pairs of protomesenteries. Of the metamesenteries, the first pair is the longest and extends as far as the aboral extremity and each ends in a slender thread-like acontium. All the other metamesenteries are shorter than the longest of the protomesenteries. In both the specimens the third metamesentery of the right side is slightly longer than its fellow of the other side. The fourth metamesentery of the right side is short and shows filament differentiation only in the older larva while that of the left side as already mentioned disappears before the termination of the actinopharynx.

As observed in *A. indica*, the lamellar portion of the mesenteries contains many large vacuolated cells. Very few thick-walled nematocysts are present in this region.

The Mesenterial Filaments.—The directive mesenteries are without any filaments and the outer free border of the hyposulcus shows the well developed ciliated tracts of the directive mesenteries very clearly (Pl. IV, fig. 1). The filament of the second pair of protomesenteries consists of a very long orthocraspedon having a straight course and without any folds or craspedonemes. In sections the orthocraspedon shows a broad flattened median region with well developed ciliated tracts (Pl. IV, fig. 2). The rounded sides of the median streak contains spirocysts measuring $7.8 \times 2.2 \mu$. Granular gland cells are also present on the median streak. In structure the spirocyst glandular tract of this protomesentery closely resembles that of *Cerianthus lloydii* and so can be classed under Type II of Carlgren. The plectocraspedon of the second pair of protomesenteries, though short, is well developed and has the typical appearance in sections (Pl. IV, fig. 3). Numerous gland cells and thick-walled nematocysts measuring $20 \times 3.3 \mu$ occur in this region. The cnidoglandular tract is wavy in its course and a couple of craspedonemes is formed. The plectocraspedon is followed by a short telocraspedon, which is slightly longer than the plectocraspedon of the same mesentery. In the third pair of protomesenteries the ciliated tract

region is short and, in sections, presents a different appearance from that found in the second pair of protomesenteries (Pl. IV, fig. 4). The median streak is rounded and contains spirocysts and gland cells. The ciliated tracts are well developed. The orthocraspedon of this protomesentery resembles in structure the ciliated tract region of *Botrucnidifer norvegicus* and so belongs to Type III of Carlgren. The plectocraspedon is long and well developed with the folds of the filaments forming a number of small craspedonemes. This is the best developed region of the mesenterial filament of the third pair of protomesenteries. A telocraspedon is present in the third pair of protomesenteries, but is shorter than the orthocraspedon of the same mesentery.

The ciliated tract region of the first pair of metamesenteries is fairly long and forms the longest orthocraspedon of the mesenteries in *A. panikkari*. The structure of this region is the same as that of the second pair of protomesenteries and belongs to Type II and thus differs from the condition found in *A. albida*. It is interesting to mention here that in *A. valdiviae*, the ciliated tract region of the first pair of metamesenteries is like the corresponding region in the third pair of protomesenteries of *A. panikkari*. The cnidoglandular region is completely absent in the first pair of metamesenteries. The telocraspedon forms the longest region of the mesenterial filament and is well developed in this pair of metamesenteries. It consists of supporting cells with a few spirocysts and gland cells. Large thick-walled nematocysts are very common in the endodermal portion of the telocraspedon of this mesentery (Pl. IV, fig. 5). The cnidae, found in large numbers anteriorly, are practically absent in the posterior region of the craspedion.

There are two acontia in *A. panikkari*, each arising from the terminal region of the telocraspedon of the first pair of metamesenteries. They are slender, long and thread-like and could be seen actively moving inside the body cavity of the larva in the living condition. Panikkar (*op. cit.*) has suggested that in *A. indica*, the acontium and the directive tentacle probably develop at about the same time. This is in complete contrast with the condition found in the present species where the acontium and the directive tentacle are developed during the larval and adult stages respectively. In sections the acontium is composed of a compact mass of supporting cells in which are found gland cells, mucus cells and very rarely nematocysts (Pl. IV, fig. 6). In some adult Ceriantharia studied by Carlgren, he has noted distinct zonations in the acontium representing the ascending and the descending limbs of the craspedion region separated on either side by groups of endodermal cells. In *A. indica* a similar condition has been described at the basal region of the acontium only, while at the tip the endoderm disappears and the two limbs completely fuse. In *A. panikkari* the endodermal portion of the acontium could not be detected in the two specimens sectioned and suggests that this portion has undergone complete reduction resulting in the fusion of the two limbs of the filament.

The remaining metamesenteries are shorter than the second pair of protomesenteries; yet, the various regions of the filament are well developed. The second couple of metamesenteries agrees with the third pair of protomesenteries in the proportion of the various regions. Further, the structure of the orthocraspedon is similar to that of the third

pair of protomesenteries. The plectocraspedon forms the longest region of the filament and is drawn out into small craspedonemes as in the third pair of protomesenteries. The telocraspedon is of about the same length as that of the third pair of protomesenteries. In the third couple of metamesenteries, the orthocraspedon is the longest region. The cnidoglandular region is completely absent in this metamesentery. The craspedion region is short and is about half the length of the orthocraspedon. This metamesentery is like the second protomesentery and the first metamesentery in the structure of the ciliated tract region and resembles more closely the latter in the absence of the cnidoglandular region. Though the fourth metamesentery of the right side of the older larva is extremely short, the different regions are well developed with the ciliated tract region similar to that of the third protomesentery and the second metamesentery. The cnidoglandular region is slightly longer than the orthocraspedon followed by a telocraspedon of about the same length as the latter.

Reviewing the structural features and the proportions of the different regions of the filaments of the mesenteries, we find that the second pair of protomesenteries, the first and the third pairs of metamesenteries are similar, but for the short plectocraspedon present in the protomesenteries. The very long orthocraspedon of these mesenteries belongs to Type II of Carlgren. The third pair of protomesenteries, the second and the fourth pairs of metamesenteries are alike, in that they possess only a very short orthocraspedon of Type III and a well developed long plectocraspedon, the folds of which form small craspedonemes. A craspedion region is present in all the mesenteries.

DISCUSSION.

Carlgren, in his monograph on Ceriantharian larvae, includes only the species *albida*, *sibogae* and *valdiviae* under the genus *Arachnactis*, removing forms like *Arachnactis bournei*, *Arachnactis lobiancoi* and *Arachnactis brachiolata* of different authors to separate genera. *A. indica* is the only species added to the genus in subsequent years. A comparison of the characters of *A. panikkari* with those of the different species of *Arachnactis* clearly shows that this species possesses distinct features. The most important difference is that presented by the directive marginal tentacle. In *A. albida*, *A. sibogae* and *A. indica* the directive tentacle develops after the formation of four pairs of marginal tentacles. In *A. valdiviae* the directive tentacle originates after the formation of three pairs of marginal tentacles and probably simultaneously with the formation of the fourth pair of marginal tentacles. In *A. panikkari*, in the final pelagic condition with nine marginal tentacles, there is absolutely no indication of the growth of the directive tentacle. So the directive tentacle in *A. panikkari* seems to develop only after the transformation of the larva into the adult. In the absence of adaxial mucus cell bands and abaxial bands of cnidae the present form differs from *A. valdiviae* and in the absence of definite groups of cnidae at the tips of the tentacles from *A. indica*. The length of the actinopharynx is relatively short in *A. panikkari* being only one-eighth the length of the column. There is no information on this point in regard to *A. sibogae*,

but in the other species the gullet is long. It is slightly longer than a quarter of the length of the column in *A. albida* while it is about a third in length in *A. indica* and *A. valdiviae*. The hyposulcus in the present species resembles that of *A. albida* being broad and of about the same length as the gullet. In the other species it is short and is about one-third the length of the gullet. In *A. panikkari* there is a well developed ciliated tract on the hyposulcus and no trace of it could be found in the extremely short hemisulci. *A. valdiviae* and probably also *A. sibogae* are without ciliated tracts in the hyposulcus. This region is present on the hyposulcus of *A. albida* and *A. indica*, but in the latter species on the hemisulci also. In the extremely short condition of the hemisulci, the present species resembles *A. valdiviae* where also they are very short and practically absent. The ciliated tract region of the first pair of metamesenteries in *A. panikkari* belongs to Type II of Carlgren. In *A. valdiviae* the orthocraspedon comes under Type III with some resemblance to Type II and in *A. albida* and *A. indica* it comes under Type I.

These differences taken in conjunction with the structural variations presented by this species, clearly show that we are dealing with a form which is different from the other known species of *Arachnactis* and the name *Arachnactis panikkari* is proposed for it.

Family ARACHNANTHIDAE Carlgren, 1924.

Genus *Anactinia* Annandale, 1909.

Anactinia carlgreni sp. nov.

(Plate V.)

Diagnostic characters.—*Anactinia* without marginal and labial tentacles, with concentration of cnidae at the anterior extremity. Actinopharynx about one-fourth the length of the animal. Hyposulcus without ciliated tracts measuring a quarter of the length of the stomodaeum. Hemisulci about twice as long as the hyposulcus. Siphonoglyph with all the protomesenteries attached to it. The first pair of metamesenteries the longest, extending to the aboral end and each terminating in an acontium. Orthocraspedon of the second pair of protomesenteries, and the first, the third, etc., pairs of metamesenteries of Type II. Orthocraspedon of the third pair of protomesenteries, and the second, the fourth, etc., pairs of metamesenteries of Type III. Mesenterets and cnidoglandular craspedonemes present. Metamorphoses into tube-dwelling adult with marginal and labial tentacles.

EXTERNAL CHARACTERS.

Anactinia carlgreni is translucent and pale white when alive with a tinge of green colour detectable only on very close examination. The preserved specimens are opaque and white. Like *A. pelagica* the present form is also without tentacles, not even traces of them even as slight protuberances in the fully expanded larvae. The larvae are spherical

to oval when taken from the Plankton. When they are placed in fresh sea water of the Aquarium they assume an elongated oval shape (Pl. XVI, fig. 1). In the fully expanded condition, the larvae are 5 mm. long with a diameter of 2.5 mm. The mouth is in the form of a slit-like opening. A distinct aboral pore is present. When viewed under the binocular microscope, the gullet, the mesenteries and the acontia are fairly visible through the body wall of the living larvae. Such an examination further reveals the aggregation of the large nematocysts in the tentacular region at the oral end and also round the aboral pore.

STRUCTURE OF THE LARVA.

The Column.— The cylindrical column of *A. carlgreni* has, throughout its entire length, a more or less uniformly thick body wall. Further, no appreciable variation in the structure of the different regions of the column has been observed except in the disposition of the cnidae and the mucus cells. Large nematocysts measuring $43.2 \times 7.2 \mu$ form very prominent groups around the oral opening and these groups are the only indications of the position of the tentacles which appear during metamorphosis. The tentacles are formed during metamorphosis as outpushings of these nematocyst group regions and as they grow the nematocysts get scattered over the surface of the tentacle. Nematocysts of this type are present at the posterior end around the aboral pore. These nematocysts are rare in the other regions of the column. The spirocysts of the body wall, which are all of the same size, are found in enormous numbers at the extreme anterior region of the larva, particularly in the tentacular regions and around the oral opening. Such a regional aggregation of cnidae in the body wall has not been observed in *A. pelagica*. The large mucus cells of the body wall are numerous at the two extremities. At the anterior extremity they form groups at the middle of the body wall of each mesenterial compartment below the nematocyst groups (Pl. V, fig. 2). Similar mucus cell groups are also present in *A. pelagica*. Carlgren (*op. cit.*) suggests that these are morphologically similar to those found on the inner side of the marginal tentacles of some Ceriantharian larvae like *Calpanthula* and *Hensenanthula*. In *A. carlgreni*, the tentacles are formed in the nematocyst group regions situated above the mucus cell group regions and as such if the mucus cell groups persist in the adult they can be only on the outer side of the bases of the tentacles.

The ectodermal layer occupies about half the thickness of the body wall and the columnar cells composing it are closely arranged with numerous interstitial cells between them (Pl. V, fig. 3). In addition to the sparsely distributed large nematocysts, large numbers of small ones occur amidst the cells of the ectoderm. These measure $21.6 \times 4.32 \mu$, and are more or less uniformly distributed over the entire surface of the body wall. Spirocysts measuring $14.4 \times 2.16 \mu$, similar to those found aggregated in the anterior region, are also present, but are not so numerous as the nematocysts. Mucus cells are common in the body wall and occasionally gland cells are also present in the body wall. The ectodermal longitudinal musculature is fairly well developed except at the extremities. The mesogloal folds on which are placed the muscle fibres are short. The homogeneous mesogloal layer is devoid of nuclei. The prominent

endodermal layer, which is about two-thirds the width of the ectodermal layer, consists of cells vacuolated at their bases with the protoplasmic part at the apical end where the nuclei are situated. Nematocysts, such as those found in *A. pelagica*, have not been observed in the endodermal layer of the body wall.

The Stomodaeum.—The slit-like oral opening leads to the stomodaeum which extends to about one-fourth the length of the animal. The siphonoglyph is not well differentiated from the other regions of the actinopharynx and all the protomesenteries are attached to it (Pl. V, fig. 4). The ectodermal cells of the siphonoglyph are thin and long with oval nuclei and carry cilia which are of about the same length as that of the ridged portion of the stomodaeum. Mucus cells and occasionally gland cells are present amidst the supporting cells of the siphonoglyph. The ectoderm of the remaining portion of the stomodaeum forms faint ridges and there is no mesogloal extension into them. Numerous gland cells with secretory granules are present in the ectodermal ridges. Mucus cells are also present in fair numbers. Nematocysts are very common and measure $17.28 \times 3.6 \mu$. Spirocysts are extremely rare. The ridges and the furrows are uniformly ciliated.

The siphonoglyph is continued as the hyposulcus which is about a fourth of the length of the stomodaeum. The hemisulci are long and prominent and are about twice the length of the hyposulcus. The structure of these two organs is the same as that of the siphonoglyph. Ciliated tracts are completely absent in the hyposulcus of *A. carlgreni*, unlike the condition in *A. pelagica* where it is provided with distinct ciliated tracts.

The Mesenteries.—In the two specimens of *A. carlgreni* used for studying the mesenteries, 18 mesenteries are present including the directives. Of these nine belong to the right side and nine to the left (Pl. V, fig. 4). The tenth mesentery of the right side has only begun to develop and could be seen in some of the anterior sections as bud-like projections from the body wall. The last mesentery of the left side is the shortest and extends only up to the posterior border of the gullet. The directive mesenteries and the ninth mesentery of the left side do not have filaments while the remaining mesenteries carry well differentiated filaments. The ninth mesentery of the right side and its filament are short. The directive mesenteries are continued even after the termination of the hemisulci, but no filaments are present in the free portion of these mesenteries. The second pair of protomesenteries are comparatively long and of about the same length as the third pair of metamesenteries. The third pair of protomesenteries is only slightly longer than the third pair of metamesenteries. The first pair of metamesenteries is the longest and extends almost to the aboral extremity. Each mesentery of this pair is provided with a long slender acontium. The third pair of metamesenteries is the next longest of the metamesenteries with the second and the fourth pairs of metamesenteries succeeding it in their respective lengths. Therefore, the mesenterial formula for *A. carlgreni* is MBmb. Mesenterets (Grenzstreifen) are prominently developed in the plectocraspedon of the mesenteries (Pl. V, fig. 5).

The Mesenterial Filaments.—The long directive mesenteries are without filaments and ciliated tracts are absent in the hyposulcus. The filaments of the second pair of protomesenteries are well formed with a fairly long orthocraspedon which has a straight course. The orthocraspedon has a somewhat wide median region containing spirocysts in small numbers measuring $8.64 \times 1.44 \mu$. Gland and mucus cells are present in the median streak. The ciliated tracts are prominently developed. In structure the orthocraspedon of the second pair of protomesenteries and the first, the third, etc., pairs of metamesenteries resemble one another and comes under Type II of Carlgren (Pl. V, fig. 8). The plectocraspedon of the second pair of protomesenteries is of about the same length as the ciliated tract region and has the usual structure with numerous gland cells and nematocysts measuring $11.52 \times 2.88 \mu$ (Pl. V, fig. 5). This region of the filament is wavy in its course and a few craspedonemes are formed. The telocraspedon is fairly long and is not very conspicuous, the spirocysts occurring only very sparsely (Pl. V, fig. 6). The ciliated tract region of the third pair of protomesenteries is very short and in structure it is different from that of the preceding protomesentery. The median streak is rounded and the ciliated tracts are small and poorly developed (Pl. V, fig. 7). In structure this region agrees with Type III of Carlgren. The plectocraspedon is very long and forms the prominent region of the filament of this mesentery. A number of craspedonemes are formed in this region. The telocraspedon is longer than that of the second pair of protomesenteries.

In anatomical features and in the comparative lengths of the different regions of the mesenterial filaments two types could be recognised among the metamesenteries as in the other members of Ceriantharia. The first, the third, etc., pairs of metamesenteries are similar in having a ciliated tract region resembling in structure that of the second pair of protomesenteries. In these metamesenteries the cnidoglandular region is completely absent. The craspedion region is very long and arises as a direct continuation of the ciliated tract region. The other metamesenteries, namely, the second, the fourth, etc., pairs are similar in structural features and resemble the third pair of protomesenteries. The orthocraspedon is short and agrees in structure with that of the third pair of protomesenteries. The plectocraspedon is well developed with prominent and, sometimes with, branching craspedonemes. The telocraspedon is fairly long. A gradual decrease in the lengths of the metamesenteries is noted when they reach the multiplication chamber.

There is only a single pair of acontia arising from the terminal portion of the telocraspedon of the first pair of metamesenteries. In *A. pelagica*, the first, the third and sometimes the fifth pairs of metamesenteries carry acontia and in this respect this species differs from the former. The acontium is composed of a compact mass of supporting cells amidst which are found gland cells and a few mucus cells (Pl. V, fig. 9). A fair number of large sized nematocysts, the largest found in the species, measuring $65 \times 16.25 \mu$ are found in the acontium particularly at the extremity. Small nematocysts measuring $19.5 \times 4.9 \mu$ are also present in the acontium. The ascending and the descending parts of the filament with the endodermal part lying between them is seen in the acontium

and this differentiation vanishes at the tip of the acontium as has been found also in *Arachnactis indica*.

REMARKS.

Apart from the differences in the external features, the two species of *Anactinia* differ considerably in morphological features, the most important of them being the presence of acontia on the first pair of metamesenteries only and the absence of the ciliated tracts on the hyposulcus of *A. carlgreni*.

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NOTE.—References marked with an asterisk have not been referred to in the original.

EXPLANATION OF PLATE III.*

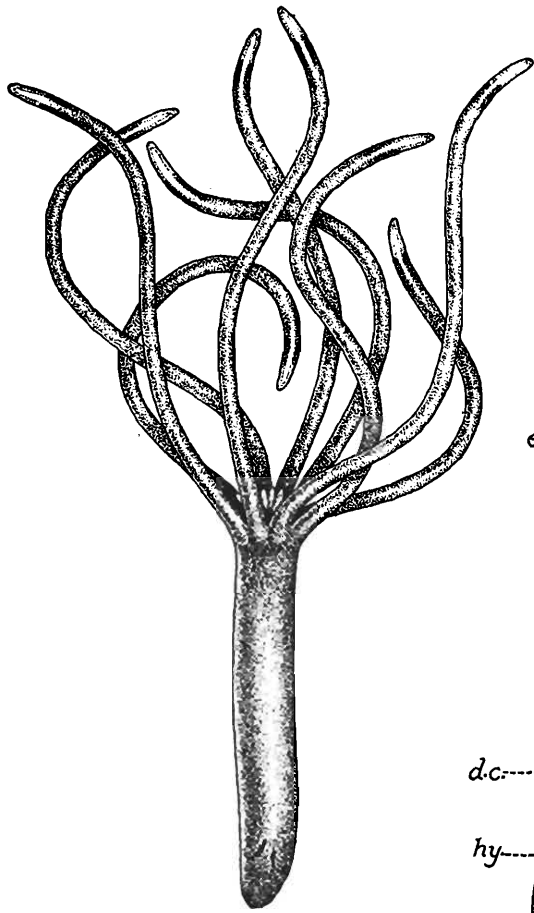
NEW CERANTHARIAN LARVAE FROM MADRAS.

Arachnactis panikkari, sp. nov.

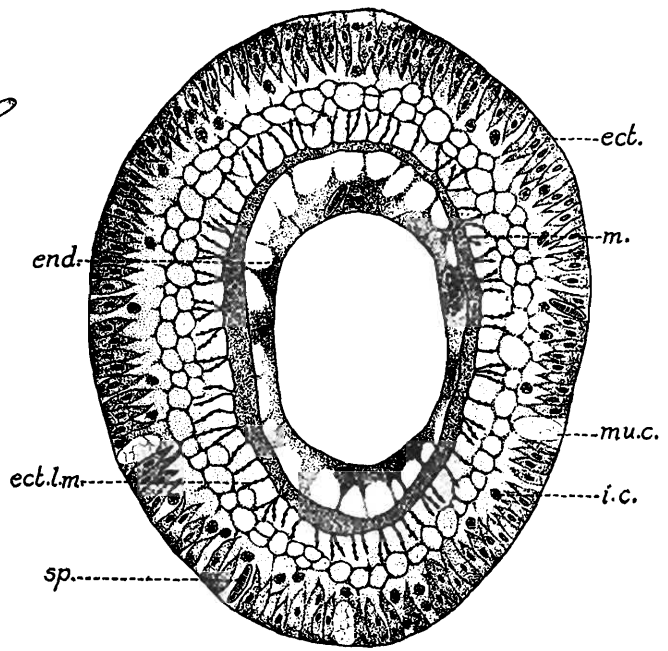
- FIG. 1.—*Arachnactis panikkari*, sp. nov., side view : $\times 5$.
FIG. 2.—Transverse section of a marginal tentacle : $\times 420$.
FIG. 3.—Transverse section of the anterior region of the column below the bases of the tentacles : $\times 80$.
FIG. 4.—Transverse section of the column in the region of the hyposulcus : $\times 80$.
FIG. 5.—Transverse section of the posterior region of the column before the origin of the acontia : $\times 80$.
FIG. 6.—A portion of the body wall from the middle region : $\times 450$.

d.c., directive chamber ; *ect.*, ectoderm ; *ect. l.m.*, ectodermal longitudinal muscle layer ; *end.*, endoderm ; *hy.*, hyposulcus ; *i.c.*, interstitial cell ; *m.*, mesogloea ; *m*¹, *m*², etc., first metamesentery, second metamesentery, etc. ; *mu.c.*, mucus cell ; *n.*, nematocyst ; *p*¹, *p*², etc., first protomesentery, second protomesentery, etc. ; *si.*, siphonoglyph ; *sp.*, spirocyst.

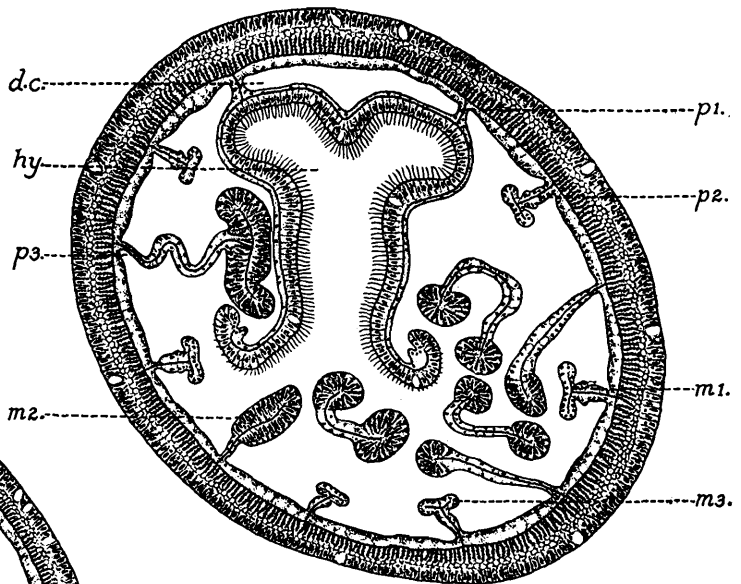
* To be read correctly as Plate " XIV " throughout.



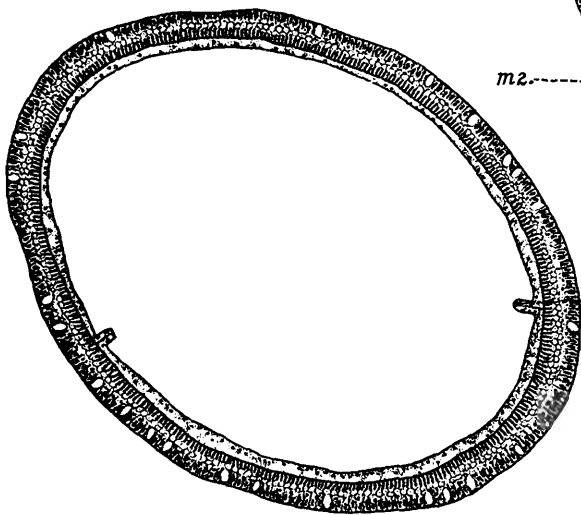
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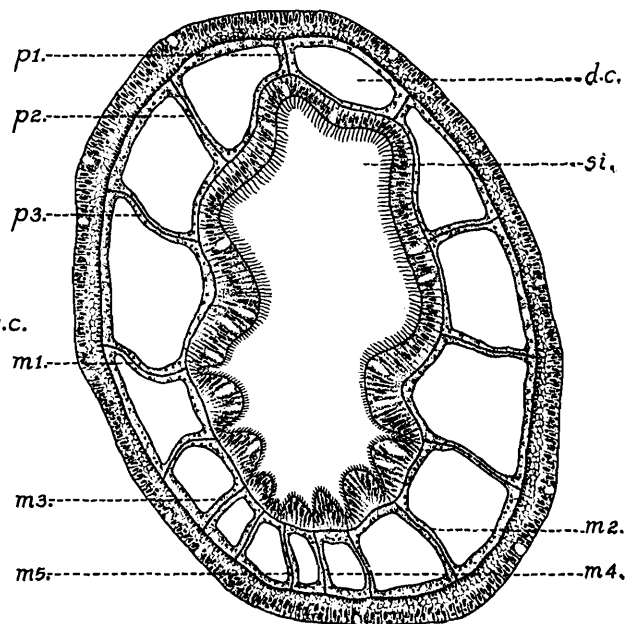
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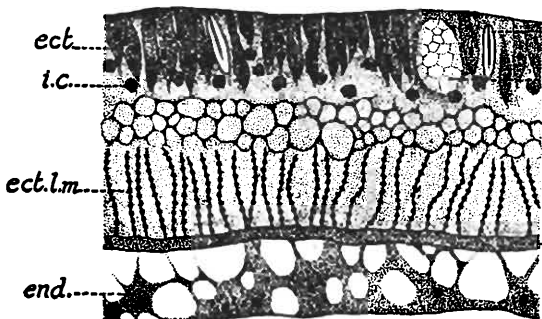
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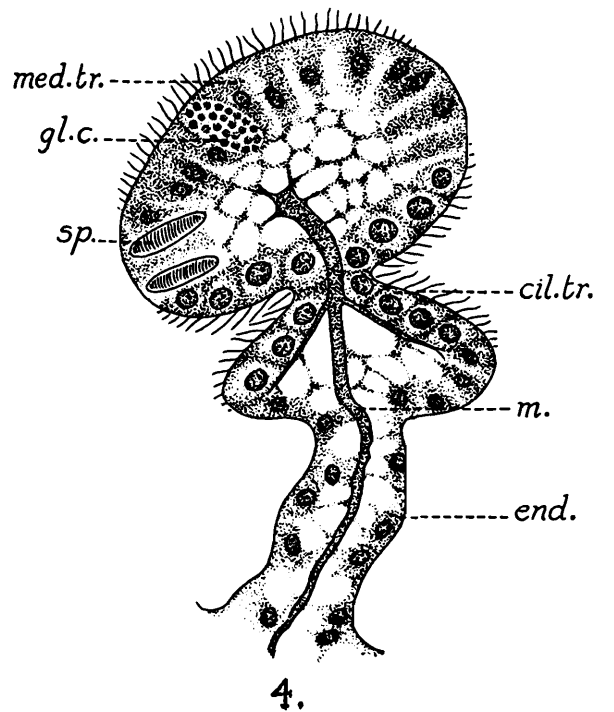
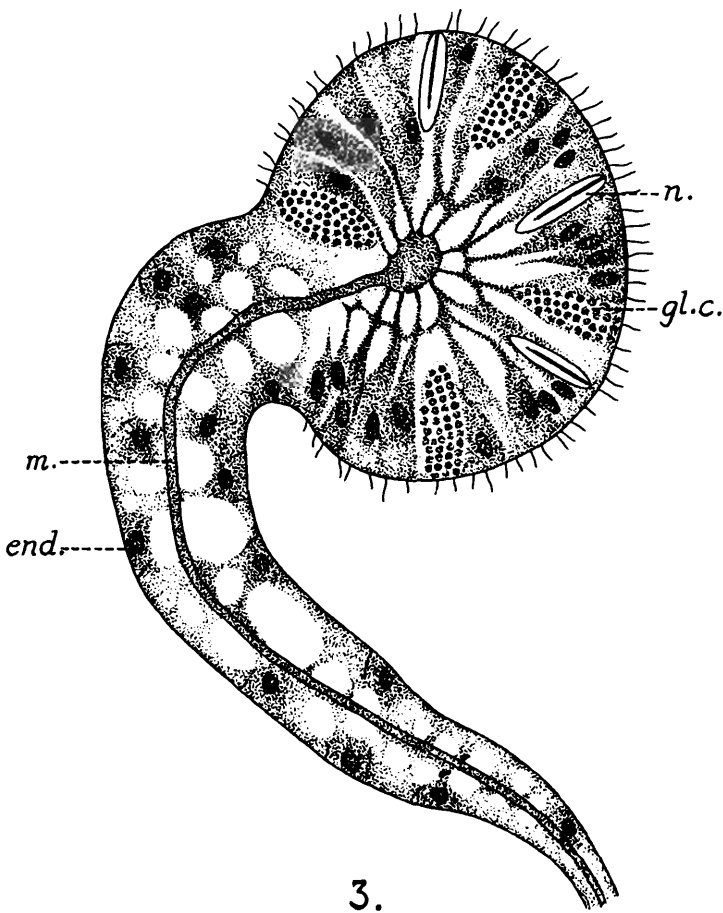
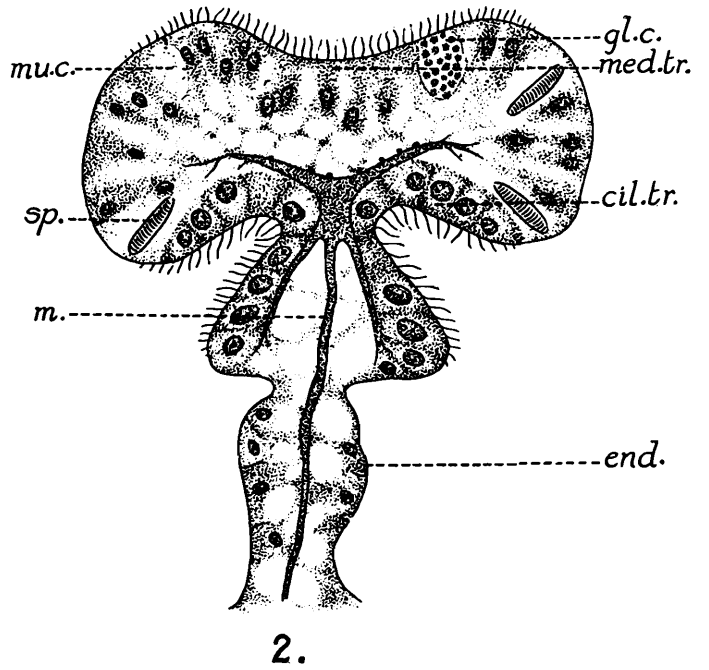
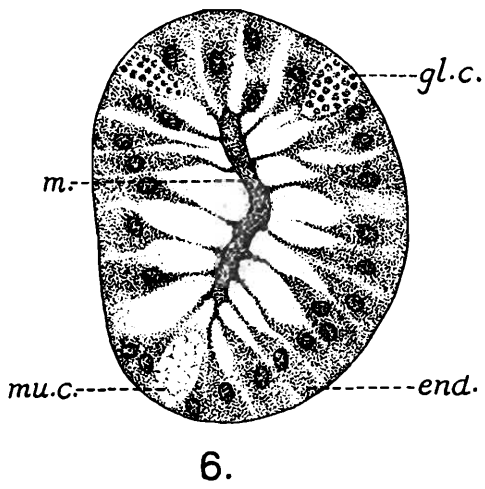
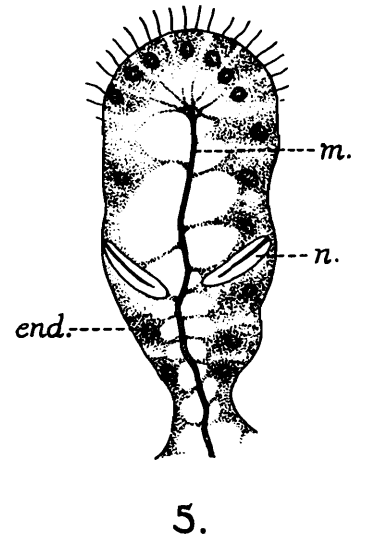
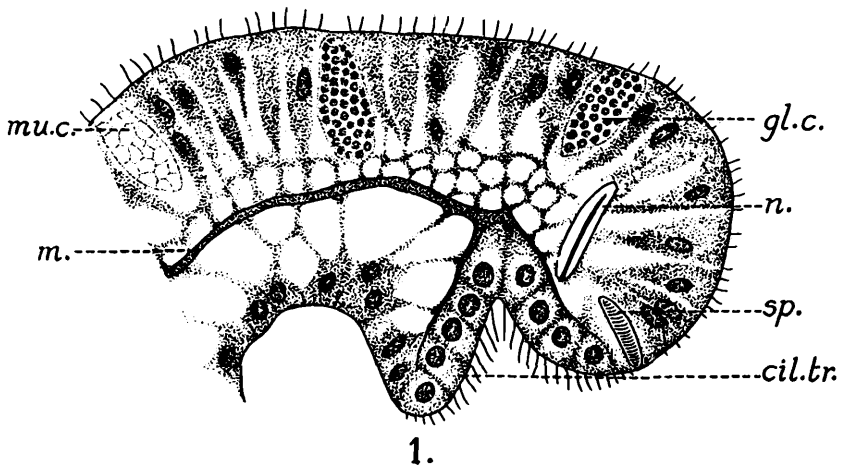
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EXPLANATION OF PLATE IV.*

NEW CERANTHARIAN LARVAE FROM MADRAS.

Arachnactis panikkari, sp. nov.

FIG. 1.—Ciliated tract region of the hyposulcus: $\times 810$.

FIG. 2.—Transverse section of the orthocraspedon of the second protomesentery: $\times 810$.

FIG. 3.—Transverse section of the plectocraspedon of the second protomesentery: $\times 810$.

FIG. 4.—Transverse section of the orthocraspedon of the third protomesentery: $\times 810$.

FIG. 5.—Transverse section of the telocraspedon of the first metamesentery: $\times 810$.

FIG. 6.—Transverse section of an acontium: $\times 810$.

cil. tr., ciliated tract region; *gl.c.*, gland cell; *med. tr.*, median spirocyst glandular tract; (Rest as in Plate XIV).

*To be read correctly as Plate "XV" throughout.

EXPLANATION OF PLATE V.*

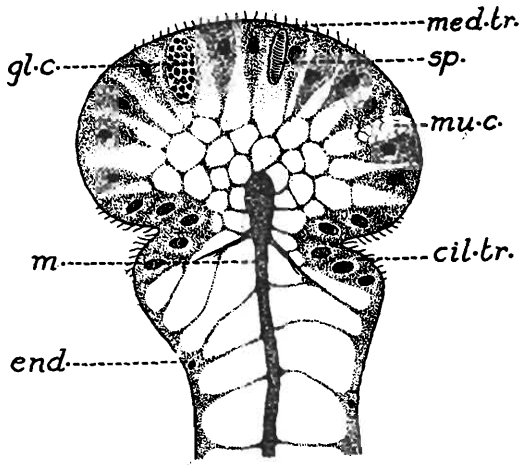
NEW CERANTHARIAN LARVAE FROM MADRAS.

Anactinia carlgreni, sp. nov.

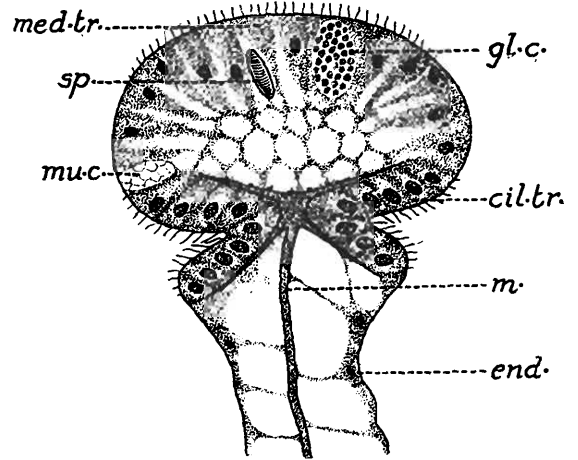
- FIG. 1.—*Anactinia carlgreni*, sp. nov., side view : $\times 10$.
FIG. 2.—Transverse section of the anterior region of the body wall showing the mucus cell group : $\times 100$.
FIG. 3.—Transverse section of the body wall from the middle region : $\times 315$.
FIG. 4.—Transverse section of the anterior region of the column : $\times 28$.
FIG. 5.—Transverse section of the plectocraspedon of the second protomesentery : $\times 315$.
FIG. 6.—Transverse section of the telocraspedon of the second protomesentery : $\times 450$.
FIG. 7.—Transverse section of the orthocraspedon of the third protomesentery : $\times 450$.
FIG. 8.—Transverse section of the orthocraspedon of the first metamesentery : $\times 675$.
FIG. 9.—Transverse section of the acontium at about the middle region : $\times 675$.

cil. tr., ciliated tract region ; *d.c.*, directive chamber ; *ect.*, ectoderm ; *ect. l.m.*, ectidermal longitudinal muscle layer ; *end.*, endoderm ; *end. a.*, endoderm of acontium ; *gl.c.*, gland cell ; *i.c.*, interstitial cell ; *l.n.*, large nematocyst ; *m.*, mesogloea ; *m*¹, *m*², etc., first metamesentery, second metamesentery, etc. ; *me.*, mesenterets ; *med. tr.*, median spirocyst glandular tract ; *mu.c.*, mucus cell ; *n.*, nematocyst ; *p*¹, *p*², etc., first protomesentery, second protomesentery, etc. ; *si.*, siphonoglyph ; *sp.*, spirocyst.

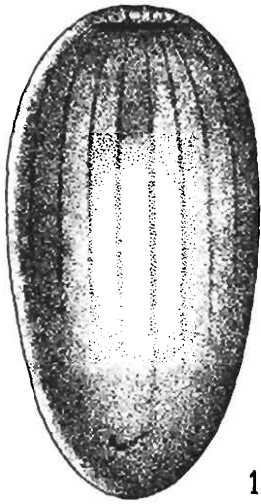
*To be read correctly as Plate "XVI" throughout.



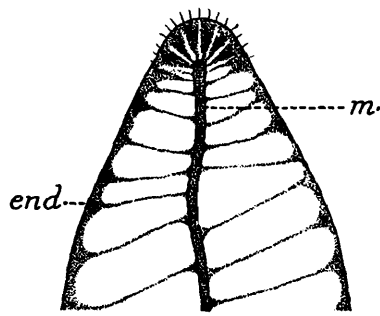
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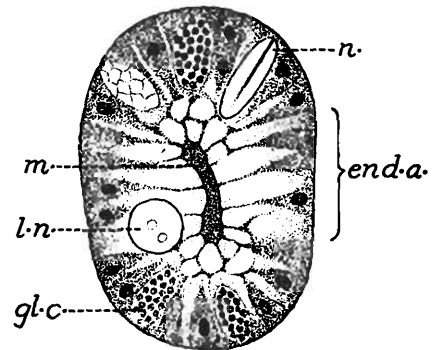
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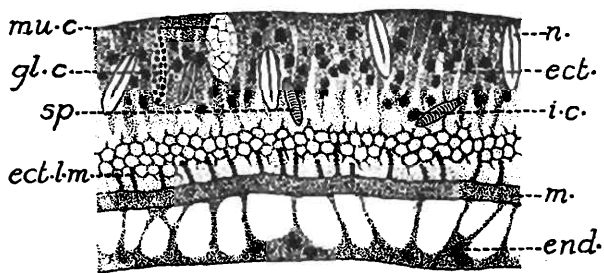
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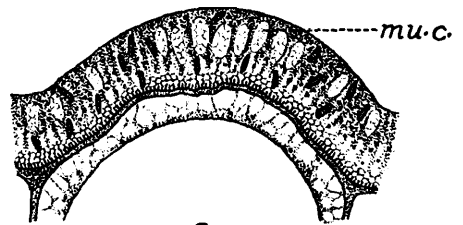
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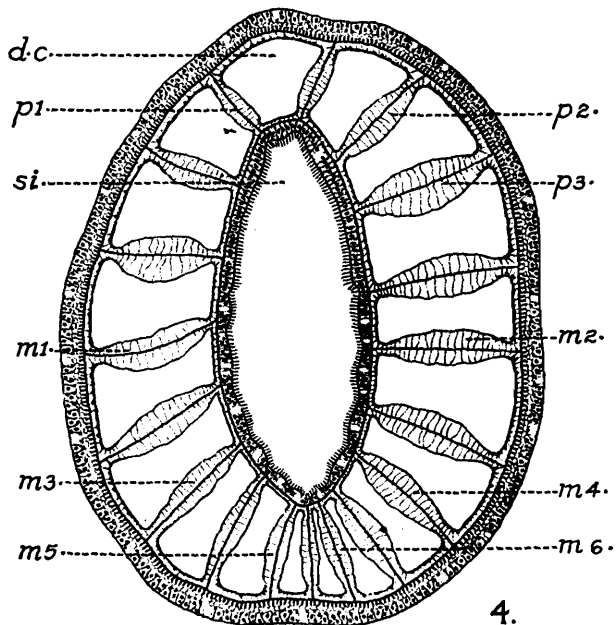
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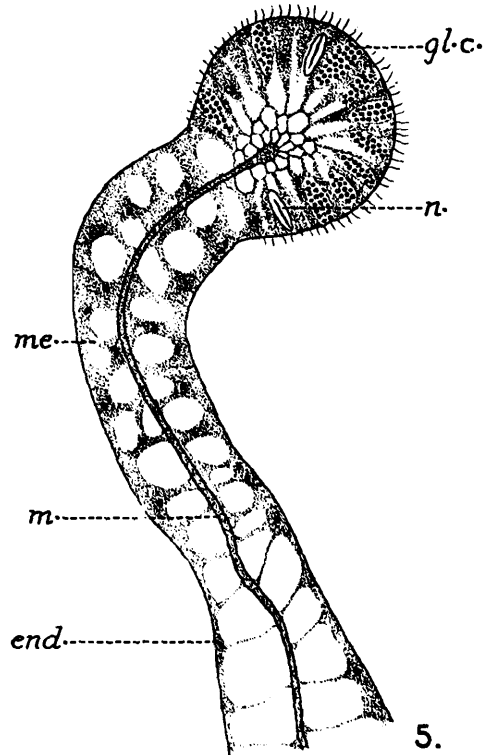
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ERRATA to

Records of the Indian Museum, Vol. XLVII; Part I (1949, published 1950), pp. 1-64, 9 pls.

ROONWAL, M.L. Contributions to the fauna of Manipur State, Assam. Part III.—Mammals, with special reference to the family *Muridae* (order Rodentia).

1. Page 8, line 1 from below.—*For* “Skullsmaller” *read* “Skull smaller”.
2. Page 8, line 3 from below.—*Add* “;” after “irregular”
3. Page 11, line 9 from below.—*For* “11=19”, “10=16”, “10=17” and “12=13”, *read* “11—19”, “10—16”, “10—17” and “12—13” respectively.
4. Page 11, line 10 from below.—*For* “12=20” and “14=16” *read* “12—20” and “14—16” respectively.
5. Page 11, line 12 from below.—*For* “1,003=1,210” *read* “1,003—1,210”
6. Page 11, line 13 from below.—*For* “219=270”, “117=132” and “36=42” *read* “219—270”, “117—132” and “36—42.” respectively.
7. Page 12, line 9.—*For* “Wroughton” *read* “Wroughton”.
8. Page 14, line 10.—*Delete* the brackets in “(Herpestidae)”.
9. Page 18, line 21.—*For* “vnsexed” *read* “unsexed”
10. Page 20, line 28.—*For* the comma after *ft.* in “4,000 ft., (b)”, *read* a semi-colon: “;”
11. Page 20, line 29.—*Add* a semi-colon “;”, between “4,000 ft.” and “(c)”
12. Page 24, Table I(b), heading.—*For* “Kangla” *read* “Kangla—”
13. Page 40, line 14 from below.—*For* “obsol etus” *read* “obsoletus”.
14. Page 50, line 25.—*For* “demar ated” *read* “demarcated”
15. Page 50, line 26.—*For* “abov” and “ben ath” *read* “above” and “beneath” respectively.
16. Page 53, line 2.—*For* “thr” *read* “the”
17. Page 53, line 3.—*For* “uppee” *read* “upper”.
18. Page 53, line 9.—*For* “occ pitonasal” *read* “occipitonasal”.
19. Page 53, line 13.—*For* “No thern” *read* “Northern”.
20. Page 53, line 2 from below.—*For* “p. 38) 6” *read* “p. 386)”
21. Page 53, line 4 from below.—*For* “Indi” *read* “India”.

22. Page 54, line 14.—*For* “ th oa ” *read* “ throat ”.
 23. Page 54, line 16.—“ hort ” *read* “ short ”.
 24. Page 54, line 29.—*For* “ hind-foo ” *read* “ hind-foot ”.
 25. Page 55, line 2.—*Delete* full-stop after “ *nagarum* ”.
 26. Page 55, line 3.—*For* “ zy omatic ” *read* “ zygomatic ”.
 27. Page 55, line 4.—*For* “ ins ead of convex ” *read* “ instead of convex ”.
 28. Page 55, line 8.—*For* “ skull ” *read* “ Skull ”.
 29. Page 55, line 22.—*For* “ 1 45 ” *read* “ 1945 ”.
 30. Page 55, line 23.—*For* “ a e ” *read* “ are ”.
 31. Page 55, line 29.—*For* “ dep h ” *read* “ depth ”.
 32. Page 55, line 35.—*For* “ ba al ” *read* “ basal ”.
 33. Page 55, line 36.—*For* “ oran e—coloured ” *read* “ orange-coloured ”.
 34. Page 55, line 41.—*For* “ *Distribut on* ” *read* “ *Distribution* ”.
 35. Page 56, Table 4, column 1, line 1.—*For* “ egistered ” *read* “ Registered ”.
 36. Page 56, Table 4, column 1, line 10.—*For* “ 11,122 ” *read* “ 11,123 ”.
 37. Page 58, line 15.—*For* “ Dim pur ” *read* “ Dimapur ”.
 38. Page 58, line 26.—*For* “ **suberi tatus** ” *read* “ **subcristatus** ”.
 39. Page 59, line 3.—*For* “ 947c) *read* “ 1947c) ”
 40. Page 64 (a) (Explanation of Plate I), line 6.—*Add* “ × 1 ” after “ Roonwal ”.
 41. Page 64 (b) (Explanation of Plate II), line 2.—*Delete* the brackets in “ Roonwal ”.
 42. Page 64 (c) (Explanation of Plate III), line 2 from below.— *For* “ ca. 2·1 ” *read* “ ca. 4·2 ”.
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