ON A BLIND ROHU FISH, *LABEO ROHITA* (HAM.).

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INTRODUCTION.

On September 9, 1939, Mr. R. M. Chatterji, Cashier, Geological Survey of India, presented the head of a blind Rohu fish, *Labeo rohita* (Ham.), to the Zoological Survey of India, and very kindly supplied the following particulars about it :—

"The head was purchased by me this morning from the Dum Dum market. The fish weighed 1 seer and 3 chataks (about 2·4 lbs) and was caught at Bagjola, in a marshy fishery about half a mile east of Dum Dum Railway Junction on the Eastern Bengal Railway."

After consulting the literature regarding such abnormalities in fishes and a superficial examination of the specimen, Dr. S. L. Hora considered it of exceptional interest and very kindly handed over the specimen and the relevant literature to me for detailed study.

I have to record my grateful thanks to Dr. Baini Prashad, Director, Zoological Survey of India, for allowing me full facilities to carry out the investigation and for his valuable criticism. I am also grateful to Dr. Hora for affording me an opportunity to study such an interesting and rare abnormality, and for his constant help and guidance in the course of my work. My thanks are also due to Mr. R. M. Chatterji who showed unusual interest in nature study by presenting this specimen to the Zoological Survey of India and later accompanying me to the fishery and the market whence the blind Rohu was procured.

HISTORY OF THE SPECIMEN.

As indicated above, the specimen under report was caught at Bagjola near Calcutta. I visited the area on the 12th October, 1939, and found that the fishery consists of an extensive, intercommunicating, marshy region situated about half a mile east of the Dum Dum Junction Railway Station between the Dum Dum Road on the south and the Dum Dum-Khulna railway track on the north. The entire fishery, with the exception of a narrow strip of clear water about 30 feet broad connecting the culverts of the bridges, was practically covered with

aquatic vegetation. The water was stagnant and foul smelling, except in the clear portion where a slow current was noticeable. The average depth of water was stated to be about 5 feet. The bottom was covered with loose, soft mud to a depth of about 2 feet. This marshy area drains towards the south-west where it is continuous with a "jheel", which was stated to extend as far as the Jessore Road. The blind fish was caught from the clear piece of water in a fixed bamboo trap, locally known as *Atol*. According to the local fishermen, fish move from one side of the marsh to the other across the clear strip of water and invariably good catches are made with fixed traps and similar contrivances.

Several fishermen were questioned regarding the occurrence of the blind Rohu in this fishery, but no such abnormalities had been seen or heard of before. The fisherman, who caught the blind fish, stated that he was not aware of the blindness of the fish till a customer, after purchasing the fish noticed the abnormality and returned it to him. When for a long time he found it impossible to sell the blind fish, he cut off its head, and the fish was then readily sold. Mr. Chatterji observed the abnormal head and out of curiosity purchased it, and presented it to the Zoological Survey of India.

A study of the literature has shown that cases of blindness in fishes, excepting the normally blind fishes of caves, etc., are very rare. However, a similar case was recorded by von Baer (1862, pp. 215-220) of *Cyprinus gibelio* [*Carassius carassius* (Linn.)] about four inches in length ; I refer to this case later.

Description of the Specimen.

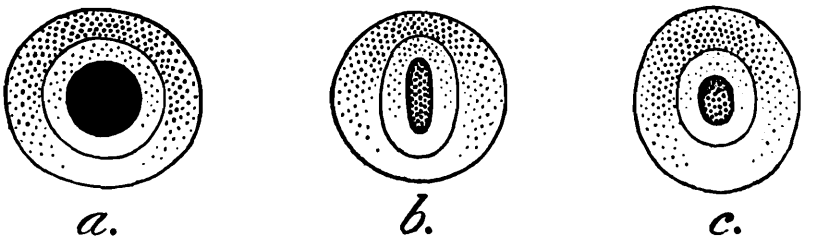
The length of the abnormal head was 80·7 mm. With the exception of the eyes, which were covered over with skin, the head of the blind Rohu seemed to be more or less normal in all respects (text-fig. 1 *a*, *b*) ; the sensory papillae on the head and the snout were, however, more numerous than in normal specimens.

Text-fig. 1.—Head of the blind Rohu, *Labeo rohita* (Ham.). $\times \frac{2}{3}$
(*a*) Right side ; (*b*) Left side.

Left eye :—In the specimen (text-fig. 1 *b*), which had been preserved in spirit, the position of the eye was indicated ventrally by the row of sensory papillae and dorsally by the orbital bone. The lower half of this area, which was lunate in outline, was somewhat transluscent and slightly bluish in colour. The upper portion of the eye region and the

dorsal surface of the head were uniform deep grey. There was an unmistakable shallow depression in the place where the eye is normally situated, and in the centre of this concavity there was a small dull white patch. Under a low magnification, low, narrow ridges of the skin were seen to radiate from this dull whitish patch.

The thick skin covering was reflected backwards by longitudinal slits and the eye was exposed. The space between the outer skin and the eye was filled with a fatty tissue which had to be removed to expose the eye. The postero-ventral side of the eye was rigidly attached by a muscle to the bone below ; I have not found any such structure in a normal eye of this species. On account of the muscular attachment noted above, the eyeball was turned posteriorly at an angle of somewhat more than 45 degrees so that what was exposed, after the removal of the fat, was a portion of the white of the eye. The eyeball was hard to the touch and the cornea was not punctured. Even if this eye had not been covered by the skin, it could have been of no use to the fish, inasmuch as it was partly turned posteriorly and was immovably fixed to the bone in this position. All the six muscles, which help in moving the eyeball, were present, but the Superior Rectus and the External Rectus were fused together to form a broad muscle near their attachment to the eyeball, while they were quite distinct near their attachments to the bones.



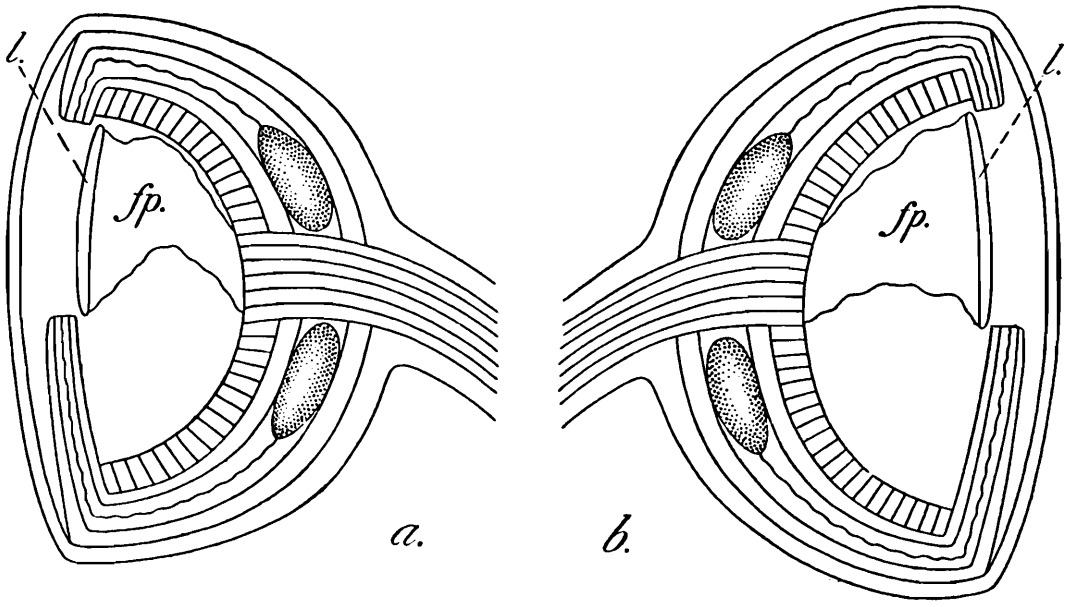
TEXT-FIG. 2.—Diagrammatic representation of the front view of the eyes of *Labeo rohita* (Ham.) showing the form of the iris in (*a*) a normal specimen, (*b*) the right eye of the abnormal specimen and (*c*) the left eye of the same. × ½.

The eye (text-fig. 2 *c*) was of a comparatively small size and in shape represented a vertically placed oval with an iris of the same shape. A normal eye (text-fig. 2 *a*) on the other hand, is circular with a circular iris and is comparatively much larger. For comparison the measurements of the head, eyes, etc., of a normal and the blind specimen are given below :—

Specimen.	Size of Head.	Left eye.				Right eye.			
		Eyeball		Iris.		Eyeball.		Iris.	
		Length.	Breadth.	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.
Normal	78	15	14	11	11	15	14	11	11
Blind	80·7	15	13	11	7	12	15	9	7

All measurements are in millimetres.

Microtome sections of the eye could not be prepared as the specimen was poorly preserved, but the gross anatomy of the eye and the related structures was studied so far as possible. The eye was divided into two symmetrical halves by a median vertical cut and all the internal structures exposed. It was found that the normal globular lens only was absent, but all other structures were represented (text-fig. 3*b*).



TEXT-FIG. 3.—Sections of the eyes of the abnormal *Labeo rohita* (Ham.). Diagrammatic. *a*. Right eye ; *b*. Left eye.
l. lens ; *fp*. Falciform process.

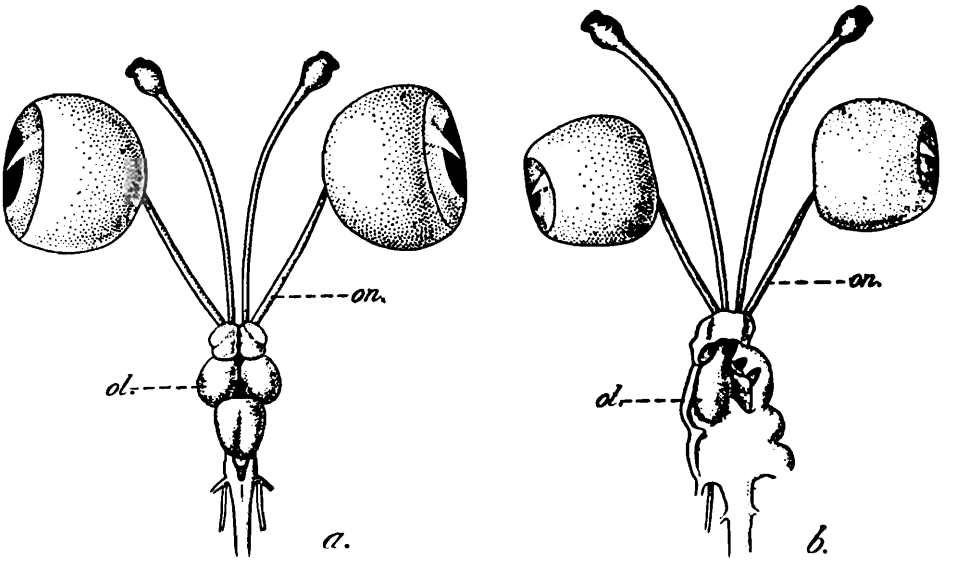
Under a binocular a hard, flat, leaf-like structure (text-fig. 3 *b*, *l*.) could be noticed occupying a part of the space where the lens is normally situated. On its posterior surface the relatively large *Campanula Halleri* end of the falciform process (text-fig. 3 *b*, *fp*.) was attached. The flat structure noted above, probably represents a degenerate lens. The lens in a normal specimen is large, globular and very hard to the touch.

Right eye :—The condition of the right eye (text-fig. 1 *a*) was similar to that of the left eye, but it was not completely covered by the thick skin and there was a small oval aperture in the centre, 2·5 mm. long and 1·5 mm. broad. Externally the boundary of the eye was marked ventrally by a few sensory papillae, while dorsally the supra-orbital bone had grown to such an extent as to cover the dorsal half of the area containing the eye. The area of the eye not covered by the bone was semilunar in appearance. There were several low ridges of skin radiating outward from the periphery of the aperture. The white structure visible through the small hole was slightly raised and uneven, indicating a superficial fibrous growth. The orbital area was bluish black above and below, but triangular dirty white areas were present along the sides.

On dissection it was found that the supra-orbital bone had grown over in a latero-ventral direction, so that it partially covered the eye. Besides, the eye was turned posteriorly by almost 90 degrees, so that the white structure visible through the aperture was only a portion of the white of the eyeball. Below the thick outer skin covering of the eye there was another layer of thin skin with a small perforation

corresponding in position to the one in the outer layer of the skin. The space between the two layers was filled up by a fatty tissue. The iris was not circular, as in a normal specimen, but appeared as a narrow vertical oval slit. Though there was no special muscle on the ventral side of the eye fixing it to the bone below, as was the case in the left eye, the hypertrophy of the supra-orbital bone presumably did not allow any kind of movement of the eyeball. The cornea was very thick, fibrous and opaque.

The right eye (text-fig. 2 *b*) was pressed dorso-ventrally to a greater extent than the left, and the iris was slightly smaller. This is clear from the measurements given in the table above. The condition of the internal structures (text-fig. 3 *a*) was similar to that of the left eye, but the degenerate lens (text-fig. 3 *a*, *l.*) was still smaller in size.

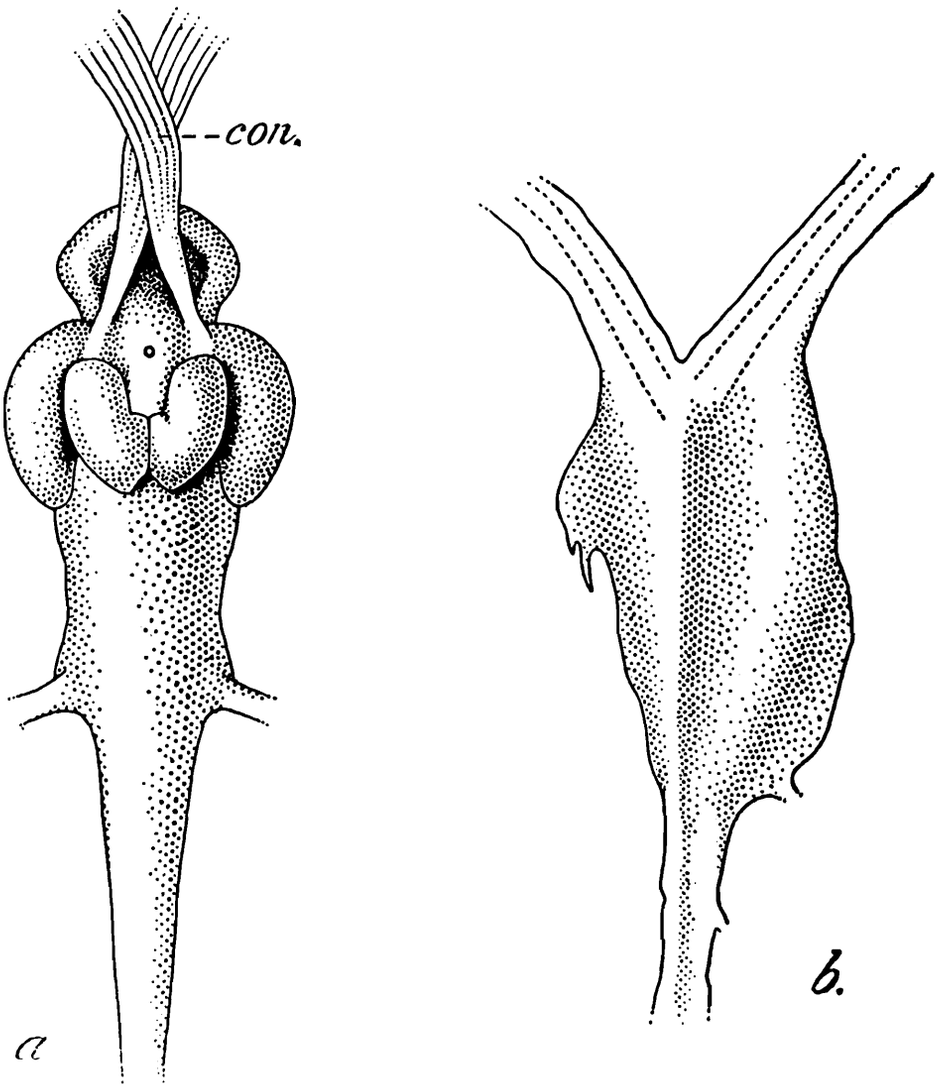


TEXT-FIG. 4.—Dorsal view of the brain, eyes and olfactory organs of a normal and the abnormal Rohu, *Labeo rohita* (Ham.).

a. Normal specimen. *ca*. Nat. size ; *b*. Abnormal specimen. *ca*. Nat. size.
ol. Optic lobe ; *on*. Optic nerve.

Brain.—To examine the brain and the nerves, ths skull was dissected from dorsal side. The brain (text-fig. 4 *b*) was very abnormal. The optic lobe (text-fig. 4, *ol.*) of the left side only was feebly developed, while that of the right side was not at all developed. The optic nerves were thick and rounded. All other cranial nerves were more or less normal. The ventral aspect of the brain (text-fig. 5 *b*) exhibited its abnormal nature more distinctly. It was quite flat but separate areas of the different regions of the brain could be distinguished as in a normal specimen. In the blind specimen there was no crossing of the optic nerves as is normally the case, but the two nerves originated from a forked stump which was a forward elongation of the optic lobe of the left side. The vagal region of the medulla oblongata was fairly distinct on the left side, but completely suppressed on the right. Even in a normal brain of *L. rohita* the vagal and facial lobes are comparatively much reduced ; and differ materially from those of the European Carp (*Cyprinus carpio*) as described by Evans (1931). According to Evans large vagal and facial lobes occur in species which obtain their

nourishment mainly from muddy bottoms. The enlarged left vagal lobe of the blind Rohu may indicate its excessive feeding on the bottom



TEXT-FIG. 5.—Ventral view of the brain of a normal and the abnormal Rohu, *Labeo rohita* (Ham.).

a. Normal specimen. ×3½; *b*. Abnormal specimen ×2⅕.

con. Crossing of the optic nerves.

mud and in this connection it may perhaps be mentioned that the fisherman, who caught this fish, had noticed that its alimentary canal was more bulky and contained a large quantity of mud.

GENERAL DISCUSSION.

It has been remarked above that the case of the abnormal Rohu corresponds to some extent to that of the blind Carp described by von Baer (1862). In both cases the head was well developed and the eyes were covered over by skin though their outlines were indicated. Both the abnormal specimens had been obtained from muddy waters where individuals with well developed eyes were always caught. Though von Baer hinted at the probable absence of light as a cause for the blindness of the fish, he did not possess sufficient data to support his hypothesis. In the case of Rohu, however, I am definitely of the opinion that, in view of a large number of normal individuals being daily caught

from the Bagjola fishery, the absence of light in the bottom layers of certain parts of the fishery cannot be a factor in producing the abormality reported above. The teratological condition of the blind Rohu is probably an outcome of the defective disposition of the brain. The brain must have become defective at a very early stage, and this must have influenced the development of the eyes which make their appearance at a fairly early stage of development. It is probable that the dislocation of various nerve centres in the brain caused the growth of the accessory structures of the abnormal eyes, namely, an extra muscle in the left eye, and the hypertrophy of the normal circular eye-lids which had become almost continuous, and completely covered the left eye and incompletely the eye of the right side, while the hypertrophy of the supra-orbital bone of the right eye may also have been responsible for inhibiting its normal development. The overgrown supra-orbital bone on the right side and the extra muscle on the left side had pushed the respective eyes posteriorly and had rendered them useless as organs of sight, while the circular eye-lids grown over the twisted eyeballs had made it impossible for any light to reach the retinal layers. The lens might have atrophied through disuse, while the hypertrophy of the falciform process resulted in its development into an unusually large structure attached to the entire posterior surface of the degenerate lens. The weight of the fish, the size of the head and the fact that it was caught while migrating from one part of the fishery to another indicate that the fish, though blind, was probably leading a more or less normal life. Probably the loss of the sense of sight had been compensated for by the development of a larger number of sensory papillae on the head. It is also probable that the lateral line organs may have been better developed in the blind fish. In any case the absence or reduction of eye in a fishery like that of Bagjola could not be a factor of very great importance in the life of the fish provided the loss of sight was compensated by a greater development of tactile organs.

Captain S. C. Dutt, Ophthalmic Surgeon, Mayo Hospital, was approached for an explanation of the ocular abnormality reported above, and after examining my preparations and report very kindly favoured me with the following note. I am greatly indebted to Capt. Dutt for the interest shown by him in this matter.

"The ocular condition discussed by Mr. K. K. Nair is obviously congenital and may be due to a more or less combination of the following factors of developmental errors, occurring at that period of Embryonic Life when the Primary Optic Vesicles begin to differentiate :—

"1. Imperfect development of the anterior part of the Neural Tube, resulting in the original cells, from which the two Optic Vesicles sprout out, to become fully and distinctly differentiated into two distinct separately growing areas in the early life of the embryo. This probably accounts for the irregular and abnormal sizes of the Optic Lobes of the fish under investigation. At a later stage, a certain amount of Dual Differentiation appears to have taken place resulting in the development of two separate, abnormal and irregular eyes. If the differentiation into two growing areas had not occurred at all, the condition of the eyes of this fish might have been what is called Complete

Synophthalmia or Cyclopia—One-eyed or United-eyed. Stockard[1] has shown that it is possible to induce such developmental irregularities by subjecting eggs of fishes to the action of magnesium salts dissolved in sea water.

" 2. Failure of the Primary Optic Vesicle in the embryo to bud out normally. When this is complete, it produces Anophthalmia, but when this is partial the result, as in the case of the fish under discussion, is an imperfect ocular growth.

" 3. Failure of the invagination of the Primary Vesicle of the developing embryo. If this failure is absolute, a cystic sort of imperfectly developed eyeball results, but an incomplete failure in invagination during the process of early embryonic development results in an irregular sort of eye structure.

" The abnormal eyes of the blind Rohu represent, in my opinion, a condition of developmental irregularities in the early embryonic life of the organism, *viz.*, irregular and partial arrest of growth of the developing Neural Canal, improper sprouting out of the Primary Optic Vesicles from the original embryonic cells and a certain amount of arrest in the process of normal invagination in the Primary Optic Vesicles in the developing embryo.

" The exact aetiology of the causation of the abnormality under review, is not capable of being clearly explained. We can surmise that, factors like Trauma, Chemical Irritants or some sort of Photo-Chemical Stimulus from surroundings in the embryonic stage of the developing organism's life might have been the agencies which determined the production of the abnormal condition cited.

" Following the lines adopted by Gemmill[2] in discussing the probable causation of Cyclopia, I would place the aetiology of the abnormal ocular manifestation discussed above under one of the following heads :—

" (1) *Mechanical.*—" Trauma " or pressure in a very limited area of the developing embryonic cells, which provoked a minimal degree of interference with the development of other structures.

" (2) Some sort of Chemical or Photo-Chemical substance in the immediate surroundings of the developing egg exerting irritation in some particular sets of growing cells concerned with ocular development, and thereby preventing the normal development of the eyes. As noted already, magnesium chloride and lithium salt experiments of Stockard (*loc. cit.*) and Herbst[3] have proved that certain chemicals specifically influence along these lines the developing eggs of fishes and sea-urchins respectively.

" (3) *Autogenetic* or *Spontaneous origin.*—This is doubtful as a causative factor for the type of abnormality in question. In abrupt spontaneous variations, one is prone to find multiple or at least more than one specimen exhibiting the same kind of perverted development."

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[1] Stockard, C. R., *Journ. Exp. Zool.* VI, pp. 285-337 (1909).

[2] Gemmill, J. F., *Teratology of Fishes*, p. 44 (1912).

[3] Herbst, C., *Zeitsch. f. wissensch. Zool.* IV, pp. 446-518 (1892); *Mittheil. aus der Zool. Station zu Neapel* XI, pp. 136-220 (1893).

SUMMARY.

The abnormal structure of the eyes of a blind Rohu fish, *Labeo rohita* (Ham.) and the provenance of the specimen are described in detail. The eyes were found to be completely or partially covered by skin, while the eyeballs were turned at an angle from their normal position ; the left eye was found to be fixed to its new position by means of a muscle, not present in normal specimens, and the right eye was kept in its new position by a hypertrophied growth of the supra-orbital bone. The brain was found to be defective and asymmetrical in several respects. It is presumed that the brain had probably become abnormal at a very early stage of development, and the normal development of the eyes had thus been inhibited. Reference is made to a similar case of Carp reported by von Baer in 1862. From the size of the specimen it is presumed that the lack of eyes did not affect the normal mode of life of the fish in the Bagjola fishery.

REFERENCES.

Baer, K. E. von. 1862.—Ein Wort über einen blinden Fisch als Bildungs-Hemmung. *Bull. de Academie Imperiale des Sciences de Saint-Petersbourg* IV, pp. 215-220.

Evans, H. Muir. 1931.—A comparative study of the Brains in British Cyprinids in Relation to their habits of Feeding, with special reference to the Anatomy of the Medulla Oblongata. *Proc. Royal Soc. London* B. vol. CVIII, pp. 233-257.