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CORRELATION OF HABITS AND HABITAT WITH BRAIN AND CRANIAL NERVES IN SOME FRESH WATER TELEOSTS : A REVIEW

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During present study a review on scheme of classification of fishes by earlier researchers has been undertaken. An attempt has been made to forward a new scheme of classification by correlating the habits of teleostean fishes with degree of development of brain and development, disposition and branching of the cranial nerves. Besides this, inconsistencies in the different species of genera like *Mystus* and *Labeo* have also been discussed in detail.

INTRODUCTION

Evans (1931-1937), Bhimachar (1935-1937), Sato (1941), Mukerjee et al. (1950), Evans (1952) and Khanna & Singh (1966) classified the different fishes on the basis of the form of their brain. Jhingaran (1975) made a review of all these systems of classifications. Evans (1931) formed three groups, the fish extracting their nourishment from and largely by mouth . taste buds, fishes feeding by sight and fishes which grobe and grab. Bhimachar (1935) separated the fishes into two main groups, the fishes feeding by taste and fishes feeding by sight. The taste feeders were further separated by Bhimachar (1935) into two subgroups, the skin taste feeders, and mouth taste feeders. Sato (1941) separated the fishes into three main groups the mouth taste feeders, skin taste feeders and sight feeders. Mukerjee *et al.* (1950) divided fishes into three main

Table I : Classification of the fishes correlating the habits with the structure of the brain.

Group I	Bottom dwellers : Fishes with well developed olfactory, gustatory or lateral
	senses, sight reduced and skin taste buds well marked where barbels much in use
	for hunting.
Subgroup A	Feeding largely by olfactory and lateral senses : Fishes with olfactory lobes and
	acoustic tubercles prominent and facial and vagal lobes reduced. Ex. *Cynoglossus*
	bilineatus (Lac.)
Subgroup B	Feeding largely by olfactory sense and taste : Fishes with olfactory lobes well
	marked, facial and vagal lobes distinct and equally developed and acoustic
	tubercles prominent. Ex. *Amphipnous cuchia* (Ham.)
Subgroup C	Feeding largely by taste (confined mostly to barbels) : Fishes with facial lobes and
	olfactory bulbs prominent, vagal lobes small and reduced and acoustic tubercles
	prominent. Ex. *Clarias batrachus, Mystus tengara* (Ham.)
Group II	Mid and surface water dwellers : Fishes with well developed sight and olfactory
	sense and gustatory sense confined to mouth. Feeding largely by sight and taste
	(confined mostly to mouth). Fishes with optic lobes and olfactory bulbs prominent
	facial lobes reduced and single, vagal lobes developed, and acoustic tubercles
	not prominent. Ex. *Cirrhina mrigala, Notopterus notopterus.*
Group III	Surface dwellers : Fishes with well developed sight and olfactory and
	gustatory sense reduced. Feeding mainly by sight : Fishes with optic lobes very
	well developed, olfactory lobes much reduced, facial and vagal lobes indistinctly
	present and acoustic tubercles prominent. Ex. *Nandus nandus, Xenentodon*
	cancila, Hilsa ilisha.

groups, the fishes feeding largely by taste, fishes feeding largely by taste and sight and fishes feeding largely by sight. Evans (1952) differentiated the fishes into bottom feeders and upper level feeders and the bottom feeders further into mouth taste feeders and skin taste feeders. Khanna & Singh (1966) classified the fishes into three main groups, the fishes feeding by sight and mouth taste, fishes feeding by barbels and fishes feeding by sight. Saxena (1969) classified the fishes correlating the habits with the form of the brain as described in Table I.

Davis & Miller (1967) have also classified different fishes on the basis of the gross anatomy of the brain in relation to their feeding habits. The classification scheme forwarded by these two workers also resemble with what forwarded by earlier workers like Evans (1931-1937), Sato (1941), Mukerjee *et al.* (1950), Evans (1952) and Khanna & Singh (1966). Animals on the basis of sense of odour perception are classified into three major categories by Moulton & Beidler (1967) *viz.* (1) Macrosmats (with acute sense of odour perception), (2) Microsmats (with feeble sense of odour perception) and (3) Anosmats (without any sense of odour perception).

However, the smell perception in terrestrial animals, the aerosmats, is brought about by odourous particles carried to the site of perception through air. Moreover, in aquatic animals which receive the odourous particles, through water current are called hydrosmats.

The fact that, fishes possess good sense of odour has been established by number of workers like Rissco Risser (1941), Kistiakowsky (1950), Moncriff (1951), Davies (1962 & 1965) and Amoore & Venstrom (1966). These workers also proved that olfactory organs are structures which are meant for the perception of the odour. The olfactory organs in fishes are connected with the brain by means of the olfactory nerves and play vital role in various aspects of the piscine biology like feeding, spawning, schooling, defence, migration and reproduction etc. Besides this Teichmann (1954) have also classified the different fishes on the basis of the dominance of either sight or smell or both during feeding, spawning, schooling, migration, defence and reproduction etc. On the same basis he has classified the fishes into three major categories namely,

- Eye fishes : with sight sense as a.major aspect in piscine life.
- Eye-nose fishes : the sighr and smell senses as amajor aspect in piscine life.
- Nose fishes : with smell as a major aspect in piscine life.

In earlier paragraphs, authors have discussed about the smell sense of fishes. Bone & Marshall (1982) have also reported that the fishes have more senses than ourselves, for they have an elaborate lateralis system, innervated by various cranial nerves, to detect near field vibrations and in addition, a fair number of fishes have modified part of this lateralis system to use it for electro-reception, sometimes using the electroreceptor system for geomagnetic navigation. As compared to terrestrial animals, however, fishes are relatively poorly equipped with proprioceptors. Bone & Marshall (1982) reported that probably the absence of an important proprioceptive sense in fishes is related to the relatively insignificant role that gravity plays in lives of fishes and to the damping of movements by the medium. Lagler *et al.* (1962) described that many fishes rely on sight for capturing food, for receiving signals that bring on or complete mating behaviour and for finding and relocating shelter which are only some of the aspects of the fish behaviour that are sight dependent or sight influenced. The fact that the surface feeder fishes mainly rely on sight for the feeding, schooling, migration, reproduction and defence etc., has also been established by earlier workers like Evans (1931-1937), Bhimachar (1935-1937), Sato (1941), Mukerjee *et al.* (1950), Evans (1952), Teichmann (1954), Khanna & Singh (1966), Davis & Miller (1967) and Saxena (1969).

Authors also observed during present investigation that in fishes like *C. catla, N. nandus, X. cancila* and *H. ilisha* both the optic lobes and optic nerves are highly developed and formation of optic chiasma is at its best, which indicates that the use of sight may be at its best in piscine life in the following specimens and the fact is that these fishes fall under the category of surface feeders. Authors examined during present investigation that in the fishes like *L. rohita, M. vittatus, C. labuca, C. mrigala and W. attu* the sense of smell (mainly by coordination of olfactory lobes and olfactory nerves) and sense of sight [mainly by the coordination of optic lobes and optic nerves) was equally developed and hence indicates the mid-column feeding habits of these fishes. The fact that the mid-column feeding fishes have almost equally developed smell and sight senses has also been established in different fishes by earlier workers like Evans (1931-1937), Bhimachar [1935-1937), Sato (1941), Mukerjee *et al.* (1959), Evans (1952), Teichmann (1954), Davis & Miller (1967) and Saxena (1969) during their investigation. Authors noticed during present investigation that in bottom feeding fishes like *B. bagarius, R. rita, L. bata, A. cuchia, M. artmatus, C. labuca, C. striatus, C. batrachus, H. fossilis and M. seenghala* mode of innervation of cranial nerves was different with that of surface and mid-column feeder fishes. The fishes having barbels were supplied with facial nerve at its best in these specimens while in surface feeding fishes having no barbels, the nerve supply by the facial nerve ends in the skin, without any branching. Because of major role of barbels, olfactory and lateral senses during feeding habits the nerve supply to these parts of body is at its best.

Bone & Marshall (1982) described that the fishes are also equipped with large numbers of solitary chemoreceptors and taste buds which in some specialized fishes are used in the same way as the olfactory and visual systems for detection of food, which they supported from the findings. Bardach and his colleagues who, as cited by Bone & Marshall (1982) showed that bull heads (*Ictalurus*) could detect food over 5 m away using the taste buds of the barbels and body. Taste buds contain secondary cells innervated in fishes by cranial nerves like facial, glossopharyngeal and vagus which synapse at bases of the sensory cells. Bone & Marshall (1982) reported that conditioning experiments to determine taste threshold have only been carried out on a few fishes, like minnows can detect sucrose at 2×10^{-5} M and NaCl at 4×10^{-5} M, much more dilute solutions than we can ourselves detect. Author during present investigation noticed that the taste buds (present on skin, barbels and mouth) were innervated by the cranial nerves, facial, glossopharyngeal and vagus at its best in fishes like *W. attu, M. vittatus, M. seenghala, C..batrachus, H. fossilis, B. bagarius and R. rita* etc., indicating better use of gustatory receptors during piscine life. Bone & Marshall (1982) have also described that the taste buds are often found on special organs, such as barbels or free fin rays which may be highly motile and use to probe the substrate for food. They also described that Mullets and goatfish have exceptionally mobile barbels which are equipped with numerous proprioceptive sensors so that the fish locate food and then can turn and snap it up.

Correlating the habits with the degree of development of the brain.and development, disposition and branching of the cranial nerves, the fishes selected for the present investigation namely *Clarias batrachus, Catla catla, Rita rita, Nandus nandus, Xenentodon cancila, Hilsa ilisha, Chela labuca, Cirrhina mrigala, Labeo rohita, Mystus vittatus, Wallago attu, Amphipnouscuchia, Bagarius bagarius, Channa striatus, Heteropneustes fossilis, Labeo bata, Mastacembelus armatus, Mystus seenghala* may he grouped in classses given in Table II.

It is difficult for the authors to correlate their scheme of classification as in past no such scheme of classification of fishes based on the development, disposition and branching of cranial nerves has been forwarded by earlier workers. However, the scheme of classification forwarded

Table II : Classification of some fishes correlating the habits with the degree of development of the brain.

Class 1	Bottom feeders : The bottom dwelling fishes are with well developed olfactory
	tracts which swells up seldom to form olfactory bulb before innervating the
	olfactory rosette. Glossopharyngeal and facial nerves are also well developed and
	branched to innervate the gustatry and taste buds present on the barbels, skin and
	mouth. Besides these, vagus nerve was also found dominantly disposed.
Subclass I	Fishes feeding with the help of olfactory and lateral senses : These fishes are with
	well developed olfactory and auditory nerves. The facial nerves on the other hand
	is not that much developed, however, the vagus nerve which make supply to the
	lateral line sense organs is found better developed as compared to the facial nerve
	e.g. *Bagarius bagrius, Rita rita* and *Labeo bata.*
Subclass II	Fishes feeding with the help of the olfactory sense and taste : These fishes are with
	well developed olfactory nerves, in many cases olfactory bulbs are also prominently
	developed. Facial and vagal nerves are also better developed as compared to the
	fishes falling under subclass I. The auditory nerve also exhibits better degree of
	development as compared to the fishes of subclass I. *e.g Amphipnous cuchia,*
	Mastacembelus armatus, Chela labuca and Channa striatus.
Subclass III	Fishes feeding with the help of taste buds chiefly present on the barbels : The fishes
	falling under this category are characterized by having well developed facial and
	olfactory nerves. The auditory nerve is also well formed in this case but the vagus
	nerve is poorly developed. *e.g. Clarias batrachus, Hetropneustes fossilis and*
	Mystus seenghala.
Class 2	Column feeders : Fishes chiefly feeding with the help of visual, olfactory and
	gustatory impulses (that too confined to the mouth). These fishes are with equally
	developed olfactory and optic nerves. Vagus nerve is also well developed in these
	fishes, facial nerves are, however, little developed as compared to the fishes failing
	under Class 1. *e.g. Wallago attu, Cirrhina mrigala, Mystus vittatus and Labeo*
	rohita.
Class 3	Surface feeders : Fishes feeding chiefly with the help of sight : Fishes falling under
	This category are with very well developed optic nerves and they do exhibit the
	formation of the optic chiasma at their best. The olfactory nerves are well
	developed as compared to the fishes of class 1 & 2. Vagus nerve shows difference
	in its development, it is found well developed in *Hilsa ilisha* and poorly developed
	in case of *Catla catla, Nandus nandus* ans *Xenentodon cancila.*

by Evans (1931-1937), Bhimachar (1935-1937), Sato (1941), Mukerjee *et al.* (1950), Evans (1952), Teichmann (1954), Khanna & Singh (1966), Davis & Miller (1967) and Saxena (1969) show topography of various parts of the brain. The observation used by the author for classifying the fishes also shows the similar developed nerves and their faculties which were employed by the earlier workers to classify the different fishes. Thus the present observation also support the scheme of classification forwarded by the earlier workers. The authors feel incorporation of cranial nerves too with the brain for making the classification of fishes on the basis of brain, topography and feeding habits. There are certain inconsistencies in the two genera of fishes selected for the present investigation like *Mystus and Labeo.* The *M. vittatus* falls in Class 2, the column feeder, feeding chiefly with the aid of visual, olfactory and gustatory impulses, however, its counterpart *M. seenghala* falls in Class 1, the bottom feeder, feeding mainly with the, aid of taste buds present on barbels. Similar difference was also marked in case of *L. bata and L. rohita.* The former falls in Class 1. The bottom feeders, feeding with the help of olfactory and lateral senses whereas the *L. rohita* falls in Class 2, the column feeder, feeding with the aid of visual, olfactory and gustatory senses. In authors opinion these differences might be due to individual adaptability of fish due to either different demand of fish or due to struggle for existence. Besides this, the author also feels that a thorough probe on this issue is urgently required from behaviour biologists and evolutionary biologists..

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