HEARING IN FISHES AND REPTILES

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Very little work has been done on trie hearing capacity or mechanism of the lower vertebrates in India. Several experimenters such as Kreidl (1895) concluded that fishes were deaf or, at best, could receive some vibrations through cutaneous sense. Only after Bigelow (1904) and others, it was proved conclusively that fishes do perceive sound. In this study an attempt is made to evaluate the hearing capacity of a few fishes and reptiles of South India.

In fishes, in addition to the inner ear, a series of integumentary sense organs, known as lateral line system are present, which perceives displacement of the medium and near field sounds of low frequency range (Harris and Van Bergejik, 1962, Tavolga, 1971). It is thus obvious that the hearing mechanism in lower vertebrates differs vastly from those of man and other mammals, and a comparison of the different hearing mechanisms could be of special interest. While it is known that some of the lower vertebrates have the capacity to hear air conducted sounds, it is said that snakes perceive sounds by bone conduction (Tumarkin, 1968).

Materials and Methods

Three species of telecost fishes namely *Rhinomugil corsula* (Mullet), *Tilapia mossambica* (Tilapia) and *Anabas scandans* (Indian climbing perch), a lizard, *Calotes versicolar* (common garden lizard), md the following snakes: *Ply as mucosus* (yellow and black rat snakes), *Coluber fasciolatus* (Banded Racer), *Boiga ceylonensis* (Ceylon cat snake), *Eryx jhoni* (Sand Boa) and *Dryophis nasutus* (Green whip snake) were used for this study. Of these snakes, Boiga and Dryophis are poisonous snakes (Rajendran, 1968).

An audiometer (BEL) with provision for pure tone and speech audiometry was used for the study along with an activity chamber modified by Kutty *et al.*, (1971) connected to an electronic counter

The experimental animal was left inside the transparent plastic annular activity chamber and the two earphone of the audiometer with ear cushions were snugly fitted to the two top wells of the chamber. This unit was kept inside a wooden box to shut off external light and disturbance. A peep hole covered

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with a one way plastic viewer, was used for observing the animal. The interior of the box was lighted from above. There was provision for measuring the random activity of the animal when it moved round the chamber. This was facilitated by focusing two beams of light (directed from outside of the chamber) on two photocells fixed in the inner hollow of the annular activity chamber. When the animal moved and cut the beam of light the event was counted and a record of the activity per unit time was made.

In the case of fishes, the activity chamber was filled with water leaving an air column at the top of the wells and there was provision to flush the chamber with fresh water continuously by means of a circulatory system. As for *Calotes versicolar* and snakes, the animals were left in the chamber as such and their activity observed. In addition to random locomotary activity of the animal, other behavioural changes were also observed and recorded.

Results and Discussion

Fishes

All the three species of fishes tested responded to pure tones. Different behavioural changes were observed in the three species. In the case of mullet, its random locomotor activity increased when subjected to the sound as could be seen from the data given in Table 1.

TABLE 1. Hearing Response in Rhinomugil Corsula. (Increase of Locomotor activity).

Mean Weight: 36.5 cms. Water Temp.: 25°C.
Mean Length: 16.5 cms. Room Temp.: 27°C.

Frequency c/s	10 dB	20 dB	30 dB	40 dB	50 dB and above
125		+	+	+	+
250	—	+	+	+	+
500	—	+	+	+	+
1000	—	+	+	+	+
1500	—	—	+	+	+
2000 and above	—	—	—	—	—

Thus it is seen that Mullet, which is a non-ostariophysid in which Weberian ossicles are absent can perceive frequencies upto a maximum of 1,500 cycles/ second only and the hearing threshold was found to be about 20 dB. The lateral line system helps in perceiving only low frequency tones. This finding is in conformity with that of Maliukina (1960).

Anabas scandans and *Tilapia mossambica,* the two other species of fishes did not show any significant change in locomotory activity and hence other behavioural changes like movement of the eye balls were studied in both these species.

The rate of movement of the eye balls was found to be lesser when they were subjected to pure tones of various frequencies. Hearing response in *Anabas scandans* is shown in Table 2.

TABLE 2. Hearing response in anabas scandans. (Decreased eye ball movements).

Mean weight:	26.5 cms.	Water Temp.:	2S°C.
Mean length:	10.5 cms.	Room Temp.:	27°C.

Frequency c/s	10 dB	20 dB	30 dB	40 dB	50 and above
125		+	+	+	+
250	—	+	+	+	+
500		+	+	+	+
1000	—	+	+	+	+
1500		+	+	+	+
2000			+	+	+
3000			+	+	+
+000				+	+
6000 and above	—	—	-	—	

From above it is obvious that as regards frequency discrimination *Anabas scandans* can hear tones upto 4,000 Hz., threshold of intensity for the various frequencies being 20 to 30 dB HTL. This is in conformity with the observation that ostariophysids which have a swim bladder connected with the internal ear by means of a chain of ossicles known as Weberian ossicles, perceive high frequency sound (Enger, 1968; Tavolga, 1971). The fish *Anabas scandans* has also an accessory respiratory organ known as iabyrinthiform organ—an air pocket in the head which also aids in auditory function. The sound converted as pressure wave touching the fish is amplified by the swim bladder or any other air pocket in the fish. In spite of this, the non ostariophysids are also able to perceive sound frequencies though at a lower level. Behavioural study in response to pure tone transmission in *Tilapia mossambica* further confirmed that the hearing in non-ostariophysids is limited to the low frequencies as shown in Table 3.

TABLE 3. Hearing responses in tilapia mossambica. (Decreased Eye Ball movements).

Mean Weight:	30 cms.	Water Temp.:	25°C.
Mean Length:	12 cms.	Room Temp.:	27°C.

Frequency c/s	10 dB	20 dB	30 dB	40 dB	50 dB and above
125		+	+	+	+
250	—	+		+	+
500	—	+	+	+	+
1000	—	+	+	+	+
1500 and above			–	—	—

A study of the 3 species of fishes confirmed the view that ostariophysids have a better hearing range than the non-ostariophysids. But the threshold of hearing was about the same 20 to 30 dB HTL in both ostariophysids and non-ostariophysids. It appears that the ostariophysids possess the lowest auditory thresholds and highest upper frequency limits. This is undoubtedly a function of the Weberian apparatus which couples the auditory signal received by the swim bladder to the inner ear in a manner analogous to the operation of the middle ear ossicles in man. Other air chambers can serve in similar fashion, as, for example, the branchial cavity in the labyrinthine fishes (Schneider, 1941).

It is known that fish could be subjected to conditioned reflexes and most of the earlier observations in sound perception in fishes were made by using conditioning technigues fEngor, 1968). We checked this theory of sound localisation and conditioning reflexes in fishes. In a particular temple in South India (Papanasam temple in Tirunelveli) it is a custom that the priest after offering 'Archanas' to the deity steps out from the temple and moves down to the river. He continuously rings the bell and having got down into the water throws cooked rice which is eagerly devoured by the fishes in large numbers. All these fishes belong to four species of carps (ostariophysids). We conducted experiments in this particular place. After the priest has once fed the fishes, we requested him to remain in the water without ringing the bell. The fishes disappeared, but promptly returned on ringing the bell. This certainly indicates that there is a positive response to the sound of bell and that they are conditioned to that sound as a prelude to feeding. Subsequently, we erected a cloth partition at the bank of the river and sounded a smaller bell but the fishes did not respond. However, when the temple bell was rung again the fishes gathered. From this it could be inferred that the fish (carps) in that river has been conditioned to that temple bell, that is, to its particular frequency.

In this study as sound is produced in air and transmitted through the water mainly as pressure waves there is a probability that the intensity of the sound perceived by the fish is less than the level at which it is produced though the frequency may remain the same (Enger, 1968).

Garden Lizard

Calotes Versicolar, the garden lizard was screened for its hearing capacity, but no locomotor or behavioural changes could be elicited, in spite of repeated attempts at various frequencies and intensity of pure tones. Calotes is known to be an inactive reptile in which locomotor and behavioural changes are manifested to a lesser extent. Earlier studies on activity and metabolism of calotes revealed the same (Kameswaran *et al,* 1973). Its habit could well have rendered this animal not to react to any sound that was not indicative of any immediate danger, i.e., threat. Perhaps more precise methods employing neuro-physiological techniques may yield accurate information on the hearing capacity of this sluggish reptile.

Snakes

None of the snakes responded to pure tones. However, all of them responded to music both instrumental and drum, fed to the activity chamber by means of an audiometer at 50 and 100 dB IITL. The results are shown in Table 4.

TABLE. 4 Hearing response in snakes: Room Temp.: 27°C

Species	Pure Tor.e	MUSIC 50 dB	MUSIC 100 dB
Ptyas mucosus (Yellow)	0		+ + +
Ptyas mucosus (Black)	0		+ + +
Coluber fasciolatus	0	+ + +	+ + +
Boiga ceylonensis	0	+ +	+ + +
Eryx jhoni	0	00	00
Dryophis nasutus	0	00	00

0=No response in any frequency even upto a maximum of 100 dBs.
+ =Mild response. + + = Fair response + + + = Good response.
00=No response.

Ptyas mucosus (Yellow rat snake) when exposed to the music of predominant low frequency tones at 100 dB the visible normal respiratory movements suddenly stopped and was followed by hurried respiration indicating fright. For the same music at 50 dB, the response was only mild. The response was similar in the case of black variety also.

Coluber fasciolatus (Banded racer) when screened responded markedly to music by moving its head from side to side. Its response was good both at 50 and 100 dB HTL.

Boiga ceylonensis (Ceylon cat snake) exhibited continuous movements normally as also when pure tones were fed, but responded well to music by abrupt cessation of movements.

Eryx jhoni (Sand Boa) and *Dryophis nasutus* (green whip snake) the other two snakes also tested in this study, did not show any definite response at all, to either pure tones or the music. Eryx was highly inactive and indifferent and Dryophis though active, did not respond to sound appreciably.

In all these cases, the reaction seemed tO be one of fright.

Previous work on the endolymph and allied fluids of fish and mammalia (Kameswaran, *et ah,* 1972) and the effect of labyrinthine disturbance on metabolism and activity in certain vertebrates (Kameswaran *et al.,* 1973) has shown that the inner ear as such is primitive in fishes and less markedly developed in reptiles. Hence the hearing capacity in these animals, is limited.

Summary

A study on hearing responses was carried out on selected fishes, calotes and a few snakes.

It was found that in fishes the highest frequency range upto 4000 cycles/second was noted in *Anabas scandans*, an ostariophysid. In the other two, non-ostariophysids, *Rhinomugil corsula* and *Tilapia mossambica*, the highest frequency range was found to be 1,500 and 1000 Hz respectively.

There was no significant variation in hearing thresholds between the ostariophysids and non-ostariophysids, which was about 20 to 30 dB.

Calotes versicolar by virtue of its inactive nature was found to be indifferent to the extraneous sounds employed in this study perhaps neuro-physiological techniques will only yield useful information on its hearing.

It is interesting to note that snakes did not respond to pure tones irrespective of the frequency or intensity, whereas they responded only to music which was of predominant low frequency and that the response was chiefly one of fear.

Of the snakes, studied, *Ptyas mucosus, Coluber fasciolatus* and *Boiga ceylonensis* exhibited very good response to sounds, whereas *Eryx jhoni* and *Dryophis nasutus*, showed no definite response.

The results of this study confirm that the fishes and reptiles have a much limited hearing range when compared to man.

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