

ON SOME EYE-ABNORMALITIES IN THE MALABAR SOLE,  
*CYNOGLOSSUS MACROSTOMUS* NORMAN

By G. SESHAPPA

*Central Marine Fisheries Research Institute, Cochin*

INTRODUCTION

IN a previous note (Seshappa, 1970) the present author has described a specimen of *Cynoglossus semifasciatus* Day with the right eye on the 'blind' side of the head, almost in the original unmetamorphosed symmetrical position, and the left eye in its normal adult position on the coloured side of the body; this is apparently the first instance of this kind recorded for any flat-fish in the Indo-Pacific region. Two more such specimens with the eyes situated in positions similar to the above have been since discovered. Also a large number of instances of eye-abnormalities of various degrees have been noticed by the author so far in the routine collections of this species examined during the years 1965-69. As the position of the eye and its migration form a very important part of the metamorphosis in the flatfishes, these specimens have been examined in some detail and the present paper gives an account of the results of these studies together with a discussion of the probable significance of the various abnormalities noticed.

I am thankful to Shri K. N. Krishna Kartha for reading through this paper.

DETAILS OF EYE-ABNORMALITIES

Table I shows the sizes, dates of collection and other details relating to 20 selected cases of eye-abnormalities in *C. macrostomus* from West Hill, Calicut. These are classified into four categories and are described below.

(a) *Cases with one eye missing*.—Most of the abnormalities are instances of one of the eyes being absent; the missing eye is more frequently the right eye than the left eye. In most of these the eye seems to have been lost by some injury or predation; the area of the missing eye is usually marked by a small depression, the injury itself being in various states of repair. In most of the specimens tabulated here, the repair is nearly complete and the skin shows normal pigmentation and general appearance though the scales are smaller in the depression than in the surrounding area of the skin. Instances of fresh wounds are not very frequent in collections examined and are not included here.

(b) *Reduction in the size of the right eye*.—The second category of eye-abnormality includes cases where the left eye is normal in position and size, but the right

---

\*The Malabar sole is to be called *Cynoglossus macrostomus* Norman, instead of *C. semifasciatus* Day, hereafter according to Menon (1970).

eye is highly reduced in size though it occupies the normal adult i.e. metamorphosed position. Two good examples of this type are available in the present material, one caught on 24-2-1967 and the other on 9-9-1966. In the former specimen the right eye measures only 0.5 mm while the left eye which is of normal size, measures 1.4 mm in diameter; in the other, the abnormal right eye measures 1.0 mm while the normal left eye measures 2.2 mm. in diameter. In normal individuals of the species the two eyes are about equal in diameter, though not always exactly so. In both these cases the specimens are otherwise completely normal. It is difficult to state whether the small eyes in the two specimens mentioned here are functional or not, though for all outward appearance they are normal except for size.

TABLE I  
Details relating to 20 abnormal-eyed specimens of *C. macrostomus*

Sl. No.	Date and locality	Total length (cm.)	Sex	Remarks on abnormality
1.	7-8-65 ; W. Hill near shore	10.5 cm.	male	right eye absent ; site repair incomplete.
2.	18-11-65 ; W. Hill	12.10 cm.	female	right eye absent; caudal fin regenerated.
3.	3-2-66 ; W. Hill, 3F.	11.2 cm.	„	Left eye absent.
4.	10-2-66 ; W. Hill, 6F	10.3 cm.	„	-do-
5.	-do- -do 3F.	8.4 cm.	„	Right eye absent.
6.	20-5-66 ; W. Hill, 6F.	13.8 cm.	„	Left eye absent.
7.	12-8-66 ; W. Hill, 2F.	6.3 cm.	„	Right eye absent.
8.	-do- -do-	9.1 cm.	„	Right eye hidden in head in normal adult position.
9.	9-9-66 ; W. Hill	14.3 cm.	male	Right eye very small.
10.	-do- -do-	12.4 cm.	female	Right eye absent.
11.	24-2-67 ; W. Hill	7.8 cm.	„	Right eye very small.
12.	1-6-67 ; Velleyil	7.7 cm.	male	Right eye absent.
13.	24-11-67 ; W. Hill, 3F.	8.1 cm.	?	Right eye fully developed but in original unmetamorphosed position in blind side.
14.	-do- -do-	7.5 cm.	male	-do-
15.	29-12-67 ; W. Hill	9.9 cm.	female	-do- (described in separate note).
16.	9-2-68 ; W. Hill, 6F.	7.4 cm.	male	Right eye absent.
17.	23-2-68 ; W. Hill, 6F.	9.6 cm.	„	Right eye hidden in head.
18.	-do- -do- 3F.	11.2 cm.	female	Right eye hidden under skin on blind side.
19.	8-3-68 ; W. Hill, 3F.	11.0 cm.	male	Right eye hidden under skin on left side.
20.	22-3-68 ; W. Hill 6F.	9.5 cm.	„	Right eye absent.

(F.=fathoms)

(c) *Cases of hidden right eye.*—The third category includes cases where the left eye is normal but the right eye is hidden inside the tissues of the head. There are three instances of this kind listed in the above table. In specimen No. 18, the eye could be easily exposed by teasing the skin covering it; in another case (specimen No. 19 in the table) the hidden eye is in the normal position beneath the skin on the left side, i.e. in the metamorphosed position; in specimen No. 17, the eye is situated so deep within the tissues that its presence can be noticed (without dissection) only by means of transmitted light. Such cases can possibly be mistaken at first sight, for cases of loss of eye with the site repaired. Detailed examination will however not leave any such doubts normally.

(d) *Cases of normal right eye developed in the larval position without participation in the metamorphosis.*—In this category are included individuals of the kind mentioned in the introduction, with the left eye in the normal adult position, and the right eye also well-developed but situated in the original larval position without taking part in any rotation or movement. Three such specimens are listed in the table, one of these three having been described in detail with a photograph in the note which is separately under publication. In all these cases the right eye appears to be quite normal.

It may be mentioned here that in all the four categories described above, the individual soles are otherwise normal and apparently unaffected by the eye-abnormality.

#### DISCUSSION AND CONCLUSIONS

Seshappa and Bhimachar (1955) have described in detail the shifting of the eye from the right to the left side in the metamorphosis of *C. semifasciatus* Day, and have also reported a very interesting case under experimental conditions where in three metamorphosing individuals the eye of the blind side failed to shift to the opposite side but remained imbedded in the tissues of the head thus resulting in one-eyed specimens after metamorphosis. Records of one-eyed condition are rare in nature, though instances of arrested rotation of the eye have been reported (see Dean 1923, Kyle 1923 and Holt 1894).

The rotation of the eye has been one of the most important problems in the study of the metamorphosis of the flatfishes. Norman (1934) while dealing with the metamorphosis and eye migration in *Pleuronectes*, *Pseudopleuronectes* and *Scophthalmus* (as observed by various authors) states that early in the metamorphosis a supra-orbital bar of cartilage is formed on both sides of the head (this being the precursor of the frontal bone on either side) and that it soon disappears by resorption on the blind side, with the exception of the postorbital portion and sometimes also a small part at the anterior end; the eye is said to pass through the gap thus created till it reaches the supra-orbital bar of the opposite side which latter becomes twisted over to that side of the head by the movement of the two eyes into their final position; the ethmoid region of the chondrocranium is also similarly affected; the supra-orbital bar of the ocular side is subsequently resorbed except as a stump anteriorly. Norman concludes: 'It seems improbable that any twisting of the skull has been brought about by the effort made by the fish to see with the lower eye. . . . the movement of both eyes into their final position on the side of the head is accompanied by a certain degree of torsion of the orbital part of the cranium, but this is certainly not caused by the migration of the eye'.

In the present work, the internal structure of the head of these abnormal specimens has not been studied, but as far as can be made out from external appearance it is apparent that metamorphosis has been complete and normal except for the peculiarity connected with the eye. Considering the three important categories (b, c and d cited above) in the light of the findings of Seshappa and Bhimachar (1955) it seems that *C. macrostomus* is an instance that supports Norman's view that the eye-rotation and the torsion of the cranium are independent of each other. The impoundment of the right eye inside the tissue of the head is obviously a case of retardation and arresting of the movement of this eye while the other processes of the metamorphosis have progressed normally. The factors inducing the retar-

dation and even the complete non-initiation of the rotation of the right eye would be a matter of speculation. In the experimental work of Seshappa and Bhimachar cited above the abnormalities that were reported occurred when the larvae were kept in darkened containers during both day and night; and no such abnormality occurred when the containers were not darkened, though the controlled experimentation was of a limited nature only. While there was some indication that the failure of the eye-rotation may be due to lack of light, it was also interesting that in both darkened and un-darkened containers the metamorphosis took place in the night only! Thus the question of the controlling factors associated with this interesting phenomenon remains still unsolved; it seems not impossible however, that the abnormalities described here were caused by some peculiarities in the environment forcing the metamorphosing individuals to remain in continued darkness during the critical stages of their lives.

#### SUMMARY

Four categories of abnormalities of eye have been found in the Malabar sole, *Cynoglossus macrostomus* Norman (= *Cynoglossus semifasciatus* Day) from the West Hill area at Calicut, during the period 1965-69 and the details relating to 20 of these individuals are tabulated. In the majority of the abnormal specimens one of the eyes is lost (presumably due to some injury or predation) and the site is repaired. In two individuals the right eye is in the normal adult position but is very small. In three other cases the eye has failed to complete its migration and has consequently been hidden inside the head either just beneath the skin or much deeper. There are also three cases where the right eye is well-developed and apparently functional but has remained in its original larval un-metamorphosed position although the metamorphosis is other wise complete and normal, the specimens being fully grown adults.

It is thus noticed that all stages of arrested rotation linking the completely normal cases of metamorphosis with those of the right eye remaining absolutely in its original larval position occur in this species. This occurrence, considered along with the normal metamorphosis in the species and also the abnormal cases described by Seshappa and Bhimachar (1955), seems to support Norman's contention that in the flatfishes the rotation of the eye and the torsion of the cranium are independent of each other.

#### REFERENCES

- DEAN, B. 1923. *A Bibliography of Fishes*, 3 : 615.
- KYLE, H. M. 1923. The asymmetry, metamorphosis and origin of flat fishes. *Phil. Trans. Roy. Soc. Lond.*, B, (211), pp. 87 & 105.
- HOLT, E. W. L. 1894. Cited by Norman, 1934.
- MENON, A. G. K. 1970. On the specific identity of the Malabar sole. *J. mar. biol. Ass. India*, 11: 311-315.
- NORMAN, J. R. 1934. *A systematic monograph of the flat fishes (Heterosomata)*, 1, London.
- SESHAPPA, G. AND BHIMACHAR, B. S. 1955. Studies on the fishery and biology of the Malabar sole, *Cynoglossus semifasciatus* Day. *Indian J. Fish.*, 2 : 180-230.
- SESHAPPA, G. 1970. An interesting case of an adult sole, *Cynoglossus semifasciatus* Day with a normal eye on the 'blind' side of the head. *J. mar. biol. Ass. India*, 10 (2) : 401-402.