ULUA MANDIBULARIS (MACLEAY) (CARANGIDAE, PISCES), A NEW RECORD FROM THE INDIAN SEAS

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ABSTRACT

The paper reports for the first time the occurrence of *Ulua mandibularis* in the Indian seas. A detailed description of the species is given including several important and additional characters. The changes in body form, in the soft dorsal fin length and in the dentition with growth of fish are described and illustrated.

A study of the descriptions of *U. mandibularis* (Macleay) and *U. richardsoni* Jordan and Snyder in the light of the present observations reveals them to be synonymous, the latter being the junior synonym.

INTRODUCTION

The occurrence of *Ulua mandibularis* (Macleay) is reported here for the first time from the Indian seas, based on collections from the Andaman Sea (at Port Blair, Andamans), the Palk Bay and the Gulf of Mannar around Rameswaram Island. The present record makes the distribution of this species almost continuous from the east coast of Africa to North Queensland, the reported distribution of this species being, "Coast of British East Africa; East Indies area" (Williams, 1958), and North Australia, North Queensland and New Guinea (Marshall, 1964). It was also reported from the Seychelles by Smith and Smith (1963). A detailed description of the species is given here including several important and additional characters. The affinity between *U. mandibularis* and *U. richardsoni* Jordan and Snyder is also discussed.

MATERIAL AND METHODS

Material examined comprised one specimen from Andamans (270 mm TL, 205 mm SL) collected on 2-8-1963 from a stake net operated at about 10 meters depth and 16 specimens of different sizes in the range of 122-368 mm TL (96.5-284 mm SL) collected from Rameswaram Island during 1966-68 from drift nets operated at 15-50 meters depth. In the description of the species given below, the range and mean (in parantheses) of the various body proportions and counts of specimens from around Rameswaram Island are given first followed by the corresponding figures for the Andaman material. Determination of scutes and calculation of the 'mean lateral

TABLE 1. *Counts of gill rakers of the four branchial arches and the lateral line scales and scutes*

a. *Counts of gill rakers* (left side)

Branchial arch	I	II	III	IV
Upper	24-26(25.5),24	6-9(7.7),7	5-8(6.3),5	4-6(4.9),4
Lower	53-59(55.5),53	33-38(35.5),34	31-35(33.1),30.0	27-34(30.3),26
Total	79-85(80.9),77	40-46(43.2),41	37-43(39.4),36	32-40(35.2),30

b. *Counts of scales and scutes*

	Curved portion		Straight portion (up to caudal base)		Over caudal base (hardened scales)	Combined count of scales and scutes (up to caudal base)
	Scales	Scutes	Scales	Scutes		
Left	51-66(59.0),54	Nil	0-6(2.9),3	26-35(30.9),27	6-12(9.6),9	87-99(92.8),84
Right	53-63(58.5),50	Nil	0-5(1.9),4	26-35(31.2),29	5-12(9.5),7	84-98(91.6),83

Dentition—All teeth small and short, most of them bluntly conical but some slightly recurved, soft and deciduous. Teeth present on both jaws, on vomer and palatines; no teeth on tongue but fine papillae present in young; all variable with growth of fish (Fig. 1 A, B). Upper jaw teeth in young fish (up to about 145 mm SL) in a narrow band; in older ones they become less prominent due to overgrowth of tissue and tend to form more or less a single row. Lower jaw teeth in young fish remain almost as a single row to a great extent forming a very narrow band anteriorly; in older fish teeth appear relatively smaller, sparse and lie in a single row; hard bony crests alone present in place of teeth in some intervening regions of the lower jaw; the posteriormost 4-5 lower jaw teeth prominent in small fish but become obscure in older ones. Head of vomer with dense recurved teeth which in larger fish tend to become obscure by overgrowth of tissue. Palatine teeth in a broad band in young fish, and in a single row covered over by tissue in older ones. The fine papillae on tongue become obscure in fish about 175 mm SL.

As per cent of standard length: depth at D_2 43.5-56.9(51.9), 48.3; depth at D_1 40.6-55.9 (48.7), 45.4; depth at hind margin of head 39.5-52.9 (46.6), 43.4; depth at hind margin of eye 31.0-38.8 (35.7), 32.7; longest gill-raker of outer arch 6.2-7.9 (7.2), 7.3; longest gill filament of outer arch 5.2-5.8 (5.4), 5.4; snout 9.7-10.9 (10.3), 10.7; eye (bony orbit) 8.10-11.9 (10.7), 10.2; eye (fleshy orbit) 6.0-9.4 (8.2), 7.6; interorbital space 8.5-11.9 (10.3), 10.2; suborbital width 3.7-5.2 (4.6), 4.4; post-orbital width 12.7-14.7 (14.0), 13.7; head (from snout) 29.2-32.8 (31.4), 30.7; head

line ratio' (MLR) were made according to Berry (1959), at whose suggestion were also made the gill-raker counts from the four branchial arches, and the counts of scales and scutes on the curved and straight part of the lateral line.

Three specimens have been deposited in the Reference Collection Museum of the Central Marine Fisheries Research Institute, Mandapam Camp (Reg. No. CMFRI-F.82/613).

DESCRIPTION

GENUS *ULUA* JORDAN AND SNYDER, 1908

Ulua Jordan and Snyder, 1908 (orthotpye, *Ulua richardsoni* Jordan and Snyder=*Caranx mandibularis* Macleay 1883).

Ulua mandibularis (Macleay)

Caranx mandibularis Macleay, 1883; *Ulua richardsoni* Jordan and Snyder, 1908; *Ulua richardsoni* Wakiya, 1924; *Ulua richardsoni* Oshima, 1925; *Ulua mandibularis* Mc Culloch, 1924; *Carangoides mandibularis* Fowler, 1928; *Ulua mandibularis* Weber and de Beaufort, 1931; *Ulua mandibularis* Williams, 1958; *Ulua mandibularis* Marshall, 1964.

D. VIII + I, 20-22 (20.9), VIII + I, 21; A. II + I, 17, same;
Pect. I, 19-20 (19.1), I, 19; MLR. 1:1.1—1:1.3 (1:1.2), 1:1.3
the straight portion of lateral line (posterior limit being caudal base) is longer.

Body subovate in young, becoming more elongate in older ones (Pl. I). Dorsal profile more convex than ventral. Predorsal median line down to nostrils sharp-edged. Cleft of mouth between centre and lower third of eye. Adipose eyelid narrow and thin. Lips sharp-edged. Maxilla reaches centre of eye. Lower jaw forms a prominent 'chin'. Scales on head and body small, wanting on breast ventrally and laterally in a triangular area from behind base of pelvics to a little beyond base of pectorals. Curved portion of lateral line joins straight part under 8th-11th dorsal ray. Dorsal spines weak. Pectorals falcate. First dorsal ray produced, reaching almost to tip of caudal lobe in young (96.5 mm SL) and gradually shorten with increase in size of fish. Lobes of dorsal and anal formed by 5-6 and 4-5 rays respectively and covered by scales. Two oblique caudal keels present on either side of caudal base (one specimen, 258 mm SL, had three lower caudal keels). A shallow dorsal and ventral caudal pit present.

Gill rakers long, each raker with a single row of fine processes of unequal length along the inner margin; tips of anterior rakers extend to a little beyond base of tongue. In a lateral view of the gaped mouth, tips of anterior 8 to 16 gill rakers of outer arch are visible only in fish above 128 mm SL, below this size they are scarcely visible, perhaps due to the relatively posterior position of the base of tongue and the tip of the lower limb of branchial arch. Gill rakers longer than gill filaments. Counts of gill rakers of the four arches, and of the lateral line scales and scutes are given in Table 1.

(from lower jaw tip) 30.6-34.5 (32.7), 32.2; maxilla 14.4-16.4 (15.1), 15.1; lower jaw: length 16.6-19.8 (18.7), 19.0; height at anterior end 2.7-3.5 (3.1), 3.4; height at middle 6.1-7.2 (6.7), 6.3; maximum height 7.9-9.5 (8.7), 8.3; pectoral 37.3-43.1 (40.2), 40.5; pelvic 11.6-17.6 (13.9), 12.2; height of 3rd dorsal spine 9.8-12.5 (11.3), broken; height of D_2 45.4-73.5 (63.5), broken; height of anal 28.0-44.4 (33.9), 27.3; height of upper caudal lobe 28.7-32.8 (30.5), 30.7; least height of caudal peduncle 3.9-5.5 (4.6), 4.4; maximum width of caudal peduncle 4.8-5.9 (5.4), 5.1; length of curved part of lateral line 31.2-37.0 (34.9), 32.7; and length of straight part of lateral line 38.4-43.2 (40.8), 42.9.

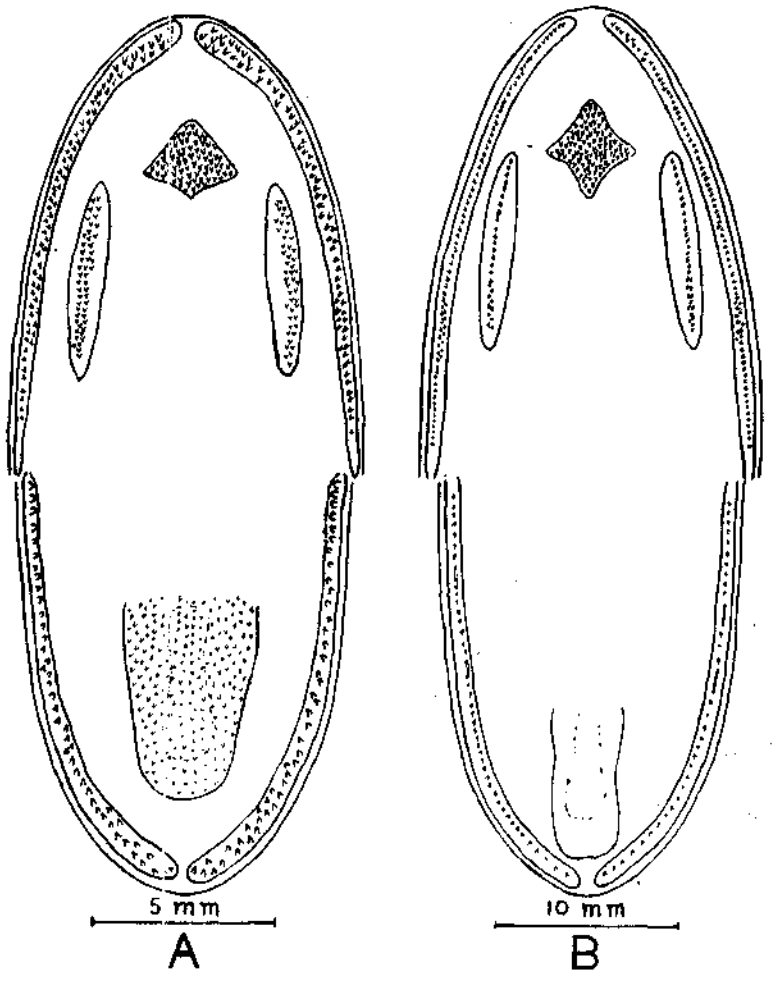


FIG. 1. Semi-diagrammatic representation of dentition in *Ulua mandibularis* at 128 mm TL (102 mm SL) (A), and at 234 mm TL (180 mm SL) (B). The structure within the mandibular arch is the tongue which is covered by papillae in (A). Almost similar pattern of dentition as in (B) is present at 368 mm TL (284 mm SL).

Colour— 4-8 hours after death, body light blue-green above and silvery below; head dusky with a tinge of blue-green above, silvery below; snout-tip and chin black; margins of dorsals and anal dusky, rest hyaline; margin of caudal dark; pectoral with black axillary patch; no spot or black patch on opercle or shoulder, but Williams (1958) mentions, "On large (specimens) darkish area at shoulder, but no distinct spot." Seven dusky vertical bands on each side of fish up to 116 mm SL, the first band being on snout and the seventh on caudal peduncle.

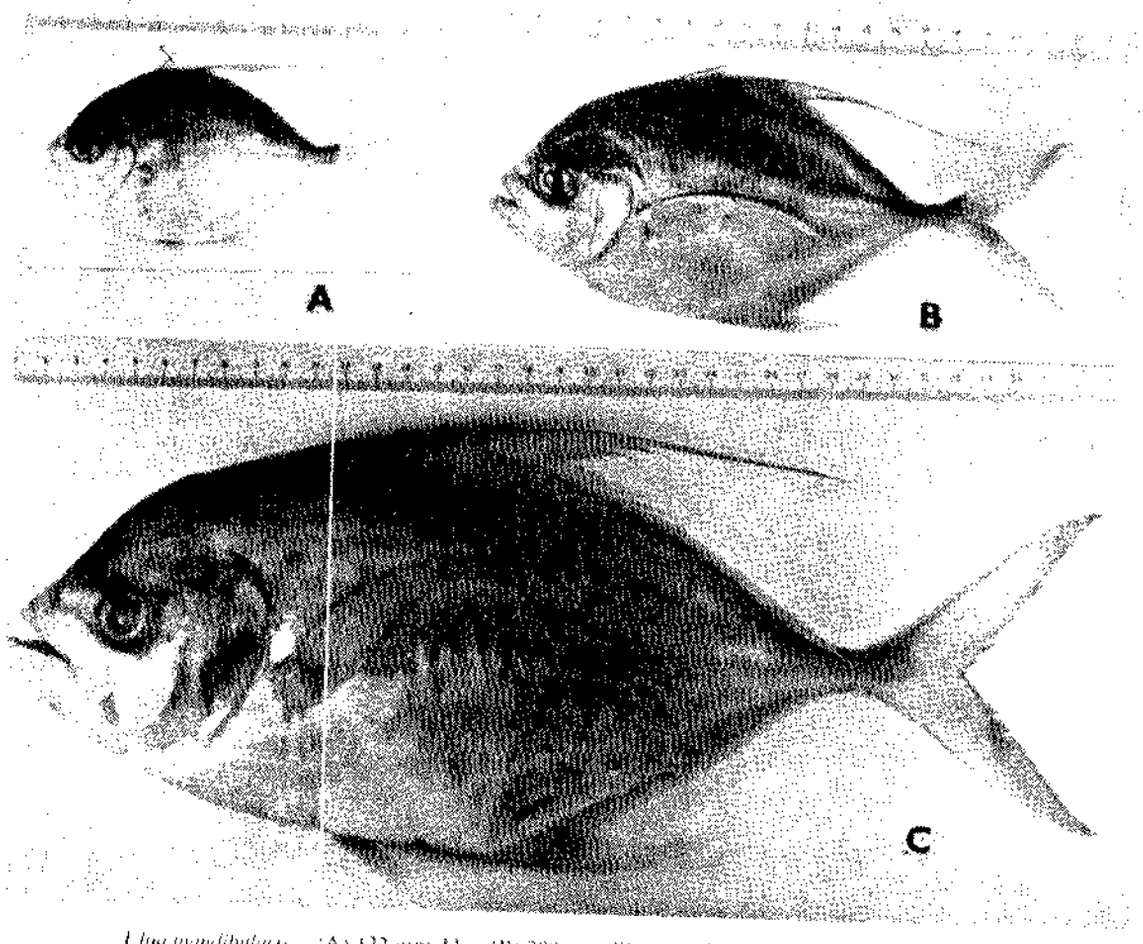
Abnormalities— (i) In a specimen 228 mm SL, in both the outer gill arches the anterior nine gill rakers of the lower limb were irregularly curved, the distal portions of 10-14 gill rakers were fused, and the 15th gill raker, although fused, was also irregularly curved. (ii) In a specimen 153 mm SL, the curved portion of lateral line behind its 37th scale, gave rise to a short backwardly directed branch with six scales which, however, were not included in the scale count.

Changes with growth of fish— The subovate form of the body of very small-sized fish changes to oblong shape in larger ones showing an apparent decrease in the height of the body. This is accompanied by the failure of the tip of the second dorsal fin lobe to reach the upper caudal lobe in larger specimens. Thus a decrease in the growth rates of these two characters seems to be associated with an increase in size of fish (Pl. I).

Diameter of orbit, width of inter-orbital space and length of pelvic fin also show the same growth trend. The oblong body form becomes obvious in fish beyond 200 mm TL. In smaller sizes the frontonuchal outline is convex, with a slight rostro-frontal concavity. In larger specimens the dorsal profile between snout to occiput is steep, and thereafter it rises more gently to origin of soft dorsal. The procumbent spine of first dorsal is exposed in fish up to 144 mm SL and occasionally up to 180 mm SL, but it gets embedded in flesh in older specimens. Growth changes in teeth pattern are given in the section on dentition. Tongue does not keep pace with the growth of other parts of mouth region and it occupies a relatively anterior position in older fish (Fig. 1).

AFFINITY WITH *ULUA RICHARDSONI* JORDAN AND SNYDER

According to Herre (1953) two species are known under the genus *Ulua*, viz., *U. richardsoni* Jordan and Snyder 1908, and *U. mandibularis* (Macleay) 1883, the former being the orthotype. However, the validity of *U. richardsoni* appears to be doubtful. The other two authors besides Jordan and Snyder (1908) who described *U. richardsoni* viz., Wakiya (1924) and Oshima (1925) made no reference to *U. mandibularis* in their accounts. Similarly the authors who described *U. mandibularis* viz., Weber and de Beaufort (1931), Hardenberg (1934) and Roxas and Agco (1941) made no reference to *U. richardsoni*. Mc Culloch (1926) appears to be the first who recognised the similarity between these two species. Recently Williams (1958) mentioned *Caranx mandibularis* Macleay 1883 as the type of the genus *Ulua* Jordan and Snyder 1908, and Marshall (1964) seems to suggest *U. mandibularis* to be the



Uha mandibularis (A) 132 mm FL, (B) 200 mm FL and (C) 368 mm FL, to show the relative reduction in body depth and soft dorsal filament length, and also the change in profile with increase in size of fish

(Photographs by Mr. S.P.D. Ghansani and Mr. C. Mukundan.)

Facing p. 184

only species under the genus *Ulua*. But both made no reference to *U. richardsoni*. Similar implication is apparent in Weber and de Beaufort's account of *U. mandibularis* (P. 261) under whose habitat they included Formosa, the type locality of *U. richardsoni*, with a query, perhaps indicating the two species to be same. However, there seems to be no account wherein the two species are explicitly considered as synonymous.

TABLE 2. *Combined total ranges of body proportions and meristic counts compiled from different authors on* U. richardsoni [1] *and* U. mandibularis [2], *together with the observations of the present author*

		U. richardsoni (Sizes 303, 457 mm TL)	*U. mandibularis* (Size range 162-658 mm SL)	Present author (Size range: 122-368 mm TL, 96.5-284 mm SL)
1.	Dorsal fin	VII+21[3], VII+1,21	V-VIII+I,20-21	VIII+I,20-22
2.	Anal fin	III+16[4], II+I, 17	II+I, 17-18	II+I, 17
3.	Pectoral fin	20 (I, 19)	I, 18-I, 21	I, 19-20
4.	Scales on lateral line	About 90	—	87-99
5.	Scutes	About 20[5]-32	About 20[6]-33	26-35
6.	Gill rakers	24-28 upper; 54-58 lower	24-27 upper 1+50-59 lower	24-26 upper; 53-59 lower
7.	Depth in standard lengh (SL)	2.17-2.33	1.80-2.81	1.75-2.30
8.	Head in SL	3.46-3.50	2.60-3.87	3.05-3.43
9.	Pectoral fin in SL	2.40-2.45	2.40	2.32-2.68
10.	Caudal fin in SL	3.25	—	3.05-3.49
11.	Snout in head	3.00-3.43	3.09-3.62	2.79-3.26
12.	Eye in head	3.60-4.90	3.11-5.66	2.67-3.61(3.46-4.88)[7]
13.	Pelvic fin in head	2.48-2.66	2.63-3.40	1.82-2.68
14.	Maxillary in head	2.10-2.25	1.96-2.23	1.97-2.24
15.	3rd Dorsal spine in head	2.75-3.50	2.94-4.59	2.55-3.20
16.	Length to gill-raker in head	3.50-4.25	—	3.86-5.17
17.	Inter-orbital space in head	3.26-3.33	3.58-4.14	2.67-3.46
18.	No. of rays in dorsal fin lobe	4-6	5-6	5.6
19.	Keel over base of caudal on each side of the median row of Scutes	Present	Present	Present
20.	Colour of pectoral axil	Black	Black	Black

1. Jordan and Snyder (1908), Oshima (1925).
2. Macleay (1883), Mc Culloch (1924), Weber and de Beaufort (1931), Hardenberg (1934), Roxas and Agco (1941), Williams (1958) and Marshall (1964).
3 & 4. D. VII+I, 21 and A. II+I, 17 could be counted in the figure in Jordan and Snyder (1908), Plate LIII.
5. 30 scutes could be counted on lateral line in the figure in Jordan and Snyder (1908), Plate LIII; counts made from 7th scale of straight part of lateral line to base of caudal fin.
6. It is not possible to verify this count in Mc Culloch (1926).
7. Eye diameter taken between inner margins of eye lid.

The figure of *U. richardsoni* was from the type, a specimen 18 inches (457 mm) long. Its body shape largely conforms to the one figured here (Pl. I, C) from a specimen 368 mm TL. Jordan and Snyder (1908) have mentioned that "a cotype measuring 9 inches (229 mm) from the same locality has the interorbital area slightly lower, the soft dorsal decidedly filamentous, the tip extending backwards to middle of caudal fin.....". This is similar to the condition seen in *U. mandibularis*. Further, a comparison of the body proportions, meristic counts and other characters of the two species of *Ulua* from published accounts, together with the present author's observations (Table 2), reveals a very close similarity between the two species except that *U. richardsoni* was reported to be edentulous. It is possible that the minute dentition which is normally partially covered by tissue in fish of the sizes examined (303 and 457 mm TL) would have been overlooked by the authors. Mc Culloch (*op. cit.*) remarked: "The two typical specimens of this species (*U. mandibularis*) are preserved in the Macleay museum and a co-type is in the Australian Museum. They are very similar to the figure of *U. richardsoni*, but have the frontal profile a little more convex, the eye larger and a few more anal rays." In a personal communication Mr. Frederick H. Berry states "I can find no difference between the illustration and description of *Ulua richardsoni* by Jordan and Snyder, and that described for *Ulua mandibularis* by both Williams and by Weber and de Beaufort ..... I would presume the two species to be synonymous .....".

From the foregoing account it would appear that *Ulua mandibularis* (Macleay) and *Ulua richardsoni* Jordan and Snyder are synonymous, the latter being the junior synonym.

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References

Berry, F.H. 1959. Young jack crevalles (*Caranx* species) of the Southeastern Atlantic coast of the United States. *U. S. Fish and Wildl. Serv. Fish. Bull.*, **59** (152): 417-535.

Fowler, H.W. 1928. The Fishes of Oceania. *Mem B.P. Bishop Mus.*, **10**: 151.

Hardenberg, J.D.F. 1934. Some new or rare fishes of the Indo-Australian Archipelago III. *Treubia* **14**: 291.

Herre, A.W.C.T. 1953. Check list of Philippine Fishes. *Fish and Widl. Serv. Res. Report*, **20**: 286.

Jordan, D.S. and J.O. Snyder. 1908. Description of three new species of carangoid fishes from Formosa. *Mem. Carnegie Mus.*, **4** (2): 39-41, Plate LIII.

MACLEAY, W. 1883. Contribution to a knowledge of the fishes of New Guinea No. II. *Proc. Linn. Soc. N. S. Wales*, 7: 356-357.

MARSHALL, T.C. 1964. *Fishes of the Great Barrier Reef and Coastal water of Queensland.* Angus and Robertson Ltd., Halstead Press, Sydney, 225 pp.

MC CULLOCH, A.R. 1924. Ichthyological items. No. 2. *Mem. Queensl. Mus.*, **8** (1): 75.

OSHIMA, M. 1925. The carangoid fishes of Formosa. *Philippine J. Sci.*, **26**: 405.

ROXAS, H.A. AND A.A. AGCO. 1941. A review of the Philippine Carangidae. *Philippine J. Sci.*, **74**(1): 49.

SMITH, J.L.B. AND M.M. SMITH. 1963. *The Fishes of Seychelles.* Dept. of Ichthyology, Rhodes Univ., Grahamstown.

WAKIYA, Y. 1924. The carangoid fishes of Japan. *Anns Carnegie Mus.*, **15** (2&3): 210.

WEBER, M. AND L.F. DE BEAUFORT 1931. *The Fishes of the Indo-Australian Archipelago*, 6: 266-267.

WILLIAMS, F. 1958. Fishes of the family Carangidae in British East African Waters. *Ann. Mag. nat. Hist.*, (13) **1**: 411-412.

AGE AND GROWTH OF THE HORSE-MACKEREL, *CARANX KALLA* (CUV. AND VAL.)

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ABSTRACT

The length frequency distribution method was used to trace the growth and assess the age of *C. kalla*. This species attains a length of about 82 mm at the end of its first year, 132 mm at its second year and 167 mm at its third year.

Recruitment to the inshore fishery of this fish appears to take place twice a year, the major one in December-January and the minor one in July-August. The local inshore fishery is seen to be supported by the II year group fish.

By using Walford's growth transformation method the values of 'k' and $L\infty$' obtained for *C. kalla* are 0.71 and 271 mm respectively.

INTRODUCTION

Caranx kalla is one of the major species contributing to an important horse-mackerel fishery of the Malabar coast of India. In spite of this, no detailed information on the biology of this species is available in the literature excepting for a few general remarks made in the publications of the Madras Fisheries Department (Chacko and Mathew, 1955; Chidambaram and Venkataraman, 1946). A comprehensive study on the biology of this species was, therefore, undertaken and the preliminary observations have already been published (Kagwade, 1965). The present paper deals with the age and growth of this species.

MATERIAL AND METHODS

C. kalla was collected from the commercial catches made by boat seines, locally called *paithuvala*, and gill nets, *chalavala*, in the inshore waters off Kozhikode. Specimens were also obtained from the catches made by regular experimental fishing operations carried out weekly or biweekly in the inshore waters off Kozhikode by the department.

The cycloid scales and otoliths were examined for growth marks but they were not found helpful. Hence, the assessment of growth for this species is based on the length frequency distribution method.

The total length of 2,979 fish from 74 samples, collected randomly between January 1958 and December 1960, was measured to the nearest millimeter. They were within the size of 26 and 169 mm and were grouped under 29 size groups with 5 mm class intervals.

Samples from boat seines and gill nets were analysed separately. During certain months there were no landings by boat seines. Further, in order to get a clearer picture of the length frequency distribution, the samples from boat seines and gill nets were pooled together and analysed.

Length Frequency Distribution

Boat seine catch

In all 49 samples consisting of 2,233 fish from boat seines were measured during the period from January 1958 to December 1960.

In Fig. 1 three modes *a* to *c* are seen in January 1958 at 137, 117 and 82 mm respectively. Of these the mode *a* shifts to 142 mm in April and to 167 mm in November 1958. The mode *b* moves to 122 mm in February, 127 mm in April and to 142 mm in November 1958. The mode *c* shifts progressively to 117 mm in November 1958. In January 1959, that is twelve months after the first observation, three modes *c*, *d* and *e* are seen at 137, 117 and 87 mm. Of these, the one at 137 mm can be traced back to the mode *c* of January 1958, thus showing an increase in growth of 55 mm in a period of twelve months. In January 1958 the mode *c* at 82 mm apparently represents the average growth of fish one year younger to those represented by the mode *a*.

The mode *d* seen at 72 mm in July 1958 almost corresponds to the position occupied previously by the mode *c* in January 1958. Mode *d* further moves on to 117 mm in January 1959 and corresponds to the mode *b* in January 1958. This shows that the time lapse between the modes *b* and *c* is six months. Further movements of mode *d* cannot be traced from February onwards. In January 1959, the mode *e* appearing at 87 mm shifts to 122 mm in December 1959. The movement of mode *e* in the said period is parallel to that of the mode *c* from January to November 1958. Again in August 1959, another mode *f* is seen at 87 mm which almost corresponds to the position occupied previously by the mode *d* in July 1958; it subsequently moves to 117 mm in six months, i.e., by February 1960 and by August of the same year. It shows that in about twelve months it attains the value of 137 mm. In December 1959 another mode *g* appears at 87 mm and it can be traced to the value of 112 mm in October 1960. Its progression is more or less parallel to that of modes *c* and *e* for the comparable time intervals. In October 1960, the mode *h* at 57 mm can be traced up to December 1960 when it attains the value of 67 mm.

Gill net catch

Although gill nets operated throughout the three-year period except during monsoon, they landed *C. kalla* only in twelve months. During this period 25 samples consisting of 746 fish were measured.

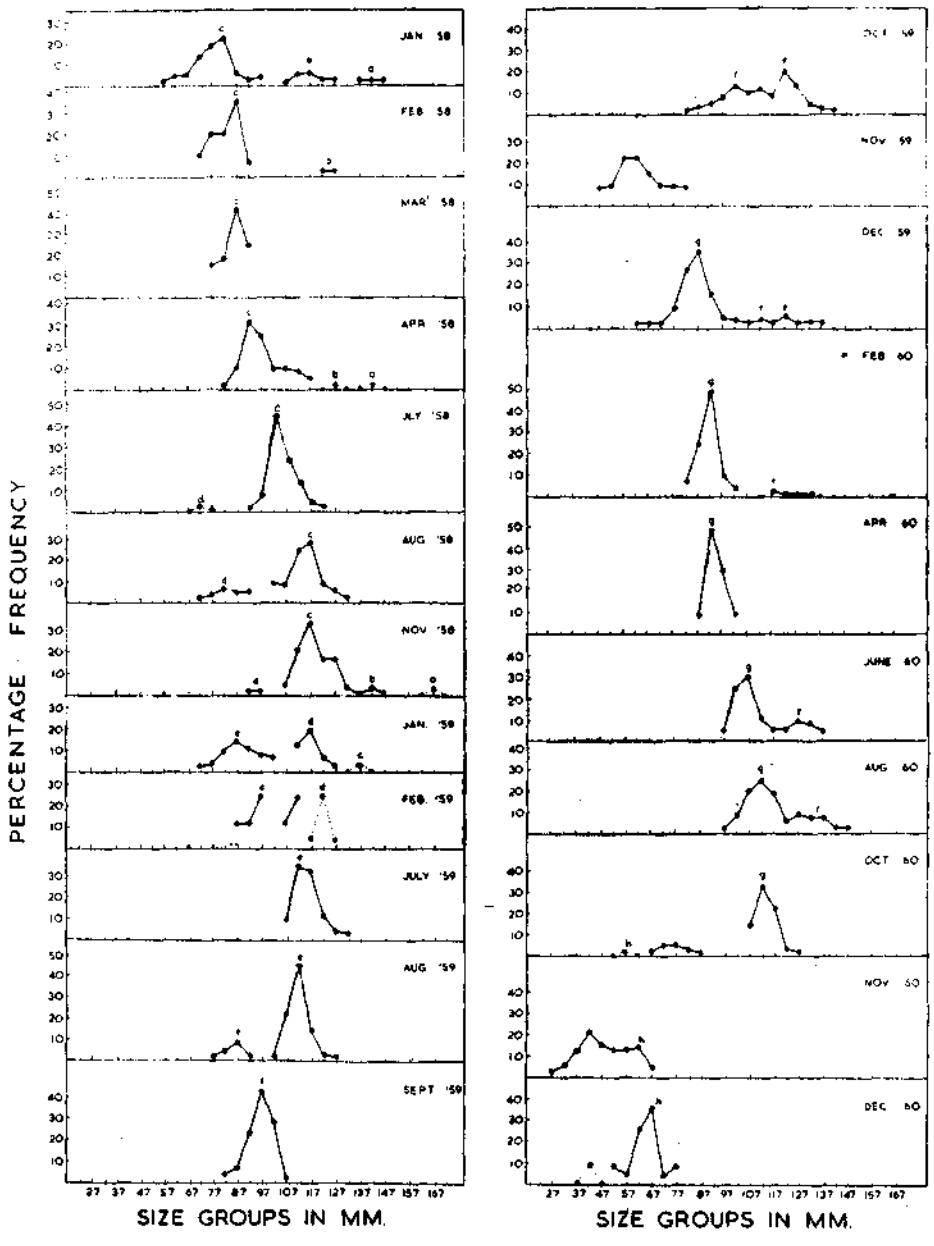

FIG. 1. Length frequency distribution of *C. kalla* in the boat seine catches.

In Fig. 2 there is a mode at 102 mm in April 1958, and in December 1958 there are two modes, b^1 at 157 mm and c^1 at 127 mm. Though it is rather difficult to establish the identity of the mode in April with certainty in the absence of landings from May to November 1958, it is likely that it is the same mode as c^1 of December 1958. It is seen in the figure for boat seine catch, that the mode c of November 1958 shifts to 137 mm in January 1959. So it is probable that the mode c^1 in December 1958 may represent the growth of mode c of November in Fig. 1. If so, the mode c^1 may correspond to mode c in Fig. 1 and similarly the mode b^1 may correspond to mode b in the same figure. In February 1959, two other modes, namely, d^1 at 122 mm and e^1 at 92 mm are seen. Comparing this distribution with that of the same month in Fig.1, it can be seen that the mode d^1 corresponds to d and e^1 to e. The mode d^1 shifts to 142 mm in May 1959, while the mode e^1 shifts progressively to the right to attain the value of 127 mm in February 1960. In December 1959, there is a mode g^1 at 87 mm which shifts to 97 mm May 1960. It can be seen that this mode g^1 corresponds to mode g of Fig. 1.

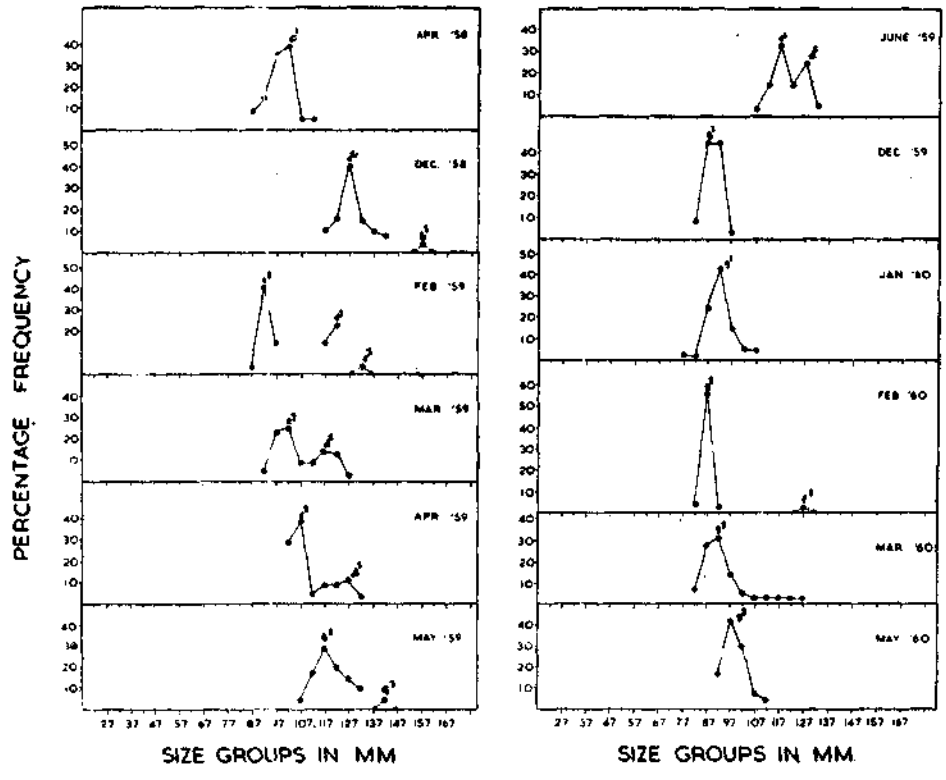

FIG. 2. Length frequency distribution of *C. kalla* in the gill net catches.

Pooled data from boat seine and gill net catches

From the earlier account it is clear that the length frequency distributions in boat seine and gill net catches are more or less the same. In the months when both the gears landed this fish, the gear-wise analysis showed the appearance of modes in the same or nearly the same positions. In those months when one of the gears did not land *C. kalla*, the length frequency distribution in the catch of the other gear showed the progressive growth of different modes serving as the links in building up continuous series. The smallest fish collected from the boat seine measured 26 mm, while that from the gill net 77 mm. This difference may be due to gear selectivity, but it is seen above that as far as the length frequency distribution for this species is concerned the results are not vitiated even if the samples from both boat seine and gill net catches are pooled together. Therefore, in order to follow the unbroken series of distribution, the samples are pooled and the resulting frequency distribution is presented in Fig. 3.

It can be seen that the pattern of the modal progression in Fig. 3 is more or less the same as that for the boat seine catch. The mode *A* at 137 mm corresponding to mode *a* of boat seine catch can be traced from January to November 1958 when it attains the value of 167 mm. The mode *B* at 117 mm corresponding to mode *b* of boat seine and b^1 of gill net catches moves from January to December 1958 to attain the value of 157 mm. The mode *C* at 82 mm in January 1958, corresponds to mode *c* of boat seine catch and c^1 of gill net catch and it can be traced till May 1959 when it measures 142 mm. The mode *D* at 72 mm corresponding to mode *d* of boat seine and d^1 of gill net catches, can be traced from July 1958 to June 1959 when it attains the value of 127 mm. The mode *E* at 87 mm corresponding to mode *e* of boat seine catch and e^1 of gill net catch can be traced from January 1959 to February 1960 at 127 mm. The mode *F* at 87 mm corresponding to mode *f* of boat seine and f^1 of gill net catches can be traced from August 1959 to August 1960 at 137 mm. The mode *G* at 87 mm in December 1959, corresponding to mode *g* and g^1 of boat seine and gill net catches respectively, is noticed to move to 112 mm in October 1960 and the mode *H* at 57 mm in October 1960, corresponding to the mode *h* of boat seine catch, to 67 mm in December 1960.

Deduction of age groups

It is seen that the fish after attaining about 82 mm length adds about 50 mm in the subsequent twelve months and about 35 mm in the next. Now, if one considers that the fish measuring about 82 mm in length as six months old, then it has to attain the length of 107 mm at the end of its first year's growth by adding about 25 mm in the next six months, and measure 149 mm at the end of its second year by adding another 42 mm. This means that the growth of 107 mm in the first year suddenly decreases to only 42 mm in the very next year. Again the maturity study has shown that the size at first sexual maturity for this fish is 124 mm (Kagwade, 1968). If 82 mm is supposed to be the growth in the first six months then there will be a wide

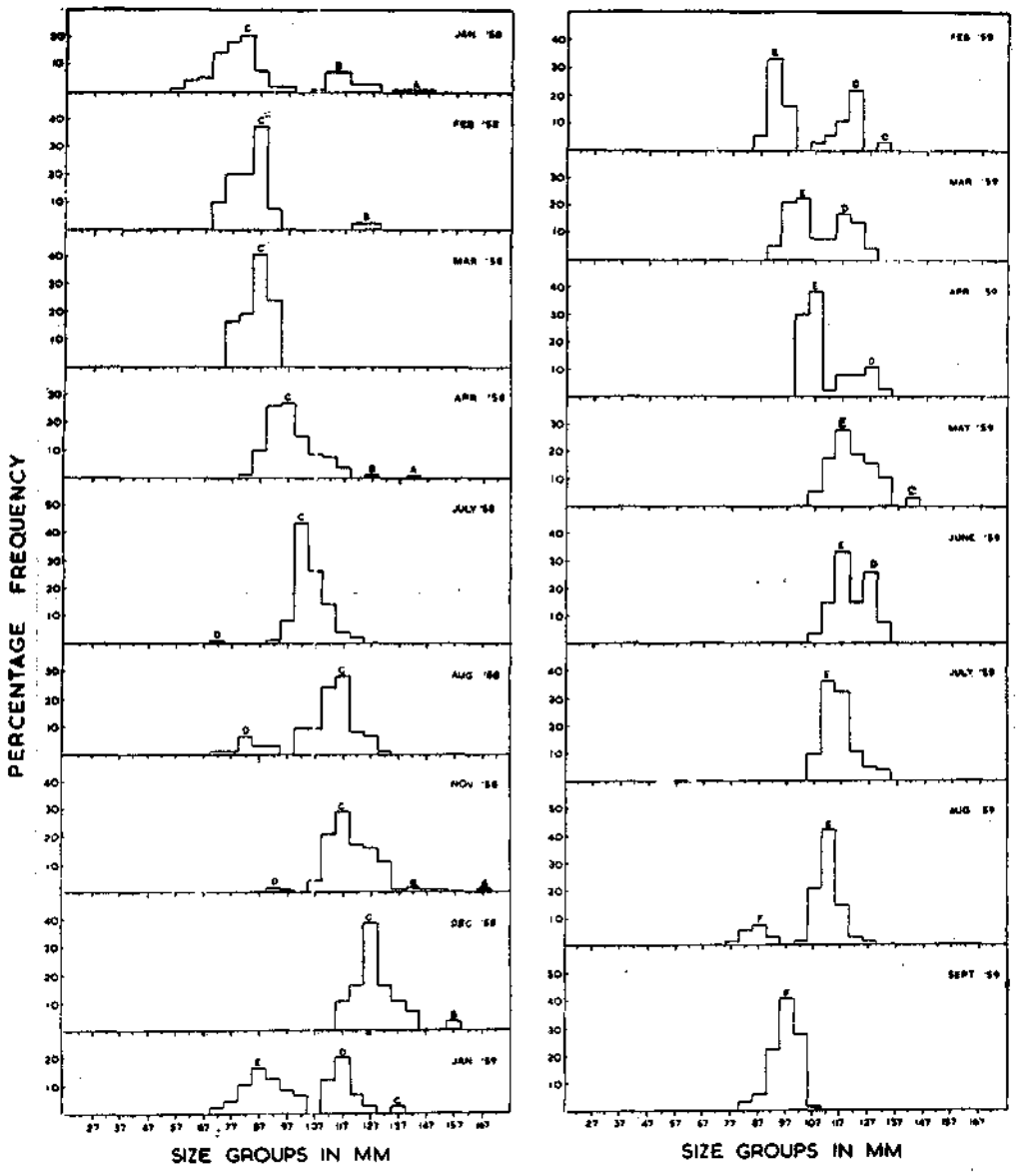

FIG. 3. Length frequency distribution of *C. kalla* from the pooled data of the boat seine and gill net catches.

range in the growth rates of the fish in its immature stage. In the first six months it will grow at the rate of 13.7 mm per month and thereafter, till it matures, the growth rate will be only 4.1 mm per month. These growth rates seem rather unconvincing and also inconsistent with the observed growth rates of a variety of fishes mentioned in the literature.

The maturity study has indicated two peak spawning periods in this species, the major one being in December-January and the minor in May-June (Kagwade, *loc. cit.*). Two recruitments, corresponding to these two spawnings, are evident in

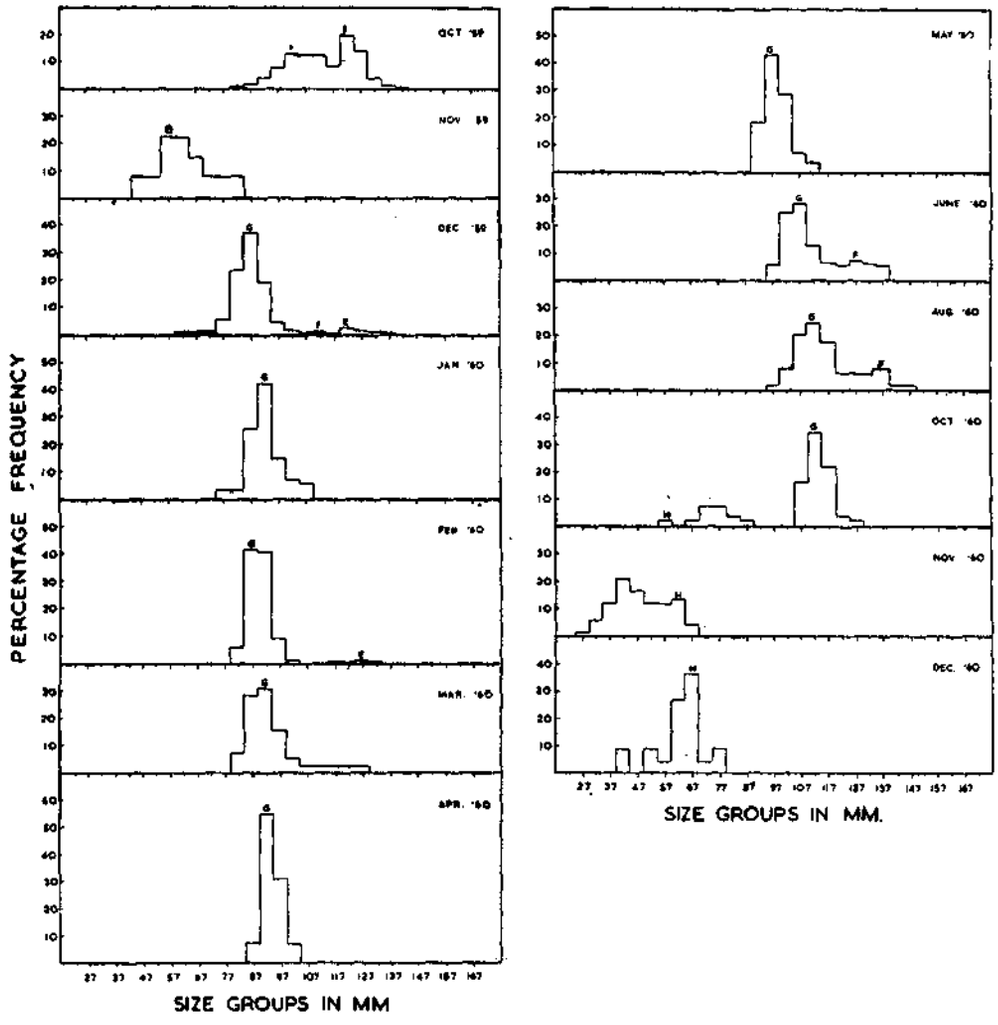

FIG. 3. *Continued.*

the length frequency histograms also. Since in the present study the major recruitment is noted to be in December-January and only a minor one in July-August, it is unlikely that the fish recruited in greater numbers to the fishery at the size of about 82 mm in December-January belong to the minor spawning of May-June and thus be six months old, but instead, they seem to be the progeny of December-January spawning and hence one year old.

Because of the above reasons, 82 mm fish is considered as one year old and in the process of growth it adds 50 mm in the second year and 35 mm in the third year. These growth rates appear to be reasonable and, hence, it is apt to conclude that *C. kalla* measures about 82 mm at the end of its first year, 132 mm at the end of its second year and 167 mm at the end of its third year.

The modes *A*, *C*, *E*, *G* and *H* of the pooled data and the corresponding modes *a*, *c*, *e*, *g* and *h* of the boat seine data and c^1, e^1 and g^1 of the gill net data represent the December-January brood while the modes *B*, *D* and *F* of the pooled data and the corresponding modes *b*, *d* and *f* of the boat seine and d^1 and f^1 of the gill net data represent the May-June brood.

Relative Abundance of Age Groups in Commercial Catches

Although the age composition of the samples do not represent the true age composition of the stock, it is worthwhile estimating the proportion in which different age groups contributed to the local inshore catch of *C. kalla*.

It can be seen from Table 1 that during all the three years of observations, the II year group with an average of 85.8% dominated the catch. Next to this came the I year group with an average of 12.5%. The III year group in the catch was insignificant. It can be concluded that *C. kalla* fishery in the inshore waters is mainly sustained by the II year group.

The monthly analysis of the catch has shown that generally the percentage of I year group was fairly high in the catch during the November-January period

Table 1. *Percentage composition of different age groups of* C. kalla *in the samples during 1958-60*

Year	I year group	II year group	III year group
1958	15.5	82.4	2.3
1959	9.3	90.1	0.6
1960	12.8	84.8	2.4
Average	12.5	85.8	1.7

while II year group dominated for the rest of the year. The increase in percentage of the I year group in November-January period may be attributed to the new recruitment to the fishery during these months.

Walford's Growth Transformation

In Fig. 4 is presented the growth transformation of *C. kalla* according to Walford's (1946) method. From this transformation curve the slope 'k' which is the coefficient of catabolism and 'L∞' the maximum length that a fish can theoretically reach, are calculated by using Walford's method. For *C. kalla* the 'k' value equals 0.71 which indicates that the yearly growth increments decrease. The higher the value of 'k' the more slowly the ultimate length, 'L∞' is reached. The ultimate length which is never attained in natural conditions, obtained from the graph and calculated by using Walford's method, is approximately 271 mm for *C. kalla.*

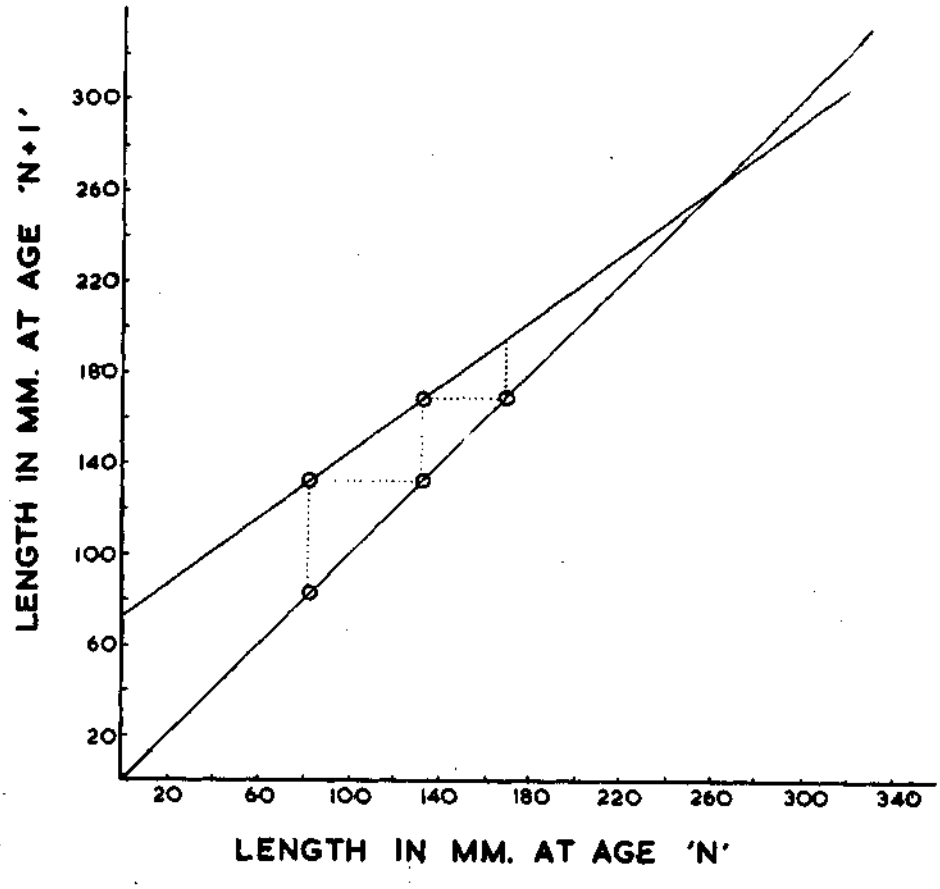

Fig. 4. Walford's growth transformation curve for *C. kalla.*

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REFERENCES

CHACKO, P.I. AND M.J. MATHEW. 1955. Biology and fisheries of the horse-mackerels of the west coast of Madras State. *Cont. Mar. Biol. Stn. West Hill, Malabar Coast*, No. 2: 1-22. Govt. Press, Madras.

CHIDAMBARAM, K. AND R.S. VENKATARAMAN. 1946. *Tabular statements on the natural history of certain marine food fishes of the Madras Presidency-West Coast*. Govt. Press, Madras: 1-26.

KAGWADE, V.N. 1965. Preliminary observations on the biology of horse-mackerel *Caranx kalla* (Cuv. & Val.). *Sci. & Cult.*, **31**: 207-208.

KAGWADE, V.N. 1971. Maturation and spawning of horse-mackerel *Caranx kalla* (Cuv. & Val.). *Indian J. Fish.*, **15** (this volume).

TANDON, K.K. 1962. *Selaroides leptolepis* (Cuv. & Val.) - II Age and growth. *Res. Bull. Punjab Univ.*, **13**: 269-275.

WALFORD, L.A. 1946. A new graphic method of describing the growth of animals. *Biol. Bull.*, **90**: 141-147.