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STUDIES ON DEMERSAL FISHES OF THE DEEP NERITIC WATERS AND THE CONTINENTAL SLOPE 2 ON *TRICHIURUS AURIGA* KLUNZINGER, WITH NOTES ON ITS BIOLOGY.

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ABSTRACT

During the exploratory fishery surveys carried out from the deep neritic waters and the continental slope along the south west coast of India, a species of ribbonfish (Family : Trichiuridae) hitherto not reported from the Indian seas was obtained. This species has been identified as the little known ribbon-fish *Trichiurus auriga* Klunzinger (1884) originally described from the Red Sea and subsequently reported only once from the Timor Sea. A re-description of this species along with a detailed comparison of its morphometric and meristic characters with related species is given here. A key to the identification of the seven known species of ribbon-fishes from the Indian seas is included in addition to some aspects of the biology of *T. auriga* based on the material collected.

INTRODUCTION

INVESTIGATIONS on Trichiuroid fishes from the Indian seas have received more attention in recent years. At present six species of ribbonfishes, of the family Trichiuridae, namely *Trichiurus lepturus* Linnaeus (1758), *T. pantului* Gupta (1966), *Lepturacanthus savala* (Cuvier, 1829), *L. gangeticus* (Gupta, 1966) of the subfamily Trichiurinae and *Eupleurogrammus muticus* (Gray, 1831) and *E. intermedius* (Gray, 1831), of the subfamily Lepidopodinae are known from the Indian seas. Dutt and Thankam (1966) described two new species *Trichiurus russelli* and *Lepturacanthus serratus* which are now considered synonyms of *T. pantului* and *L. gangeticus* respectively (James, 1967). Recently James (1969) has opined that *T. pantului* Gupta is a synonym of *T. lepturus*.

Amongst recent workers on the Trichiuridae, Tucker (1956) and James (1967) have discussed the systematic position of the nominal species, *Trichiurus haumela* (Forsskal, 1775), *T. japonicus* Bleeker (1857), *T. malabaricus* Day (1865), *T. auriga* Klunzinger (1884), *T. coxii* Ramsay and Ogilby (1887) and *T. nitens* Garman (1889), all synonyms of *T. lepturus*; *Trichiurus armatus* Gray (1831) and *T. roelandti* Bleeker (1860) synonyms of *L. savala:* and *Trichiurus medius* Griffith (1834) and *T. glossodon* Bleeker (1880) synonyms of *Eupleurogrammus intermedius* (Gray).

At present, we have more information on the biology of *T. lepturus* (Venkataraman, 1944 ; Mahadevan, 1950 ; Vijayaraghavan, 1951 ; Prabhu, 1955 ; Sekharan, 1955 ; James, 1967 ; Tampi *et al.*, 1968 ; Narasimhan, 1972 ; and others) ; *L. savala* (James, 1967 ; Gupta, 1967 a, b, 1968 b) ; *T. pantului* (Gupta, 1968 a) ; *E. muticus* (James, 1967) ; and *E. intermedius* (James, 1967) from the Indian seas.

In the course of the exploratory surveys carried out from the deep neritic waters and the continental slope along the west coast of India, during the cruises of R. V. *VARUNA* it has been possible to obtain a species of ribbon-fish which does not agree with any of the known species from the Indian seas. The species is characterised by the absence of barbs on the teeth, smaller pectoral fins, a less deeper body, greater snout-vent length, a relatively longer head, lesser number of dorsal rays and fewer vertebrae.

Our thanks are due to Shri S. K. Dharmaraja who helped us with the statistical part of this paper and to Shri I. David Raj for help with the drawings.

On the Validity of the Specific Name *Trichiurus auriga* Klunzinger (1884)

Among the nominal species of *Trichiurus*, the combination of characters mentioned above, agree with that of a single specimen described and illustrated by Klunzinger (1884) from Kosseir in the Red Sea Coast of Egypt and named as *Trichiurus auriga*. The species was characterised by him as having 'Körper nieder, sehr gestreckt; seine Höhe c. 3 in der Kopflänge, c. 24 in der Gesammtlänge Kopflänge 7½-8 in der Gesammtlänge; die höchsten Rückenstrahlen c. 1¼ in der. Körperhohe und 3½ in der Kopflänge. Die Brustflossen c. 5 in der Kopflänge. D. ? Peitsche sehr lang, c. 1½-2 mal so lang als der Kopf. Zähne einfach conisch ohne Ansatz. Neue Art.' Weber (1913) described one specimen of a ribbon-fish obtained in the trawl during the Siboga Expedition from Station 302 at 10°27'.9 S 123°28'. 7 E in the Timor Sea from 216 m depth as '*Trichiurus* (*auriga* Klunzinger ?)'. This specimen was re-described by de Beaufort (1951) as follows :

'D about 120, A about 65, P. 10, V. O, Height 19 (13-18.8), head 7.3 (5-6.1), eye 5.5. (5.3-6.8), 1.7 (1.7-2.2) in snout, and more than flat interorbital space. Maxillary reaching to below front border of pupil. Fangs not barbed. Origin of dorsal above hind border of preopercle. Longest dorsal rays somewhat larger than snout. Anal spines minute, the anterior ones hidden in the skin. Origin of anal about below the 38th dorsal ray. No ventrals. Pectorals much shorter than snout, twice in post-orbital part of head. The distance between the lateral line and the ventral profile at anus much more than twice in its distance from base of dorsal. Colour in preserved specimen silvery. Dorsal and pectorals whitish. Length 320 mm'.

Further, de Beaufort (1951) commented that 'Weber's specimen, which I redescribe here, agrees in most part which (with) that of Klunzinger. *T. auriga* seems to be very closely related to *T. haumela*, differing by its lesser height, comparitively larger eyes, smaller pectorals, and by the absence of barbs on the fangs.'

Tucker (1956) while reviewing the fishes of the family Trichiuridae included *Trichiurus auriga* Klunzinger (1884) as a synonym under *T. lepturus* Linnaeus with the remarks that '*T. auriga* Klunzinger, placed very close to *T. haumela* by Klunzinger (1884) himself and founded on a very young specimens (250 mm S. L.) is probably no more than a juvenile of the latter species, though published illustrations contain peculiar features at variance with the description. The only serious difficulty is the definitely stated absence of barbs from the teeth.' James (1967) has also followed Tucker (1956) in considering *T. auriga* as a synonym of *T. lepturus*, both attributing the noted differences between *T. auriga* and *T. haumela* to be due to age, the two known specimens of the former (250 mm and 320 mm) being considered immature.

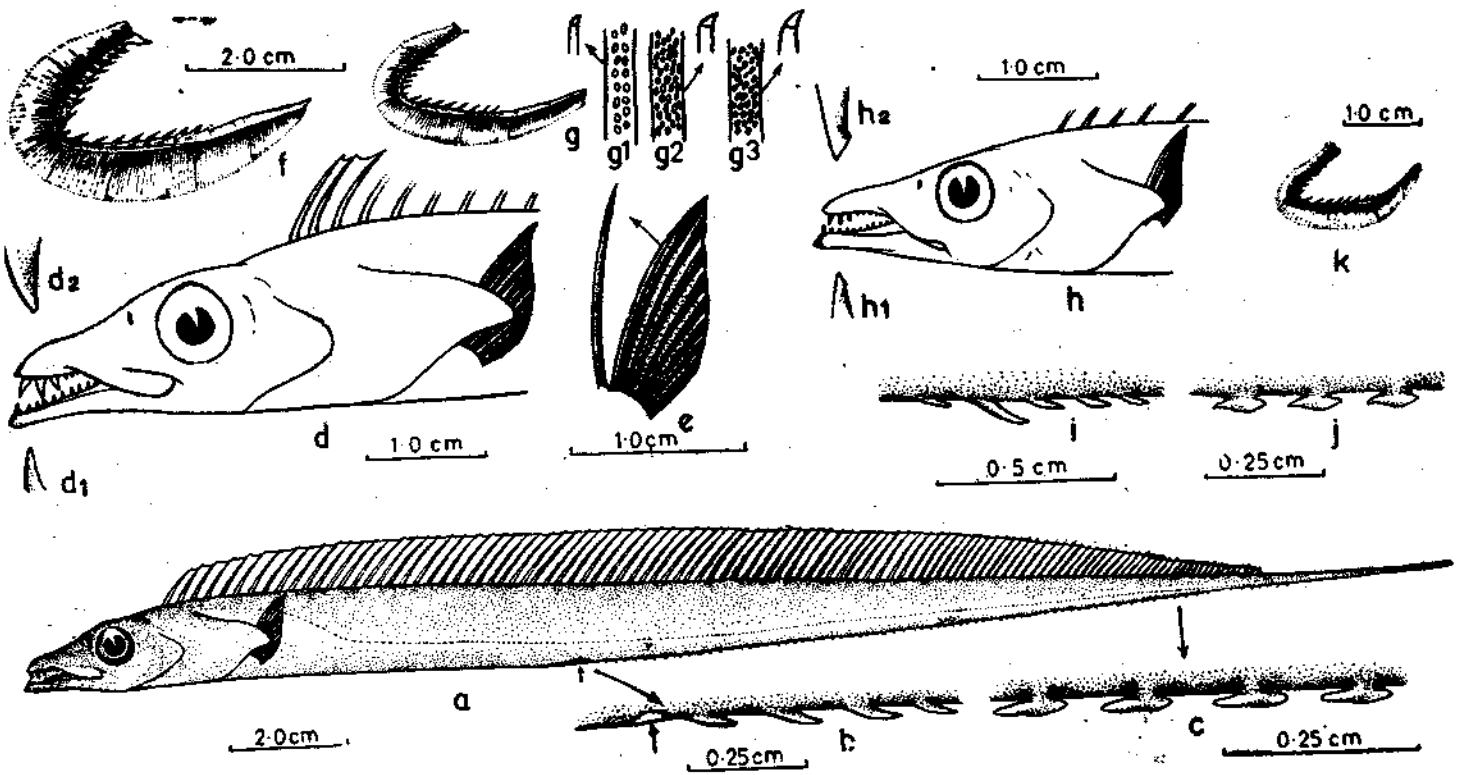

Fig. 1. *Trichiurus auriga* Klunzinger. a. Lateral view ; b. Vent and first few anal spines showing non-enlargement of second spine ; c. Posterior anal spines showing anteriorly directed branch; d. Head and anterior part of body ; d^1. Tooth of lower jaw ; d_2. Cannine teeth showing absence of barb ; e. Pectoral fin showing non-serrated pectoral spine; f. Outermost gill arch of a specimen 320 mm in T. L.; g. Same in a specimen of 217 mm in T. L. ; g^1 Biserial palatine teeth in *T. auriga* ; g_2. Multiserial palatine teeth in *L. savala* ; g_3. Multiserial palatine teeth in *T. lepturus*; h. Head (T. L. 171 mm) ; h^1. Barbed tooth of lower jaw ; h_2. Barbed tooth of upper jaw ; i. First few anal spines showing enlarged second anal spine ; j. Posterior anal spines showing anteriorly directed branch ; k. Out-ermost gill arch in specimen 171 mm in T. L.

It is now evident that a species of ribbonfish exists in the deeper waters of the continental shelf and upper continental slope in the Indo-West Pacific. The specimens in the present collections which vary in length from 179 mm to 347 mm (T. L.) clearly indicate that it is a much smaller species compared to either *T. lepturus* or *L. savala*. Specimens with T. L. of 260 mm had spent recovering ovaries and males 217 mm and above in T. L. had oozing milt. The combination of diagnostic characters in which these specimens differ from other ribbonfishes indicates a strong likeness to *T. auriga* which was presumed to be the young ones of *T. haumela* (=*T. lepturus*) (Tucker, 1956 ; James, 1967) which we feel is incorrect. In view of the very close identity of our specimens with that of *T. auriga* we have no hesitation in considering this as a valid species. A detailed redescription of this little known species (Fig. 1) based on 112 specimens is given here along with observations on some aspects of its biology.

Redescription of *Trichiurus auriga* Klunzinger (1884)

Material :

All specimens were obtained in trawl catches as follows : 5 specimens on 2-9-1965 from 270 m during R. V. *VARUNA* Cruise, Off Cochin ; 1 specimen on 19-10-1967 from 355 m during M. V. *TUNA* Cruise in the Quilon Bank ; 8 specimens on 25-10-1967 from 305 to 325 m during M. V. *KLAUS SUNNANA* Cruise in the Quilon Bank ; 10 specimens on 7-11-1967 from 295 to 325 m during M. V. *KLAUS SUNNANA* Cruise in the Quilon Bank ; 1 specimen on 23-12-1968 during R. V. *VARUNA* special fishing Cruise from Quilon Bank ; 85 specimens on 13-3-1969 from 324 to 352 m during R. V. *VARUNA* Cruise 133 from 7°05'N 77°17'E ; 1 specimen on 18-1-1973 from 250 m during R. V. *VARUNA* Cruise 146 from 250 m off Goa ; 1 specimen on 8-2-1973 from 250 m during R. V. *VARUNA* Cruise 147 from 19°17'N 69°46'E.

For methods of measurements and counts please, *see* James (1967).

General Variability

Description :

D III, 106-113 ; A. i, I, 74-84 ; P_1. 10-12 (generally 10 or 11) ; P_2 absent ; Total vertebrae 138-145.

Head 38.70-45.27 ; snout 12.37-14.95 ; eye diameter 6.00-7.69 ; inter-orbital distance 4.14-5.48 ; length of maxilla 12.90-15.38 ; distance from tip of snout to origin of dorsal fin 24.47-29.20 ; prepectoral distance 34.04-41.84 ; height through middle of eye 11.33-14.75 ; height at dorsal origin 13.97-16.66 ; height at vent 12.49-17.69 ; height of longest dorsal ray 11.01-17.39 ; height of longest pectoral ray 11.18-13.46 per cent in snout-vent length. Snout 28.57-35.55 ; inter-orbital distance 10.20-12.72 ; and diameter of eye 14.28-18.60 per cent in head length.

In order to see whether morphometric characters showed any significant differences in both sexes, data for five dependable characters were examined (Tables 1-4 and Figs. 2 and 3) and no significant differences were seen.

TABLE 1. *Body proportions of* T. auriga *as hundred times ratios to Snout-vent length*

Character	No. of specimens	Snout-vent length (range in mm)	Mean	Standard deviation	Standard error		
Head Length							
Males ..	16	93-118	42.48	3.62	0.91	0.29	Non-significant both at 1% and 5% level
Females	34	95-152	42.21	1.57	0.27		
Eye Diameter							
Males ..	16	93-118	7.01	0.32	0.08	0.52	do.
Females ..	34	95-152	6.71	0.46	0.08		
Height of Longest Dorsal Ray							
Males ..	16	93-118	14.54	1.57	0.39	1.10	do.
Females ..	34	95-152	14.06	1.10	0.19		
Depth of Body							
Males ..	16	93-118	15.98	0.87	0.21	1.30	do.
Females ..	34	95-152	15.62	1.00	0.17		
Height of Head							
Males ..	16	93-118	13.20	0.84	0.21	0.14	do.
Females ..	34	95-152	13.17	0.81	0.14		

TABLE 2. *Sum of squares and products of morphometric data of males and females of* T. auriga

Sex	N	Independent variable X	Dependent variable Y	ΣX	ΣY	ΣX^2	ΣY^2	ΣXY
Females ..	34	Snout-vent length	Head length	4148	1748	516418	91304	216967
Males ..	16	do.	do.	1717	730	185045	33591	78649
Females ..	34	do.	Eye diameter	4148	273	516418	2223	33816
Males ..	16	do.	do.	1717	120	185045	906	12942
Females ..	34	do.	Height of longest dorsal ray	4148	576	516418	9956	70903
Males ..	16	do.	do.	1717	246	185045	3936	26454
Females ..	34	do.	Depth of body	4148	653	516418	12907	81355
Males ..	16	do.	do.	1717	275	185045	4823	29724
Females ..	34	do.	Height of head	4148	546	516418	9058	67903
Males ..	16	do.	do.	1717	227	185045	3295	24580

TABLE 3. *Corrected sum of squares and products of morphometric data, regression coefficient and deviation from average regression for males and females of* T. auriga

Sex	Independent variable X	Dependent variable Y	D.F.	Sum of squares and products			b	Errors of Estimate	
				Sx^2	Sy^2	Sxy		S.S.	D.F.
Females ..	Snout-vent length	Head length	33	10362	1437	3711	0.3581	107.96	32
Males ..	do.	do.	15	790	285	311	0.3936	162.57	14
Females ..	do.	Eye diameter	33	10362	31	510	0.0492	5.90	32
Males ..	do.	do.	15	790	16	65	0.0822	10.66	14
Females ..	do.	Height of longest dorsal ray	33	10362	198	631	0.0608	159.58	32
Males ..	do.	do.	15	790	154	56	0.0708	150.04	14
Females ..	do.	Depth of body	33	10362	366	1689	0.1629	90.70	32
Males ..	do.	do.	15	790	97	214	0.2708	39.04	14
Females ..	do.	Height of body	33	10362	290	1291	0.1245	130.00	32
Males ..	do.	do.	15	790	75	221	0.2797	143.18	14

TABLE 4. *Analysis of covariance*

S. No.	Source of variation	Degrees of freedom	Sum of squares	Mean square	Observed F	5 % F
1.	*Head Length*					
	Deviation from individual regressions within sexes ..	46	270.530	5.881087	6.323749	251-252
	Differences between regressions ..	1	0.930	0.930000		
	Deviation from total regression ..	47	271.500			
2.	*Eye Diameter*					
	Deviation from individual regressions within sexes ..	46	16.560	0.360000	2.222222	4.05
	Differences between regressions ..	1	0.800	0.800000		
	Deviation from total regression ..	47	17.360			
3.	*Height of longest Dorsal Ray*					
	Deviation from individual regressions within sexes ..	46	309.620	6.730869	112.181101	251-252
	Differences between regressions ..	1	0.060	0.060000		
	Deviation from total regression ..	47	309.680			

TABLE 4—(*cont.*)

4. *Depth of Body*					
Deviation from individual regressions within sexes	.. 46	129.740	2.820434	3.024360	4.05
Differences between regressions	.. 1	8.530	8.530000		
Deviation from total regression	.. 47	138.270			
5. *Height of Head*					
Deviation from individual regressions within sexes	.. 46	143.180	3.112608	5.407040	4.05
Differences between regressions	.. 1	16.830	16.830000		
Deviation from total regression	.. 47	160.010			

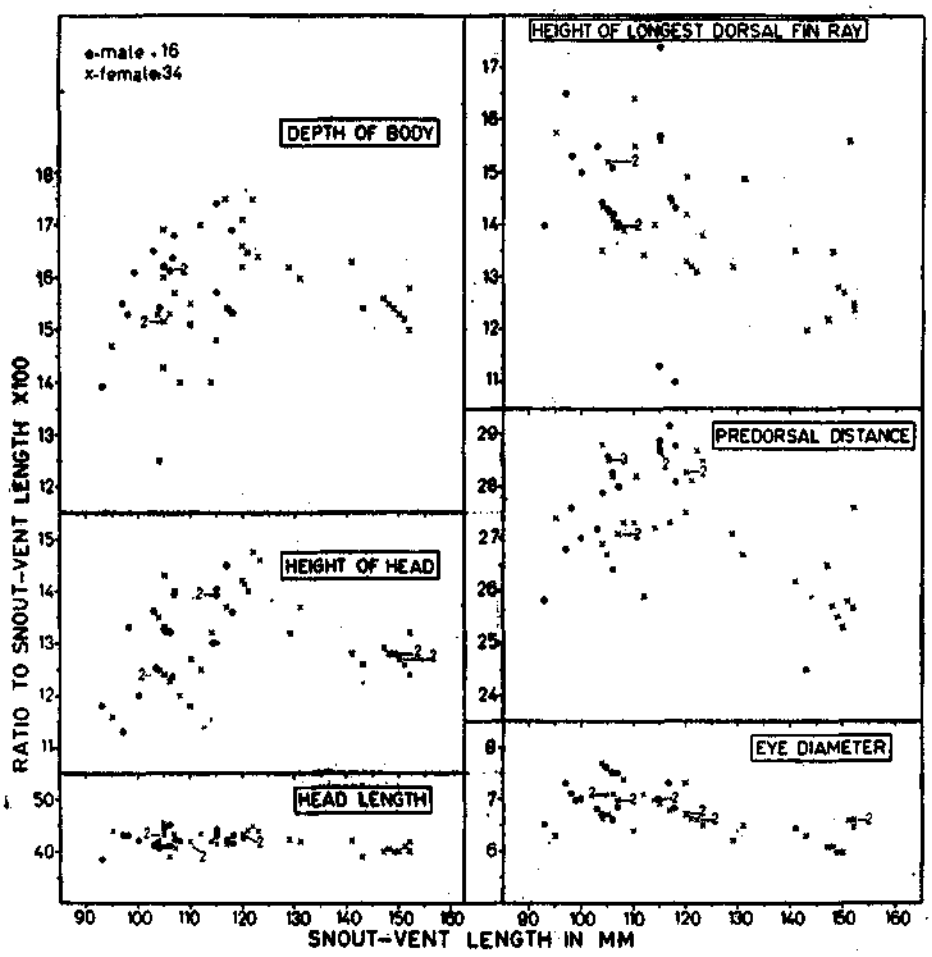

Fig. 2. Relative growth of body parts of *T. auriga* (more than one occurrence is indicated numerically).

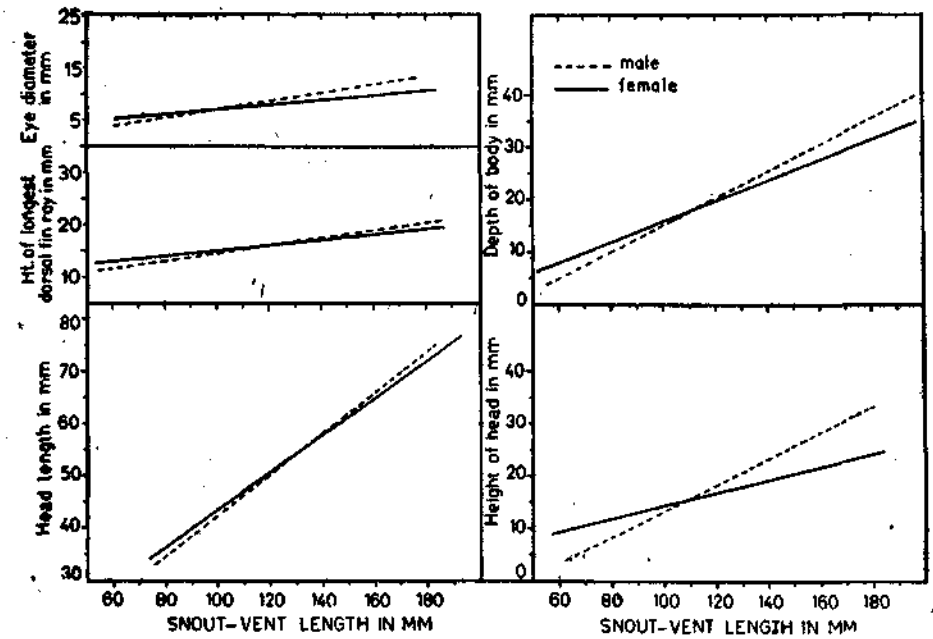

Fig. 3. Comparison of sexes for five morphometric characters of *T. auriga*.

In view of the fact that allometric growth of some of the body parts are known to occur in ribbonfishes and a knowledge of this is essential for species identification, the general trend of relative growth of body parts in the size ranges of specimens of *T. auriga* available were examined for comparison with known data of *T. lepturus* and *L. savala*. The data is not sufficient for detailed statistical comparison, but the general trends of relative growth of body parts in these species show some differences which should be of interest. The body proportions as compared with the ratio of snout-vent length × 100 indicates the following trends for *T. auriga* as compared to the data given by James (1967, Fig. 6, p. 27) for *T. lepturus* and *L. savala*. The comparison of the three species is in the size range 9-15.2 cm snout-vent length, since specimens of *T. auriga* are available only in this length range. The salient features noted are as follows :

(*a*) The head length in all these species falls within the same range and no allometric growth is seen with increase in total length.

(*b*) In *T. auriga*, in the specimens with 9-15.2 cm snout-vent length, the values for height of head fall within 11 to 14.5 while in the similar size range in *T. lepturus* it is from 14 to 17 and in *L. savala* from about 12.5 to 16.

(*c*) In *T. auriga* the depth of body falls within the values 12.5 to 17.5 while in *T. lepturus* it is about 16.5 to 20 and in *L. savala* from 18.5 to 22.5.

(*d*) The eye diameter in *T. auriga* falls within 6 and 7.75 while in *T. lepturus* it is from 6.25 to about 8.5 and in *L. savala* from 4.75 to about 7.25.

(*e*) The predorsal distance in *T. auriga* is 24.5 to about 29.25 while in *T. lepturus* it is about 26.25 to 31.25 and in *L. savala* 28 to about 33.

(*f*) The height of the longest dorsal ray in *T. auriga* is between 11 and 17.5 while in *T. lepturus* it is about 12 to 18 and in *L. savala* about 13.75 to 23.5.

These differences noted in the size range studied point to the desirability of instituting more detailed comparisons between graded series of specimens of these species.

Gupta (1967 a) has carried out a comparison of biometrical characters of four species of ribbonfishes namely, *T. haumela*, *T. savala*, *T. gangeticus*, and *T. pantului* from the Hooghly estuary. The data given is utilised here for comparison and their range, mean, and number of specimens examined along with data for *T. auriga* is given in Table 5 and in Fig. 4. In the case of *T. auriga*, the range, mean, the

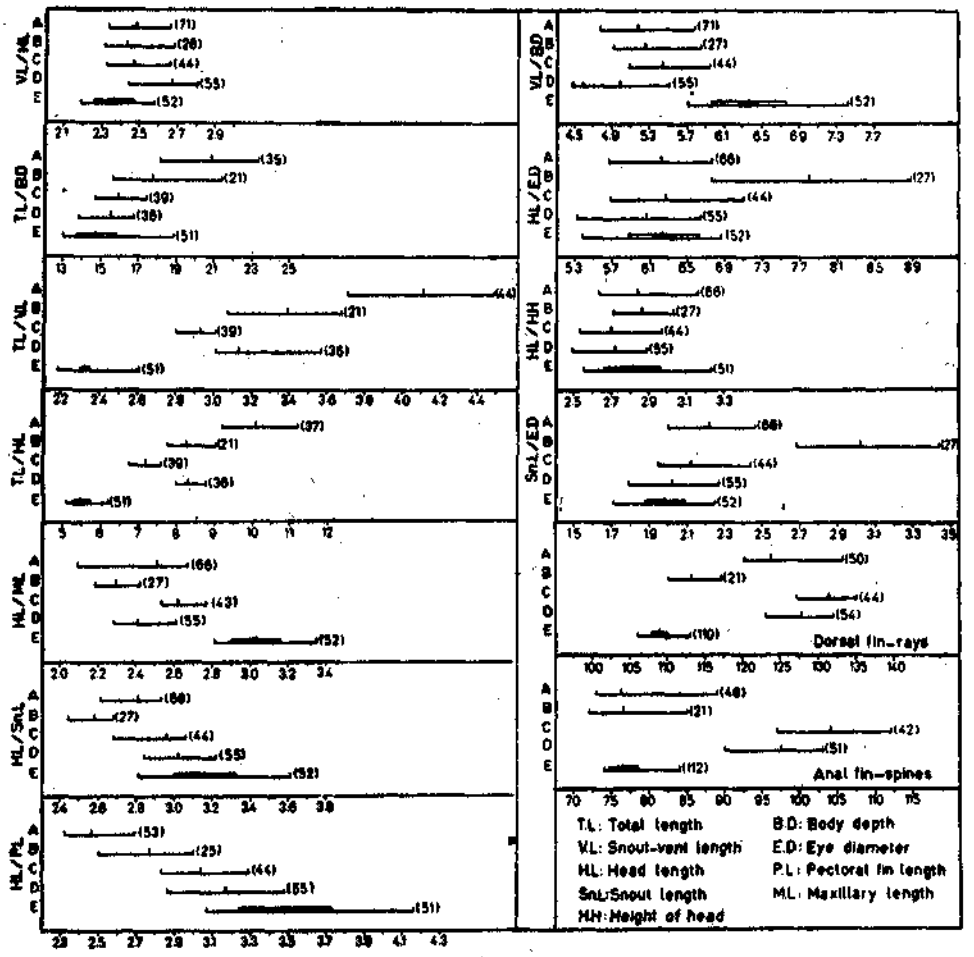

Fig. 4. Graphic representation of some body proportions in five species of ribbonfishes. (The horizontal line represents the total range ; the short vertical line the mean ; the solid rectangle two standard errors on each side of the mean ; the hollow rectangle one standard deviation on each side of the mean. The standard deviation and standard error are given only for *T. auriga*). The number of specimens is indicated in parenthesis. A=*L. gangeticus* ; B=*L. savala* ; C=*T. lepturus*; D=*T. pantului* ; E=*T. auriga*.

TABLE 5. *Morphometric characters of five species of ribbonfishes*

(The number of specimens examined for each character is given first followed by mean with range in parenthesis)

	V.L./H.L.	T.L./B.D.	T.L./V.L.	T.L./H.L.	H.L./M.L.	H.L./Sn.L.	H.L./P.L.	V.L./B.D.	H.L./ E.D.	H.L./H.H.	Sn.L./E.D.
L. gangeticus	71: 2.48 (2.33-2.66)	35: 20.88 (18.10-23.30)	44: 4.11 (3.71-4.49)	37: 10.13 (9.18-11.23)	66: 2.51 (2.09-2.67)	68: 2.81 (2.61-2.93)	53: 2.46 (2.32-2.68)	71: 5.17 (4.77-5.77)	66: 6.22 (5.67-6.77)	66: 2.84 (2.63-3.16)	66: 2.22 (2.00-2.46)
L. savala	26: 2.43 (2.31-2.68)	21: 17.77 (15.51-21.33)	21: 3.39 (3.07-3.68)	21: 8.27 (7.76-9.01)	27: 2.29 (2.18-2.41)	27: 2.58 (2.44-2.68)	25: 2.77 (2.50-3.00)	27: 5.25 (4.91-5.85)	27: 7.80 (6.75-8.86)	27: 2.86 (2.71-3.03)	27: 3.02 (2.68-3.44)
T. lepturus	44: 2.47 (2.32-2.66)	39: 15.95 (14.75-17.48)	30: 2.93 (2.80-3.01)	39: 7.22 (6.75-71.62)	43: 2.62 (2.53-2.77)	44: 2.96 (2.68-3.06)	44: 3.04 (2.83-3.29)	44: 544 (5.08-5.95)	44: 6.27 (5.69-7.11)	44: 2.70 (2.53-2.97)	44: 2.12 (1.95-2.44)
T. pantului	55: 2.67 (2.44-2.81)	36: 15.52 (13.86-16.73)	36: 3.13 (3.01-3.57)	36: 8.32 (7.98-8.76)	55: 2.41 (2.28-2.61)	55: 3.02 (2.84-3.22)	55: 3.17 (2.86-3.48)	55: 4.99 (4.47-5.51)	55: 6.07 (5.33-6.64)	55: 2.72 (2.49-2.89)	55: 2.02 (1.79-2.27)
T. auriga	52: 2.36 (2.19-2.58)	51: 14.74 (13.00-18.84)	51: 2.32 2.18-2.61)	51: 5.49 (5.09-6.17)	52: 3.03 (2.81-3.35)	52: 3.16 (2.81-3.61)	51: 3.49 (3.07-4.16)	52: 6.36 (5.71-7.42)	52: 6.24 (5.37-6.87)	51: 2.81 (2.55-3.23)	52: 1.98 (1.71-2.25)
	S.D. 0.110 S.E. 0.015	S.D. 1.160 S.E. 0.140	S.D. 0.02 S.E. 0.0039	S.D. 0.20 S.E. 0.02	S.D. 0.13 S.E. 0.018	S.D. 0.16 S.E. 0.02	S.D. 0.24 S.E. 0.03	S.D. 0.41 S.E. 0.05	S.D. 0.38 S.E. 0.05	S.D. 0.15 S.E. 0.02	S.D. 0.11 S.E. 0.01

standard deviation and standard error are also indicated in Fig. 4. It will be seen that in the characters Total length/Head length ; Total length/Snout-Vent length and Head length/Maxillary length, *T. auriga* shows no overlap in characters with the other species. *T. auriga* also shows significant differences in other characters such as Head length/Pectoral length ; Snout-vent length/Head length ; and Snout-vent length/Body depth. Overlap with one or more species is seen in the characters Head length/Pectoral length ; Total length/Body depth ; Head length/Eye diameter ; Head length/Height of head ; and Snout length/Eye diameter.

All these point to the fact that these morphometric differences are additional grounds for considering *T. auriga* as a valid species.

Meristic Counts

(a) *Fin rays :*

The frequency of the number of dorsal and anal rays and spines given in relation to the snout-vent length (Fig. 5) indicates that with increase in size there is a slight increase in the number of dorsal rays and anal spines. In the dorsal fin, the number of rays (excluding the spines) varied from 106 to 113, with the most frequent count of 109. In the anal fin, the number of spines (excluding the first two) varied from 74 to 84, the most frequent count being 76.

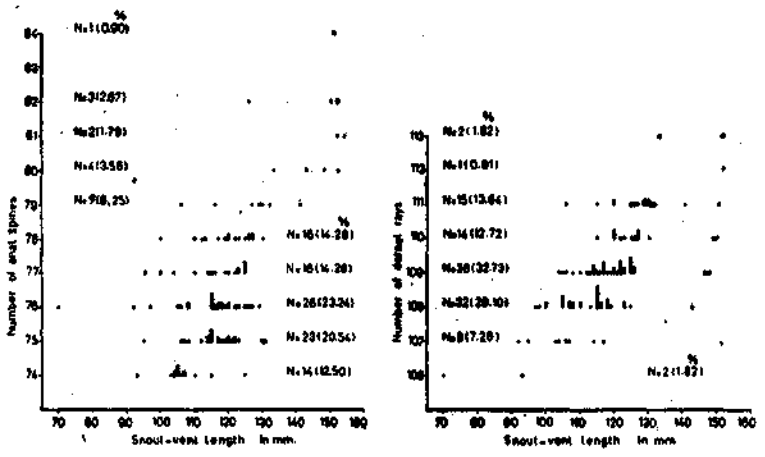

Fig. 5. Frequency of anal spines and dorsal rays in relation to snout-vent length in *T. auriga* Klunzinger.

On the basis of the data given by Gupta (1967 a) it has been possible to compare the range and mean of the fin rays for the four species *T. haumela*, *T. savala*, *T. gangeticus* and *T. pantului* with that of *T. auriga* (Fig. 4 and Table 6). In the case of the dorsal fin rays, overlap in the range is seen between *T. auriga* and *T. savala*, but the number of dorsal spines in the former is three and the latter four. As regards the number of anal spines, *T. gangeticus*, *T. savala* and *T. auriga* show overlap (Fig. 4). The second anal spine is very prominent in *T. savala* (Fig. 1 i) which is not so in *T. auriga* (Fig. 1 b). In the latter, the posterior most 15 to 17 anal spinules are directed forward (Fig. 1 c).

TABLE 6. *Meristic characters of five species of ribbonfishes*

(The number of specimens observed for each character is given first, followed by mean with range in parenthesis)

	Dorsal fin	Anal fin
L. gangeticus ..	50. 123.5 (120-133)	48. 76.3 (73-89)
L. savala ..	21. 113.1 (110-117)	21. 77.1 (72-85)
T. lepturus ..	44. 131.2 (127-135)	42. 104.1 (97-112)
T. pantului ..	54. 127.7 (123-132)	51. 97.4 (90-103)
T. auriga ..	110. 109.00 (106-113) S. D. 1.344 S. E. 0.128	112. 76.62 (74-84) S. D. 2.044 S. E. 0.1931

The pectoral fin in *T. auriga* has 10 to 12 (most frequent count 10) rays and the pectoral spine is not serrated (Fig. 1 e) as in *T. gangeticus*.

(b) *Vertebrae :*

Alizarin staining technique was used for five specimens of *T. auriga* with total length between 256 and 285 mm (mean 271.20 mm) and the snout-vent length of 114-125 mm (mean 119 mm) and the vertebral counts are as follows:

	Range	*Mean*
Precaudal vertebrae ..	36-37	36.30
Caudal vertebrae ..	101-108	104.20
Total number of vertebrae ..	138-145	141.00
Dorsal fin extending upto vertebrae number ..	110-113	111.66
Anal spines extending upto vertebrae number ..	114-118	116.33

(c) *Gill rakers :*

The gill rakers of the upper and lower limbs of the outer most arch are found to vary from 5-9+7-9 with the most frequent count of 7+9 (Table 7).

TABLE 7. *Frequency of gill raker counts in* T. auriga

No. of gill rakers excluding one at angle	Upperlimb					Lowerlimb			Total No. of specimens
	5	6	7	8	9	7	8	9	
Number	1	17	23	8	2	3	21	27	51
(%)	1.96	33.33	45.09	15.68	3.92	5.88	41.17	52.94	

No. of specimens	Total number of gill rakers (upper + angle + lower limb)						Mean
	14	15	16	17	18	19	
51	2	8	19	18	3	1	16.29

The rakers are small, pointed (Fig. 1 f and g), and each placed on a knobular projection which bears a number of small teeth-like processes. James (1967) has described the nature and variability of gill rakers in other species of ribbonfishes and Gupta (1967 a) has also given gill raker counts for four species from the Hooghly estuary. From the available data it is seen that the number of rakers on the upper limb of the outer gill arch shows a wider range in *T. auriga*, being 5-9. According to James (1967), the gill rakers of species such as *T. lepturus* and *L. savala* are better developed and more in number in young specimens. In fact, in *L. savala*, they are completely reduced, fewer and rudimentary in adults. In this respect, the variability with age in the size groups of *T. auriga* examined (18 cm to 34.7 cm T. L.) of which specimens over 21 cm were adults was not found to vary much (Table 7).

(d) *Teeth :*

In *T. auriga*, the teeth are present in the premaxilla, dentary, palatines and mandibles, vomer being edentulous (Fig. 1 d_1 & d_2). None of the teeth have barbs, so characteristic of species such as *T. lepturus*, and *L. savala* (Fig. 1 h_1 & h_2). The teeth on the palatines are slender, conical and arranged in two irregular rows (Fig. 1 g_1), unlike in *T. lepturus* (Fig. 1 g_3) and *L. savala* (Fig. 1 g_2) where the palatine teeth are multiserial (in 4 or 5 irregular rows) and the teeth are slightly recurved.

There are two or three fang-like teeth on each side of the upper jaw and one on each side on the lower jaw in *T. auriga*. The frequency of occurrence of the teeth in both the jaws in this species is shown in Table 8.

TABLE 8. *Frequency of occurrence of teeth in the upper and lower jaw of* T. auriga

Upper jaw (one side only)	II+14	II+15	II+16	II+17	II+18	II+19	II+20	II+21	II+22	II+23	III+17	III+18	III+19
Number of specimens	2	2	2	3	2	2	3	2	1	1	1	1	2

Lower jaw (one side only)	I+13	I+14	I+15	I+16	I+17	I+18	I+19	I+20	Total number of specimens	Mean
	1	3	3	4	1	2	1	2	17	I+16.23

Total number of cannines and smaller teeth

	Upper jaw										Total No. of specimens	Lower jaw								Total No. of specimens
	16	17	18	19	20	21	22	23	24	25		14	15	16	17	18	19	20	21	
No. of specimens	2	2	2	3	3	3	5	2	1	1	24	1	3	3	4	1	2	1	2	17
	Mean=20.28											Mean=17.23								

(e) *Pyloric caeca :*

The number of pyloric caeca in one specimen was found to be 12. James (1967) has indicated 23 to be the most frequent number of pyloric caeca in *T. lepturus ;* (Range 23-41 in 36 specimens 34.6-75.6 cm in S. L.) and 15 and 16 in *L. savala*

(Range 14-19 in 73 specimens 16.0-53.1 cm in S. L.). The wide ranges in *T. lepturus* is interesting since in the other species of ribbonfishes, such variation is not reported.

(f) *Colour :*

Postmortum colour : The sides are pearl white with the dorsal slightly dusky. In formalin, the sides of the body are pale flesh coloured ; the lateral line is conspicuous as a narrow brownish streak with a lighter centre starting from the upper angle of the opercle, and gently sloping and straighting at about the level of the tip of the pectoral and thence running along the lower half of the body to the caudal region. The upper part of the head is brownish ; the dorsal fin is generally hyaline, but the tip of the spines and rays, and interspinous membrane in larger specimens is light dusky ; the margin of the dorsal profile at the base of the dorsal fin has a narrow black streak running along its entire length ; tips of caudal are dusky. The snout edge of maxilla, mandible and sympysis of lower jaw are conspicuously dusky ; along the mid-lateral part of the body, a whitish band runs from behind the head to the caudal region.

DISTRIBUTION

Upto now this species has been known from only two specimens, one from the Red Sea and the second from the Timor Sea. The present collections clearly indicate that *T. auriga* occurs in shoals in the deeper waters along the continental shelf edge and upper continental slope. We are informed by Mr. K. C. George of the UNDP/FAO Pelagic Fishery Project, Cochin that he has seen large quantities of ribbonfishes in trawl collections from the continental shelf edge and slope south of Quilon along the Kerala/Tamil Nadu Coast. These should in all probability belong to *T. auriga*, the spatial distribution of which is shown in Fig. 6.

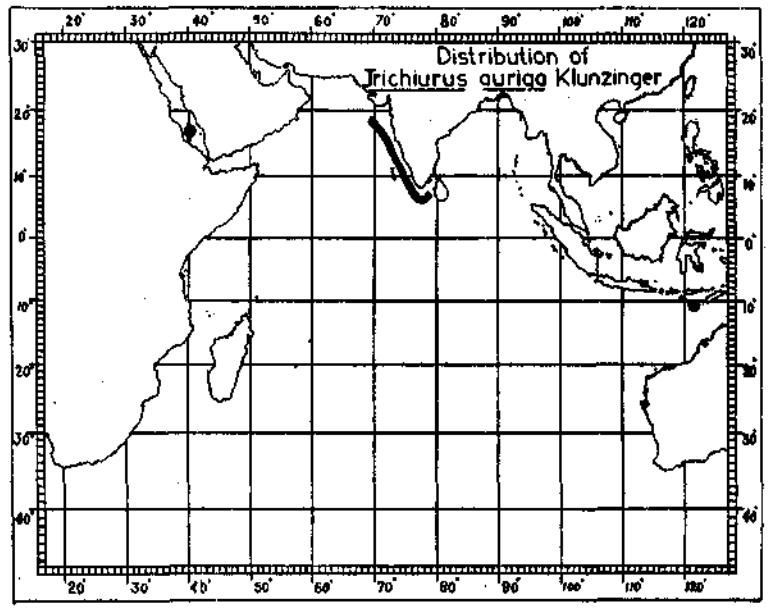

Fig. 6. Spatial distribution of *T. auriga* Klunzinger.

KEY TO THE IDENTIFICATION OF THE FISHES OF THE FAMILY TRICHIURIDAE FROM THE INDIAN SEAS

Since one more species of ribbonfish is now added to the six earlier known species, a key for their identification is given here. For some of the specific characters, the data given by earlier workers (Tucker, 1956 ; James, 1967, 1969 ; Gupta, 1966, 1967a) have also been incorporated.

1. Pelvic fins present. Lateral line gently sloping from upper angle of operculum to tip of tail so much so distance between it and ventral profile at vent is more than half distances from lateral line to dorsal profile. Lower hind margins of operculum convex. .....Subfamily Lepidopodinae 2

   Pelvic fins absent. Lateral line abruptly descending from upper angle of operculum and running along lower half of body so much so distance between it and ventral profile at vent is less than half distance from lateral line to dorsal profile. Lower hind margins of operculum concave.....Subfamily Trichiurinae 3

2. D III 123-131 ; Vertebrae 31-35+125-131 (=157-163)
   Origin of anal below D. 31-34.....*Eupleurogrammus intermedius* (Gray)

   D III 139-147 ; Vertebrae 39-42+150-159 (=189-201)
   Origin of anal below D. 38-42.....*Eupleurogrammus muticus* Gray

3. Post anal scute not enlarged and less than width of pupil of eye.....Genus *Trichiurus* Linnaeus 4

   Post anal scute prominent and dagger-like, size about half diameter of eye.....Genus *Lepturacanthus* Fowler 6

4. Fang-like teeth with barbs ; Dorsal with more than 120 rays ; Anal with more than 90 spinules ; Teeth on palatines multiserial (in 4 or 5 irregular rows).....5

   Fang-like teeth without barbs ; Dorsal with less than 120 rays ; Anal with less than 90 spinules ; Teeth on palatines in two irregular rows.....*Trichiurus auriga* Klunzinger

5. Head shorter, length 2.84-3.22 in snout-vent length and 7.98-8.76 in total length ; Posterior anal spines serrated (?).....*Trichiurus pantului** Gupta

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* While this species shows some differences from *T. lepturus* and at the same time agrees with *T. lajor* Bleeker (See James, 1969), it is likely that the specific name *T. lajor* Bleeker has precedence over *T. pantului* Gupta. The validity and status of *T. lajor* and *T. pantului* need a critical study. Of interest is that in the holotypes and 6 paratypes of *T. pantului* re-examined by James (1969), none of the anal spinules are serrated, a condition also not seen in *T. lajor*.

Head longer, length 2.53-3.06 in snout-vent length and 6.75-7.62 in total length ; Posterior anal spines not serrated..... *Trichiurus lepturus* Linnaeus

6. Pectoral spine serrated ; D. 120-133 ;Gill rakers 4-7/7-11..... *Lepturacanthus gangeticus* (Gupta)

Pectoral spine not serrated; D. 110-117; Gill rakers 2-5/4-9..... *Lepturacanthus savala* (Cuvier)

Some Aspects of the Biology of *Trichiurus auriga* Klunzinger

Food and Feeding habits :

The stomachs of 110 specimens were examined from six samples and it was noted that 92 were empty, 12 had traces of digested food and 6 stomachs were about ¼ full. The latter two categories had partly digested remains of Myctophid fishes, few remains of deep water shrimps and small quantities of unidentifiable digested pulpy matter. The observations are inadequate, but a cornivorous habit is evident. For a review on the food of other species of ribbonfishes, reference is invited to James (1967) and Gupta (1967 a, b ; 1968 a, b).

Sex and Size :

Out of 112 specimens examined 76 were females and 36 were males giving a ratio of 68:32 of females and males. The females were in the size range of T. L. 220-347 mm (S. VL. 92-152 mm), and the males T. L. 179-293 mm (S. VL. 70-127 mm).

Relation between size of gonad and size of fish :

As will be noted from Fig. 7 the length of the gonads in relation to the snout-vent length of 107 specimens of *T. auriga* shows a linear relationship in the size range of specimens (9 to 15 cm in S. VL. examined). This is interesting since the present collection contains specimens with mature, fully mature and spent ovaries, and testis with oozing milt.

Fecundity :

All ovaries with mature ova were found to contain a few residual eggs which indicates that the fish had already spawned and as such counts were of spent recovering ovaries (Fig. 8). Details of fecundity counts taken for 7 ovaries from samples collected during the September 1965 and October 1967 are shown in the Table 9 indicates that the number of ova per gram body weight varied from 180-330 in specimens weighing 8.5 to 33.0 gm in total weight.

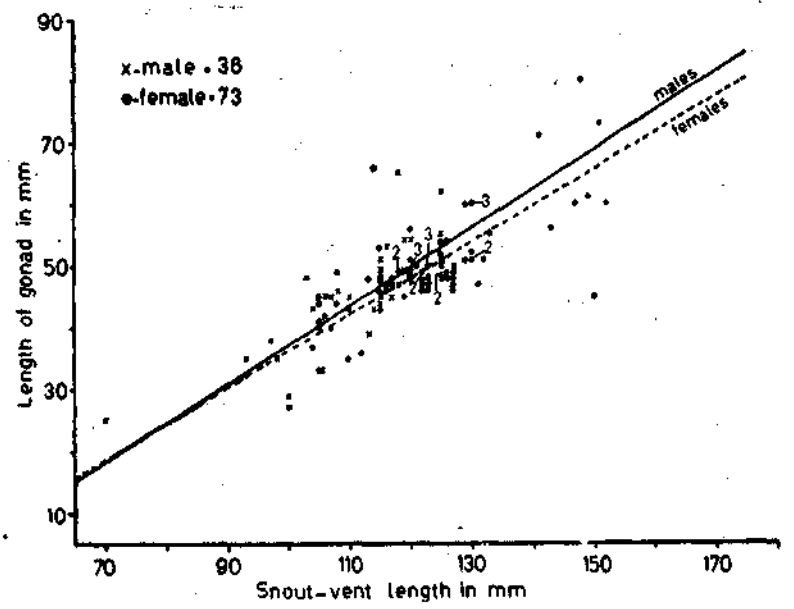

Fig. 7. Relation between the snout-vent length of fish and length of gonads in *T. auriga*.

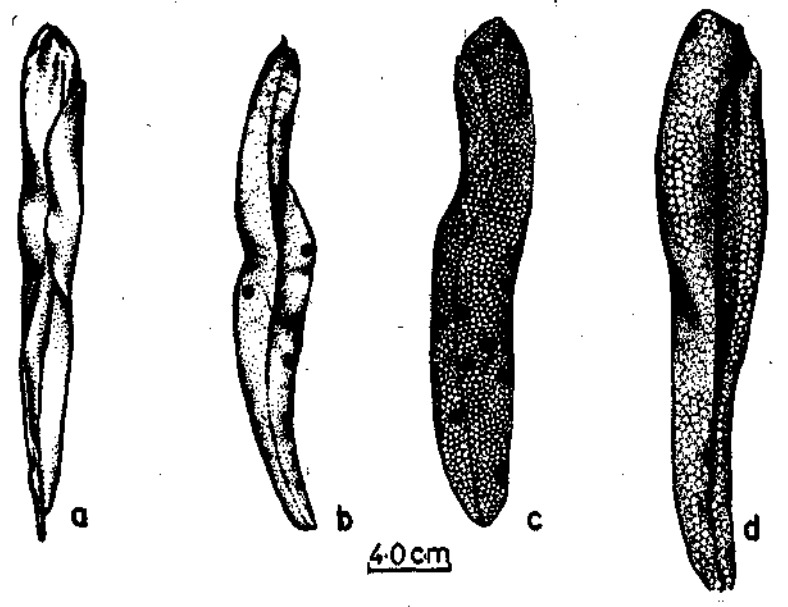

Fig. 8. *Trichiurus auriga* Klunzinger. a. Ventral view of fully matured testis containing oozing milt (T. L. 270 mm); b-d. Spent recovering ovaries with residual eggs (b & c) in the process of reabsorption seen through ovarian wall in specimens 347, 340 and 318 mm in T. L. respectively.

TABLE 9. *Details of ovum counts of* T. auriga

Date	Total length (mm)	Total wt of the specimen (gm)*	Total wt of the ovary (gm)	Wt of part of ovary taken for ovum count**	Actual count	Estimated total no. of ova	No. of ova/gm body wt	No. of ova/gm ovary wt
2-9-1965 ..	256	10.700	0.975	0.150	296	1925	180	1975
2-9-1965 ..	250	8.500	0.525	0.150	668	2339	275	4455
25-10-1967 ..	342	33.000	1.825	0.450	2679	10865	330	5953
25-10-1967 ..	335	29.700	1.150	0.300	1884	7222	243	6280
25-10-1967 ..	345	29.900	1.270	0.300	2345	9504	317	7483
25-10-1967 ..	332	30.500	2.390	0.600	2239	8923	293	3733
25-10-1967 ..	312	25.500	1.925	0.450	1162	4898	192	2545

* Specimens could not be weighed fresh. The data are for preserved material.
** 'Part ovary' would mean the combined weight of three parts each of the left and right ovaries.

However, in species of ribbonfishes, the number of mature ova in ovaries are fewer as seen from the work of Prabhu (1955), James (1967) and Tampi *et al.*, (1968). In the present specimens the number of ova in relation to total length, weight of fish in grams and weight of ovary showed a distinct increase with size and weight (Fig. 9).

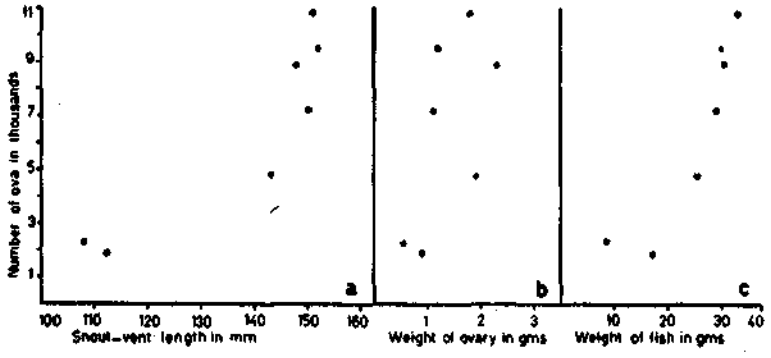

Fig. 9. Relation between fecundity and a. length of fish (S. VL); b. weight of ovary in gms; and c. weight of fish in gms in *T. auriga* Klunzinger.

Size at first maturity :

The data is scanty and does not permit detailed discussion. However, as compared to other species of ribbonfishes, it is interesting that females with 92 mm snout-vent length (T. L. 241 mm) had spent recovering ovaries indicating that the size of

the fish at first maturity was still smaller. This is indeed relatively a small size as compared to other species of ribbonfishes for which available information indicates the following :

	Species	*Size at first maturity*
1.	*T. lepturus*	47-48 cm T. L. Prabhu (1955)
2.	*T. savala*	127. 5 mm S. VL (409 mm T. L.) Gupta (1967 b)
3.	*T. pantului*	162 mm S. VL. Gupta (1968 a)
4.	*E. intermedius*	30-48 cm T. L. James (1967) (Spent ovaries in 32-34 cm recorded)

According to Anon (1971) *L. savala* of 340-540 mm with mode at 430-439 mm fished off Tuticorin, Gulf of Mannar, were generally immature. From the Hooghly Estuary, Gupta (1968 b) has found based on size frequency distribution, mature specimens of *T. savala* in III and IV stages of gonadial maturity in the size groups 250 to about 320 mm (T. L.) during the months of March and April.

Males of *T. auriga* 217 mm (T. L.) (S. VL. 93 mm) with oozing milt were found in the present collections.

For *E. intermedius*, James (1967) found specimens 20 cm (T. L.) as immature, with more than 50% in the size groups 20-22 cm (T. L.) in maturing stages and spent individuals in the group of 28-30 cm. From these, it would appear that *T. auriga* matures at a much smaller size than the other species of ribbonfishes.

Distribution of ova in the ovaries :

Ova diameter measurements (5 md and above) were taken for ovaries of 23 specimens collected at different times between 1965 and 1969 as follows : 2-9-1965, 5 specimens ; 25-10-1967, 6 specimens ; 7-11-1967, 3 specimens ; 13-3-1969, 9 specimens. These specimens were collected from the depth range 270 to 350 m, Off Cochin and Off Quilon along the Kerala coast.

September 1965

In all 5 specimens examined (Fig. 10a) the ovaries had prominant blood vessels and also a good number of residual eggs in various stages of reabsorption. The mature batch of ova had diameters between 10 to 30 md (= 0.21 to 0.63 mm) with a single mode at 15 md (= 0.31 mm). No developing ova between 5 and 10 md were seen, but very minute ova less than 5 md were present. The ovaries were spent recovering with a distinct batch of maturing ova. Some of the residual eggs had thick pink distorted ovarian walls of diameter upto 90 mm (=1.88 mm) and larger oil globules of diameter 15-18 md (0.31 to 0.38 mm).

October 1967

All six ovaries examined were partly spent (Fig. 10b). Ova of the most advanced modes are clearly seen through the ovarian walls. A few residual eggs, with pink walls in highly distorted shape were present in the basal part of the ovary, but not in the middle and apical parts. Dorsally the blood vessels are black and conspicuously enlarged.

Two modes of ova between 10 to 30 md (= 0.21 to 0.61 mm) diameter and the second between 30 and 45 md (=0.62 to 0.98 mm) diameter are present. The largest ova was 60 md (1.3 mm) in diameter.

The outer wall of the residual ova are very transparent, some pinkish, and the yolk is present in the form of a central opaque mass surrounded by broken oil globules of golden yellow in colour.

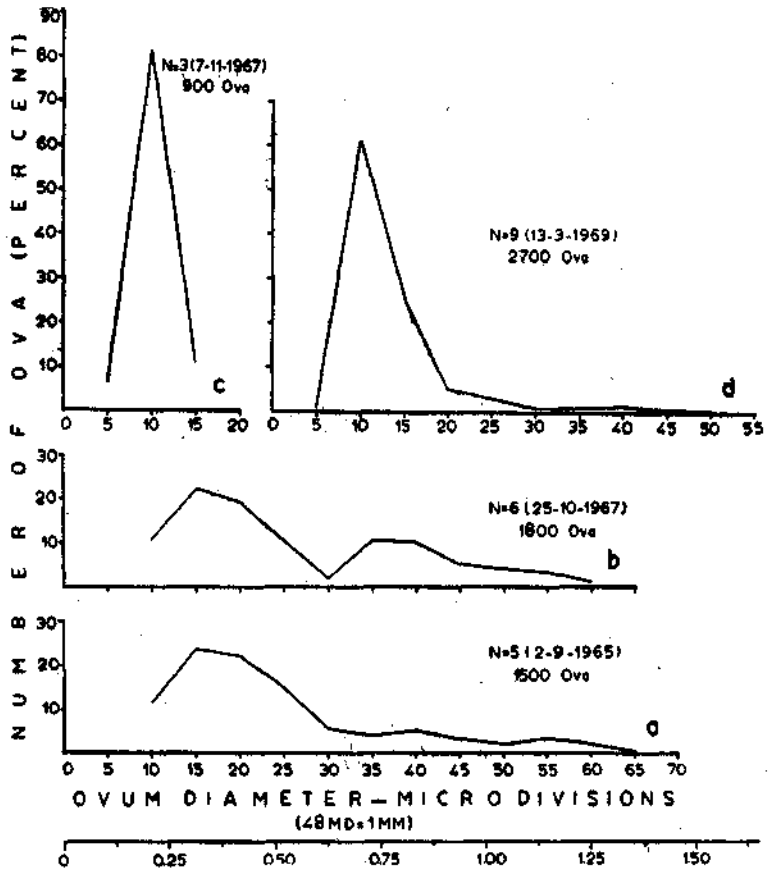

Fig. 10. *Trichiurus auriga* Klunzinger. a-d. Ova diameter frequency polygons (The number of ovaries, date of collection and number of ova examined are indicated in each figure).

November 1967

These ovaries appear to be spent recovering (Fig. 10 c) especially as they have dark blood vessels and a few grannular bodies around which new ova (less than 5 md) are seen developing in all the ovaries, and only immature ova measuring 5 to 15 md with a mode at 10 md are present.

March 1969

Nine ovaries examined were all spent recovering (Fig. 10d). The ovaries were flacid and broad with blood vessels markedly clear towards tip and base. Ova of diameter 5 to 50 md (= 0.10 to 1.0 mm) were present. Residual and degenerating ova in the process of reabsorption with diameter of about 15 to 20 md were present in most of the ovaries.

The data is not sufficient for a satisfactory study of the spawning periodicity of this species. However, the following points may be noted :

1. That all 23 ovaries examined were either spent or spent-recovering and invariably had a few residual eggs in different stages of re-absorption.

2. The collections made during October and November 1967 indicates that spawning should have taken place during or just prior to October.

3. Fully mature ovaries may have developing ova showing more than one mode. The ovaries examined for the months September 1965 shows one batch of maturing ova and another batch, part of which may or may not have been spawned, but in the process of re-absorption. Thus there is an indication of more than one spawning during the year, but this will need confirmation. The absence of specimens in different stages of maturity in the collections preclude any definite inferences.

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