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SYSTEMATICS AND DISTRIBUTION OF FISHES OF THE FAMILY LEIOGNATHIDAE (PISCES) OF THE VEMBANAD LAKE, KERALA (S. INDIA)

By

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(With 6 Text-figures, 4 Tables and 2 Plates)

INTRODUCTION

The fishes of the family Leiognathidae distinguished by the protrusible jaws, and differentiated from the Gerridae by the presence of bony ridges, nuchal crest, cleithral projections and naked head (except in *L. elongatus*). It contributes on an average (from 1958-1967) about 2.96 percent of the total marine fish catch in India (James, 1973). Extensive studies on the Leiognathidae of India are published by Arora (1951), Jones (1966), Balan (1967) and James (1973). The present paper is a systematic account of the leiognathid fishes of the Vembanad Lake, their geographical and seasonal distribution and abundance in relation to the environmental conditions. The depth of the lake does not exceed beyond 5m except in the ship channel and so the vertical distribution of fishes in relation to environmental conditions was not attempted. The hydrology of the lake has been extensively studied by Balakrishnan (1957), Ramamritham and Jayaraman (1963), George and Kartha (1963), Cherian (1967), Qasim and Gopinath (1969), Josanto (1971) and Wallershaus (1973). No attempt has been made so far to give a detailed systematic account of Vembanad Lake fishes and to relate their occurrence and abundance to the varying hydrological conditions of the lake. The available literature on the fish and fisheries of Vembanad Lake is confined to a few papers (Shetty, 1963, 1965 ; Jhingran and Gopalakrishnan, 1971 ; Gopalakrishnaya, 1972). The systematics and distribution of the leiognathid fishes are inadequate. Systematics and fisheries of lacustrine fishes have been extensively studied both in India and abroad by a number of workers, notably Chaudhuri (1916a, 1917, 1923), Coutter (1965, 1966, 1968) ; David (1954) ; Devasundaram (1954) ; Greenwood (1973a) ; Greenwood and Gee (1969) ; Holden (1967) ; Jacob (1961) ;

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Jhingran *et al.*, (1963) ; Jhingran and Natarajan (1966, 1969) ; Jones and Sujunsingani (1954) ; Menon (1961) ; Pillai (1967) and Visweswara Rao (1977). The specific identity of the available species in the lake is a pre-requisite for any study on the fish and fisheries of the Vembanad Lake.

Of the fishes of the family Leiognathidae, Day (1876) reported 14 species from Indian seas ; Weber and de Beaufort (1931) listed 16 species from Indo-Australian Archipelago ; Smith (1949) listed 4 species from S. Africa ; Munro (1955) reported the occurrence of 12 species from Sri Lanka waters and recently he has described a new species from New Guinea region (Munro, 1964, 1967). Tiews *et al.*, (1965) recorded the occurrence of 17 species from Philippines ; Kuhlmorgen—Hille (1968) reported 14 species from Gulf of Thailand which include one undescribed new species and listed 31 species of leiognathid fishes in F. A. O. fish identification sheets (Kuhlmorgen-Hille, 1974). Monkolprasit (1973) reported the fishes of the genus *Secutor* from Thailand waters which include one more new species. James (1975) revised the family Leiognathidae which include the description of 18 species, out of which 17 species were collected from Indian seas which also includes two new distributional records and one new species already reported by him (James 1968, 1969). Jayabalan and Ramamoorthi (1977) reported the occurrence of 11 species from Porto Novo waters on the east coast of India.

Abbreviations used

D=Dorsal fin ; A=Anal fin ; SD=Standard deviation ; M=Mean ; SL=Standard length ; TL=Total length.

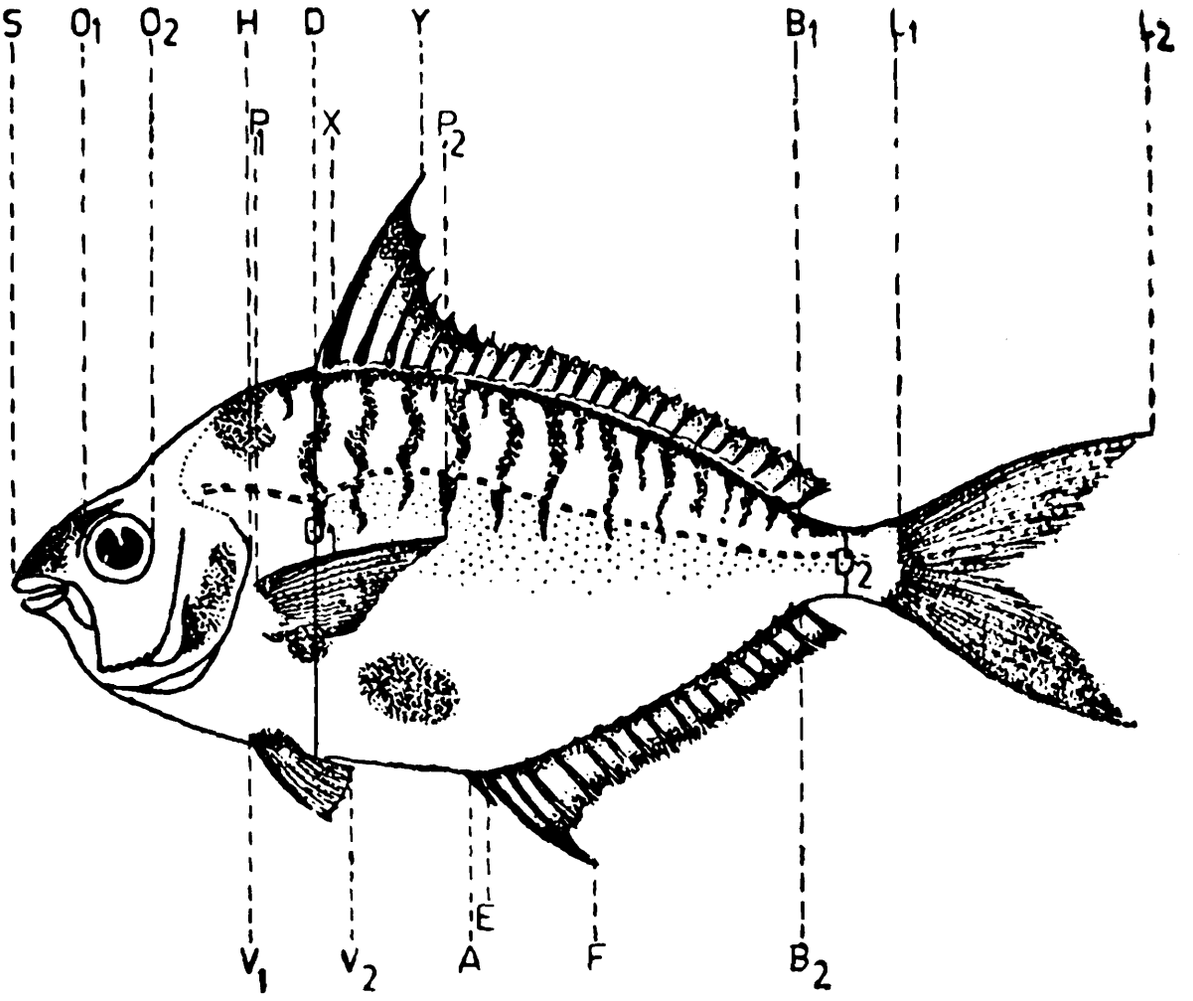
The Vembanad Lake System

The Vembanad backwater system is the largest on the south west coast of India, and extends between latitude 9°28' and 10°10' N and longitude 76°13' and 76°30'E. It has a length of about 90 km. and extends from Alleppey in the south to Thuruthippuram (east of Azheekode) in the north. The total area is about 300 sq. km. The depth varies from 1.5 to 12 m and the width varies from a few 100 m to about 14.5 km. On the northern part, there are two permanent openings to the Arabian Sea, one at Cochin, a 450 m wide channel which forms the main entrance to Cochin harbour and the other at Azheekode. These regions are subjected to regular tidal influences and have all the characteristics of a typical tropical estuary. Tides in the Cochin backwaters are of mixed semidiurnal type and two successive high and low waters occur each day with substantial difference in range and time.

The main source of fresh water for the backwater is two large rivers—Periyar in the north and Pamba in the south. Four other small rivers viz. Achankoil, Manimala, Meenachil and Moovattupuzha also empty into the backwater.

MATERIALS AND METHODS

Fortnightly cruises were made in the estuarine region and monthly cruises were made from Alleppey to Thuruthippuram in the research vessel "Sagitta" during the year 1978-'79. Fish sampling surveys were conducted from various fishing operations like stake nets, chinese



Text-fig. 1. Sketch of *Leiognathus brevirostris* showing how measurements are made.

shrimp nets and drag nets with the emphasis laid on species diversity and catch composition. Water samples for analysis were collected from 20 fixed stations.

The present study is based on the material collected exclusively from Vembanad Lake and the locations are plotted in the maps (Text-fig. 2, 3 & 4). The number of specimens examined differed for each species because of their varied occurrence. Measurements and

counts were made on preserved fishes. Considerable shrinking of specimens occurred during preservation. Details of live colouration are noted for most of the species. Except for total length, all measurements were taken from point to point (straight line) on the left side of the fish (with mouth closed). A pair of dividers and vernier calipers were used for measurements and they were rounded off to the nearest millimeter. All proportions are in per cent of standard length except the snout length, orbit diameter and inter orbital distance which are in per cent of head length (Table 1, 2 & 3). Measurements and counts are made according to William and Venkataramani (1978) and Lowe-Mc Connell (1978).

The following abbreviations are used (all measurements in m.m.) for the characters used in this study (Text-fig. 1).

SL_2 Total length, from tip of snout to tip of longest caudal fin.

SL_1 Standard length, from tip of snout to caudal base (hypural bone junction).

D_1 Body depth, from origin of first dorsal spine to dorsal point of insertion of pelvic fin.

SH Head length, from tip of snout to posterior edge of opercular bone.

SO_1 Snout length, tip of snout to the first margin of eye.

O_1O_2 Orbit diameter, horizontal distance between the free orbit rims.

XY Dorsal spine length, from origin of second dorsal spine to its tip.

EF Anal spine length, from origin of second anal spine to its tip.

B_1L_1 Length of caudal peduncle, from the point of origin of last dorsal fin ray to posterior margin of hypural bone.

D_2 Width of caudal peduncle, at the point of least depth.

DB_1 Length of dorsal fin base from origin of fin to last ray.

AB_2 Length of anal fin base.

P_1P_2 Pectoral fin length, distance from base of upper-most pectoral ray to tip of longest ray.

V_1V_2 Ventral fin length, distance from anterior point of origin of the spine to the tip of longest ray.

SD Pre-dorsal length, from tip of snout to origin of first dorsal fin spine.

SA Pre-anal length, from tip of snout to origin of first anal spine.

SP_1 Pre-pectoral length, from tip of snout to dorsal point of origin of pectoral fin.

SV_1 Pre-ventral length, from tip of snout to anterior point of origin of ventral fin.

Characters of Taxonomic Value

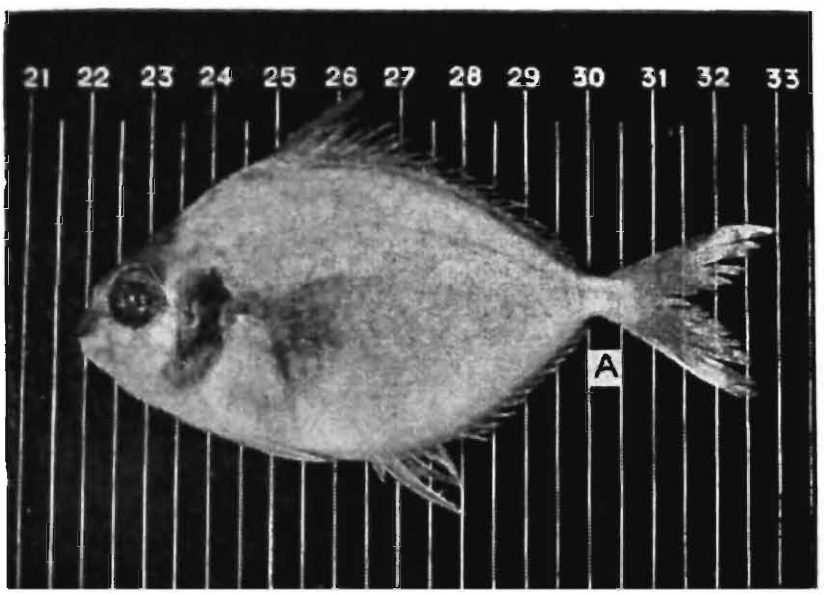
Fishes of the family Leiognathidae can be easily diagnosed due to the presence of the following specific characters : compressed body with deciduous cycloid scales ; head scaleless (except in *L. elongatus*) with

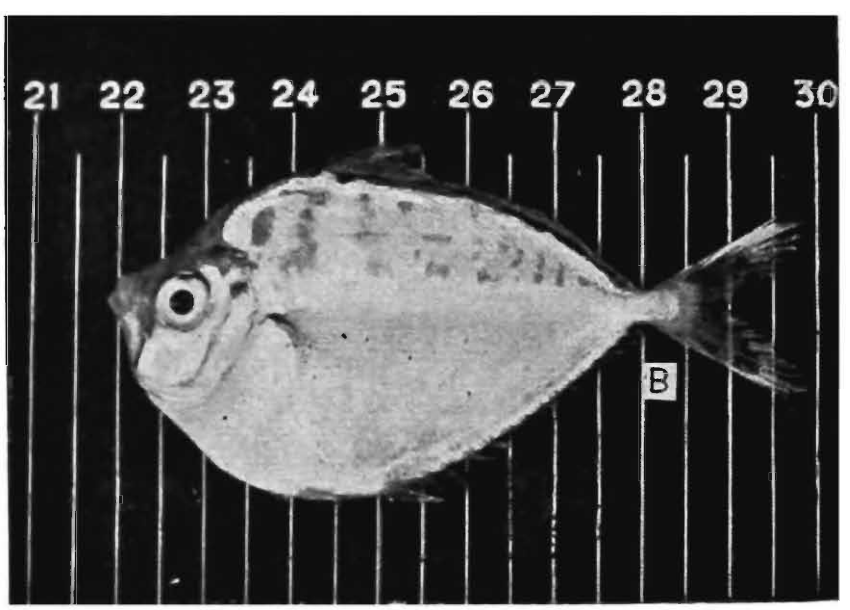
bony ridges ending in a nuchal crest. The jaws may be oblique or horizontal and extremely protrusible, thus forming a tube. Cleithral projections are present on opercle (Jayabalan & Ramamoorthi, 1977). Gill membranes united with isthumus ; five branchiostegal rays. A long single dorsal with 8 spines and 16 rays with conspicuous basal sheath ; anal fin with 3 spines and 14 rays. Ventrals short with one spine and 5 rays with an axillary scale-like structure. Caudal fin forked.

The family Leiognathidae consists of three genera, *Leiognathus* Lecépède, *Gazza* Rupell and *Secutor* Gistel (Smith 1949, Munro 1955, Kuhlmorgen-Hille 1968, 1974, James 1975, Nelson 1976). The direction of the protrusible jaws and the nature of jaw teeth are used for differentiating the genera. The body depth in relation to standard length, length of the second dorsal spine, presence or absence of breast scales, shape of snout and mandible, position of nostril and body colourations are also useful in differentiating the species within a genus.

A KEY TO THE SPECIES OF LEIOGNATHID FISHES OF VEMBANAD LAKE

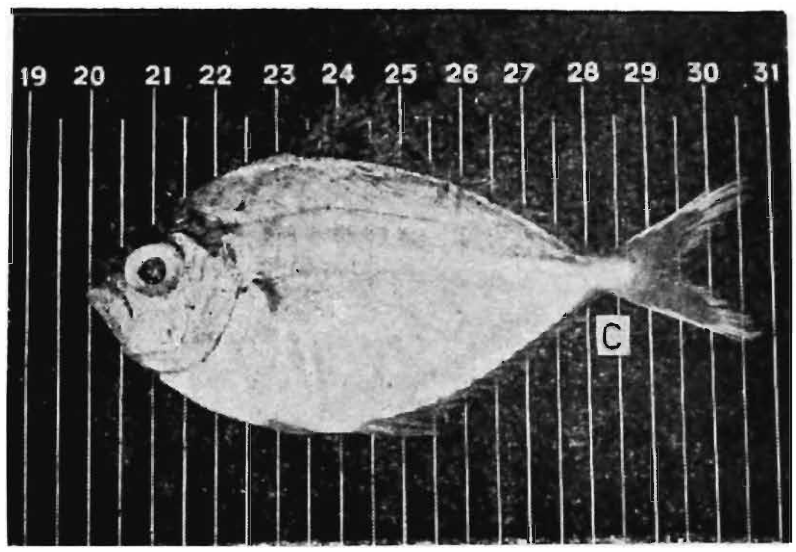
	Jaws extremely protractile, canine teeth absent. ...	... 1
	Jaws protractile, canine teeth present. ...	**Gazza** Ruppell 10
1.	Protrusible jaws point forwards or downward, mouth horizontal, 'Y' shaped bony ridges on head, 2 cleithral projections. ...	**Leiognathus** Lacépède 2
	Protrusible jaws point upwards, mouth oblique, 'V' or 'Y' shaped bony ridge on head, cleithral projections 1 or 2, ventral profile much more convex than dorsal. ...	**Secutor** Gistel 9
2.	Dorsal profile more convex than ventral, sharp ascent from truncate snout to dorsal fin. ...	... 3
	Dorsal profile equal to or nearly the same as the ventral profile, gradual ascent from snout to dorsal fin. ...	... 4
3.	Snout shorter than eye diameter, conspicuous scales on breast, mandible slightly concave, jet black blotch on spinous dorsal. ...	*L. splendens* (Cuvier)
	Snout more or less equal to eye diameter, breast with very thin scales, apparently naked, mandible strongly concave. ...	*L. equulus* (Forskål)
4.	Lateral line ending below middle or end of soft dorsal. ...	... 5
	Lateral line continued to base of caudal fin. ...	... 8

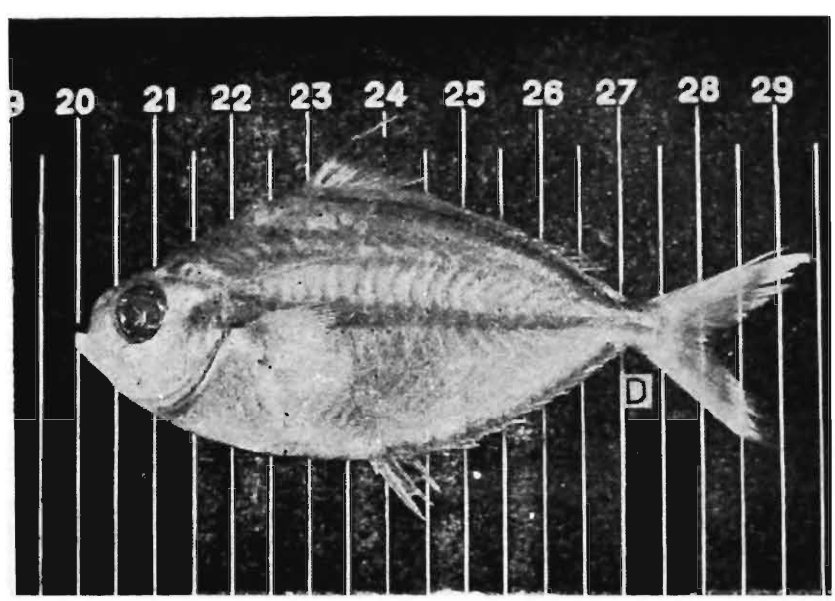




Figs. A. *Leiognathus splendens* (Cuvier)

B. *Leiognathus equulus* (Forskål)





Figs. C. *Leiognathus bindus* (Valenciennes)

D. *Leiognathus daura* (Cuvier)

5.	Jaws point forwards when protruded, small scales on breast.	... ...	6
	Jaws point downwards when protruded, no scales on breast.	... ...	7
6.	Ventral profile more deep and strongly compressed ; ventrals very short ; upper third of the spinous dorsal orange, edged with black on the lower border.	...	*L. bindus* (Valenciennes)
7.	Rhomboid body, back without irregular patterns ; yellow band along lateral line ; deep black blotch on spinous dorsal.	...	*L. daura* (Cuvier)
8.	A concavity on the anterior dorsal part of the body, back with irregular zig-zag marks.	...	*L. berbis* (Valenciennes)
	Scales absent on breast, black patch across nape, ochre-yellow blotch on abdomen, yellow spot near pectoral axil.	...	*L. brevirostris* (Valenciennes)
9.	Body oblong, depth 42.3-52.8% in S. L., Lateral line ends below a little before end of soft dorsal.		*S. insidiator* (Bloch)
	Body oval, depth 56.8-63.0% in S. L., Lateral line ends below middle of soft dorsal.	...	*S. ruconius* (Hamilton-Buchanan)
10.	Body depth less than 46.5% in S. L.	...	*G. minuta* (Bloch)

1. **Leiognathus splendens** (Cuvier) 1829

(Plate II A)

Brief description : Based on 31 specimens ranging in size 38.0-93.0 mm S. L (46.0-116.0 mm T. L). Morphometric data are summarized in Table 1. D. VIII, 16 ; A. III, 14 ; P. 18-20 : V. I, 5 ; C. 24.

Height of the body at D origin more than half of S. L. Snout length less than orbit diameter. Gill rakers on first arch 5+19-21=24-26. Lateral line with 50-57 sensory tubes.

Occurrence and Abundance in the Lake : *L. splendens* occurs from October to May in the catches from those parts of the lake (Text-fig. 2) where the salinity ranges from 19.2-33.3‰ and temperature 25.0-34.2°C. From October to January its occurrence was very sporadic and the distribution was more or less confined to the mouth and lower reaches of the estuary. The penetration of this species into the interior parts of the lake was coincided with gradual increase in salinity gradient. It's regular occurrence in small numbers was noticed from February to May in the estuary when the salinity (23.0—33.3‰) and temperature (30.4 – 34.2°C) were high.

Distribution : Indo-Australian Archipelago, New Guinea, Red Sea, Madagascar, Gulf of Thailand, Sri Lanka, Andaman Islands, Siam,

China, Formosa, Philippines, Queensland, Fiji Islands, India—East Coast: Gulf of Mannar, Gopalpur, Visakhapatnam, Kakinada, Madras, Tuticorin, Coromandal coast, Palk Bay, Godavari estuary and Porto Novo ; West Coast : Goa, Karwar, Mangalore, Calicut, Malabar, Cochin, Vizhinjam and Cape Comarin.

2. **Leiognathus equulus** (Forskål) 1775

(Plate II B)

Brief description: Based on 48 specimens ranging in size 33.0—97.0 mm S.L. (41.0—125.0 mmT.L) Morphometric data are summarized in Table 1. D. VIII, 16; A.III, 14; P. 20 ; V. I,5; C. 24—25.

Height of the body at D origin more than half of S.L. Snout length nearly equal to orbit diameter. Gill rakers on first arch 4+(14-16)=18-20. Lateral line with 57-62 sensory tubes.

Occurrence and Abundance in the Lake : *L. equulus* occurs throughout the year in the catches from the lake. It is one of the most abundant species and contributes about 40% of the total silver-belly fishery of the lake. These are euryhaline fishes which are able to occupy all regions of the lake (Text-fig. 2) where the salinity (0.2 – 33.3%) and temperature (23.0 – 34.2°C) were highly fluctuating. It was relatively abundant in the mouth, middle and lower reaches of the estuary where salinity was invariably high (18.0 – 33.3‰) during the pre-monsoon period. The catch composition of this species was relatively more in the northern half (Cochin-Thuruthippuram) of Vembanad Lake than southern half. The occurrence of this species in the region east of the Thannirmukham barrage was scarce where salinity does not exceed 3.7‰. During monsoon season almost freshwater condition prevailed in the lake, so that its availability was reduced but during intermonsoon months fairly good catches were noticed especially from February to May when the salinity (9.2 – 33.3‰) and temperature (29.3 – 34.2C°) were comparatively high.

Distribution : Indo-Australian Archipelago, Red Sea, Beira, Zanzibar, Natal coast, Delagoa Bay, Chinde, Medagascar, Bourbon, Mauritius, Muscat, Sri Lanka, Siam, Bankok, Formosa, Riykiu islands, Philippines, Marianas, Australia, Solmon islands, New Calendonia, Somoa, Fiji islands, Gulf of Thailand, India-East Coast : Coromandel coast, Mandapam, Rameswaram, Kilakarai, Pamban, Madras, Porto Novo, Godavari estuary and Chilka Lake ; West Coast : Bombay, Malabar, Cochin and Cape Comarin.

3. **Leiognathus bindus** (Valenciennes) 1835

(Plate II C)

Brief description : Based on 22 specimens ranging in size 48.0-84.0 mm S.L. (61.0-117.0 mm T.L.). Morphometric data are summarized in Table 1.

D. VIII, 16 ; A. III, 14 ; P. 18-20 ; V. I, 5 ; C. 24.

Height of the body at D origin more than half of S. L. Snout length less than orbit diameter. Gill rakers on first arch 4-6+18-19=22-25. Lateral line with 37-47 sensory tubes, ending below the middle of soft dorsal.

Occurrence and Abundance in the Lake : *L. bindus* occurs in the months from January to May in the catches from the lake. It's occurrence was strictly confined to the mouth of the estuary (Text-fig. 2) when the salinty (26.2-33.3‰) and temperature (25.0-34.2°C) were uniformly high. During January and February its occurrence was very sporadic. From March to May its regular occurrence in traces was noticed in the catches when the condition prevailed in the estuary was closely related to those of the nearby inshore areas. The salinity (28.5-33.3‰) and temperature (32.5-34.2°C) were remarkably high during the above months in the estuarine mouth. By examining the catch composition it was clear that this species maintains a very low level of population in the head of Cochin barmouth and at Azheekode during the months from March to May.

Distribution : Indo-Australian Archipelago, East-Africa, Gulf of Thailand, Sea of Penang, Sri Lanka, China, Formosa, Philippines, India—East Coast : Coromandel Coast, Mandapam, Gulf of Mannar, Madras and Porto Novo ; West Coast : Cochin.

4. **Leiognathus daura** (Cuvier) 1829

(Plate II D)

Brief description : Based on 18 specimens ranging in size 67.0-73.0 mm S.L. (86.0-96.0 mm T.L). Morphometric data are summarized in Table 2.

D. VIII, 16 ; A. III, 14 ; P. 18, V. I, 5 ; C. 24.

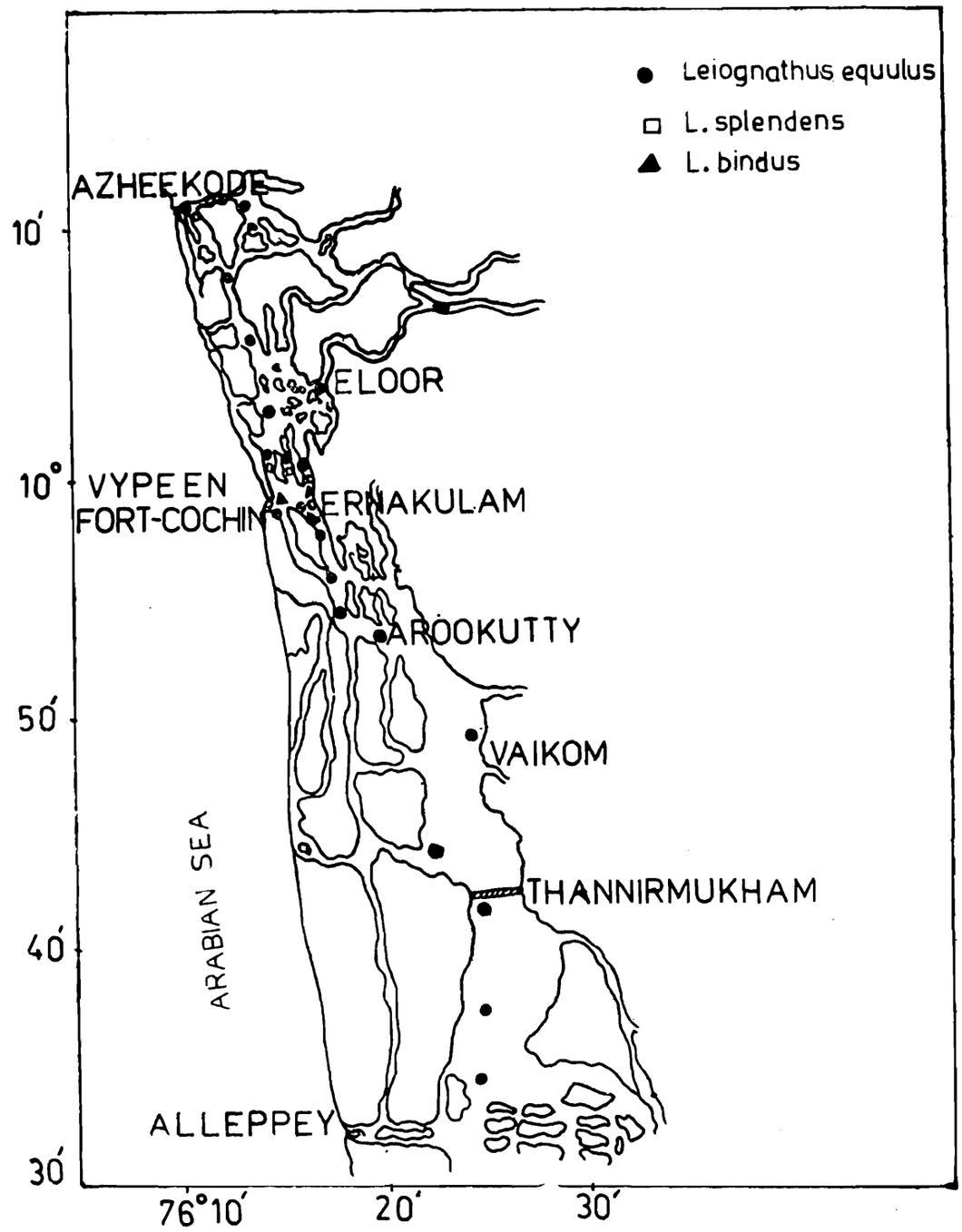
Height of the body at D origin less than half of S.L. Snout length more or less equal to orbit diameter. Gill rakers on first arch (4-6)+(15-16)=19-22. Lateral line with 49-57 sensory tubes.

Occurrence and Abundance in the Lake : *L. daura* occurs from the middle of March to May in the catches from the mouth of the estuary.

TABLE 1. Body proportions of *L. splendens*, *L. equulus* and *L. bindus* as percent of standard length and head length.

Sl. No.	Characters	*L. Splendens* Range	*L. Splendens* Mean	*L. Splendens* S. D.	*L. equulus* Range	*L. equulus* Mean	*L. equulus* S. D.	*L. bindus* Range	*L. bindus* Mean	*L. bindus* S. D.
	IN STANDARD LENGTH									
1.	Depth of body (at the origin of dorsal)	48.6-57.3	54.0	2.2	54.3-66.6	59.6	3.2	51.4-55.9	53.6	1.4
2.	Head length	31.0-34.0	32.3	0.8	33.3-37.0	34.7	1.2	29.5-31.9	30.4	0.7
3.	Dorsal origin	46.2-51.1	48.2	1.6	49.1-55.5	53.2	2.1	39.5-45.2	42.9	1.6
4.	Anal origin	49.2-56.7	53.9	1.9	52.7-60.6	57.2	1.8	52.0-59.9	55.7	1.9
5.	Pectoral origin	31.1-35.4	33.0	1.1	32.9-38.8	36.3	2.0	28.0-35.4	31.1	1.9
6.	Ventral origin	34.4-39.5	37.1	1.2	38.5-44.6	41.4	1.5	38.0-41.9	39.6	1.2
7.	D base length	49.9-59.1	56.4	2.3	52.9-62.9	56.9	3.0	54.1-59.9	57.1	1.6
8.	A base length	39.4-47.6	45.8	2.0	43.8-51.0	46.8	1.8	43.0-51.9	47.9	2.3
9.	Pectoral length	22.7-26.3	24.9	0.9	19.5-25.7	23.2	2.1	19.3-23.8	21.1	1.2
10.	Ventral length	15.0-18.0	16.3	0.7	13.6-15.7	14.7	0.8	8.8-12.4	10.1	1.0
11.	Length—Second dorsal spine	21.8-23.8	22.6	0.9	18.1-23.5	21.4	1.5	17.1-20.7	18.8	1.1
12.	Length—Second anal spine	16.4-21.0	18.3	1.4	15.4-20.6	18.3	1.5	12.5-15.2	14.5	0.9
13.	Length—Caudal peduncle	9.0-12.4	10.6	0.8	7.8-12.3	9.8	1.2	8.0-11.1	9.5	1.4
14.	Depth—Caudal peduncle	7.8-10.8	9.5	0.8	5.5- 9.2	7.4	1.0	6.6- 7.7	7.1	0.3
	IN HEAD LENGTH									
1.	Eye diameter (Horizontal)	35.0-42.3	38.4	2.1	29.1-35.4	31.6	2.0	34.6-42.8	39.4	3.7
2.	Snout	26.0-32.5	29.4	1.8	28.0-37.5	32.9	2.6	24.0-31.8	27.9	2.4
3.	Inter orbital space	33.3-40.0	35.9	1.8	33.3-43.7	38.2	3.2	30.0-43.4	36.1	3.5

During these months the entire estuary has a marine habitat. High salinity (29.6-33.3‰) and temperature (32.8-34.2°C) were noticed from its known region of occurrence (Text-fig. 2). By examining the catch composition it is clear that this species have a meagre population in the estuary during these months and constitute only a minor local fishery.



Text-fig. 2. Geographic distribution of *Leiognathus equulus*, *L. splendens* and *L. bindus* in Vembanad Lake (based on specimens personally examined).

Distribution : Indo-Australian Archipelago, Gulf of Thailand, Sea of Penang, South Arabia, Andaman Islands, Sri Lanka, Siam, Queensland, India—East Coast : Palk Bay, Gulf of Mannar, Coromandel Coast, Chilka lake and Porto Novo ; West Coast : Goa and Cochin.

5. **Leiognathus berbis** (Valenciennes) 1835

(Plate II E)

Brief description : Based on 8 specimens ranging in size 86.0-96.0 mm S.L. (106-118.0 mm T.L). Morphometric date are summarized in Table 2.

D. VIII, 16 ; A. III, 14 ; P. 16-18 ; V. I, 5 ; C. 24.

Height of the body at D origin less than half of S.L. Snout length greater than orbit diameter. Gill rakers on first arch (3-4)+(13-14)= 16-18. Lateral line with 35-52 sensory tubes, ceasing before end of soft dorsal.

Occurrence and Abundance in the Lake: *L. berbis* was found only in very small numbers during the first week of May from the ship channel and the mouth of the estuary (Text-fig.3) where high salinity (33.3‰) and temperature (32.8°C) were noticed.

Distribution : Indo-Australian Archipelago, Red Sea, Zanzibar Philippines, India—East Coast : Palk Bay, Gulf of Mannar and Porto Novo, West Coast : Goa and Cochin.

6. **Leiognathus brevirostris** (Valenciennes) 1835

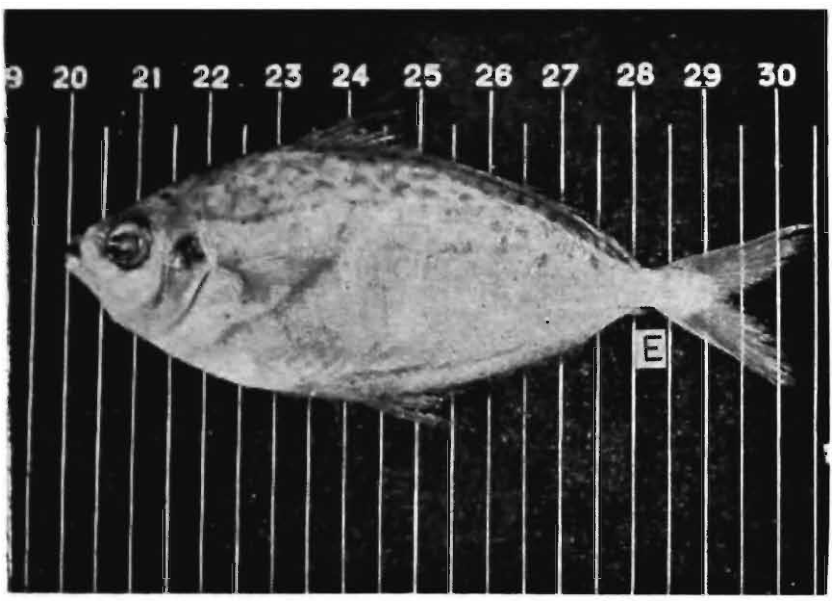
(Plate II F)

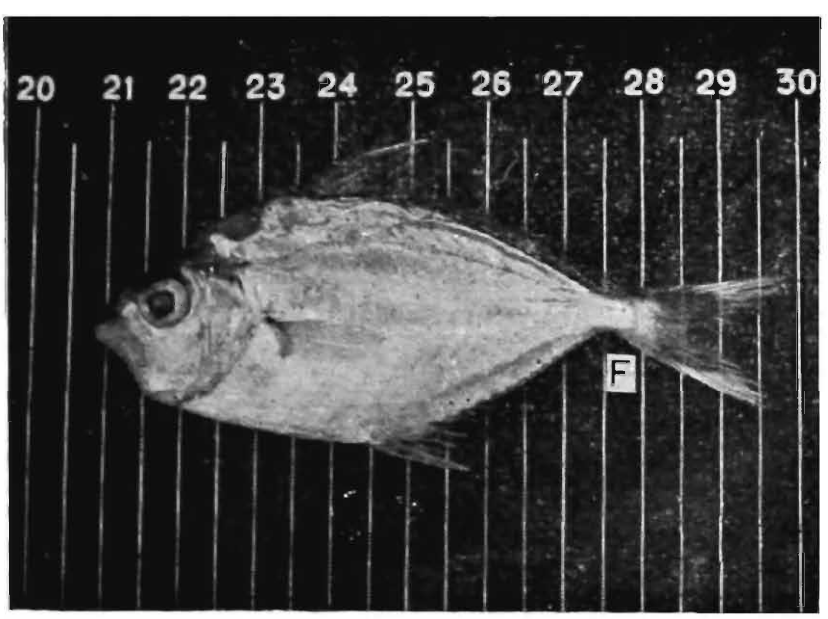
Brief description : Based on 52 specimens ranging in size 59.0–85.0 mm S.L. (79.0–105.0 mm T.L). Morphometric data are summarized in Table 2.

Height of the body at D origin less than half or nearly half of S.L. Snout length more than orbit diameter. Gill rakers on first arch (4-6) + (18-19)=22-25. Lateral line with 55-60 sensory tubes.

Intensity of colour varies with localities. Diffuse 12-14 irregular bands on dorsal profile. Narrow bluish green strand from isthmus to caudal peduncle in fresh condition. Opercle yellow. Golden yellow on lateral line, bordered by dusky margins. The membrane between anal spines and rays fringed with orange red colour.

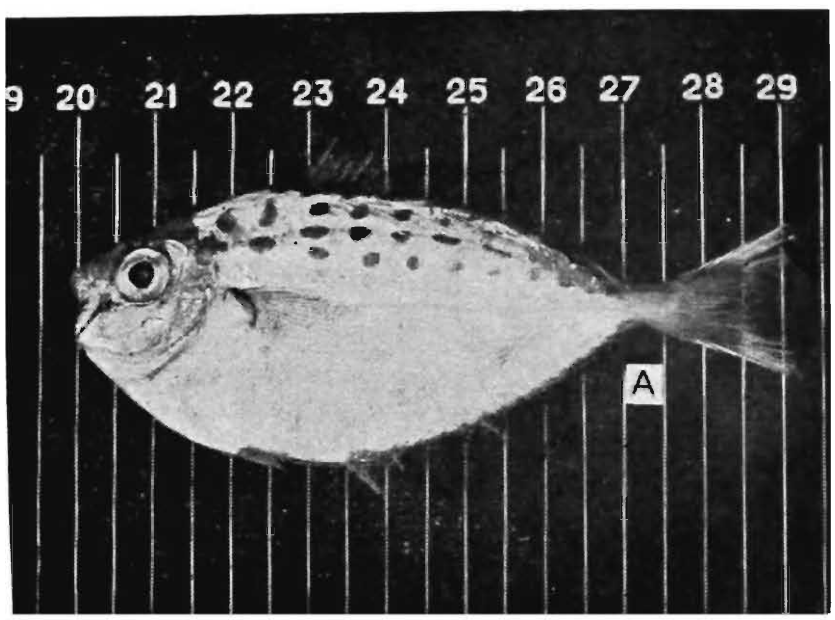
Occurrence and Abundance in the Lake : *L. brevirostris* was equally abundant as *L. equulus* and its occurrence was noticed throughout the year in the catches from the lake. These are also euryhaline fishes which were able to occupy all regions of the lake (Text-fig. 3) and forms local fisheries of considerable importance. The distribution pattern of this species was more or less similar to that of *L. equulus*. During monsoon its availability was reduced but during intermonsoon months fairly good catches were noticed, especially from December to May

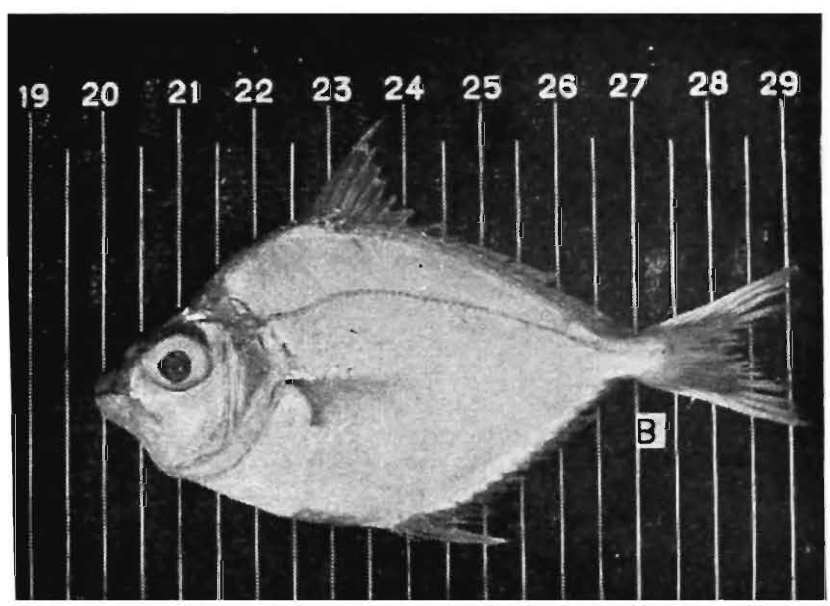




Figs. E. *Leiognathus berbis* (Valenciennes)

F. *Leiognathus brevirostris* (Valenciennes)



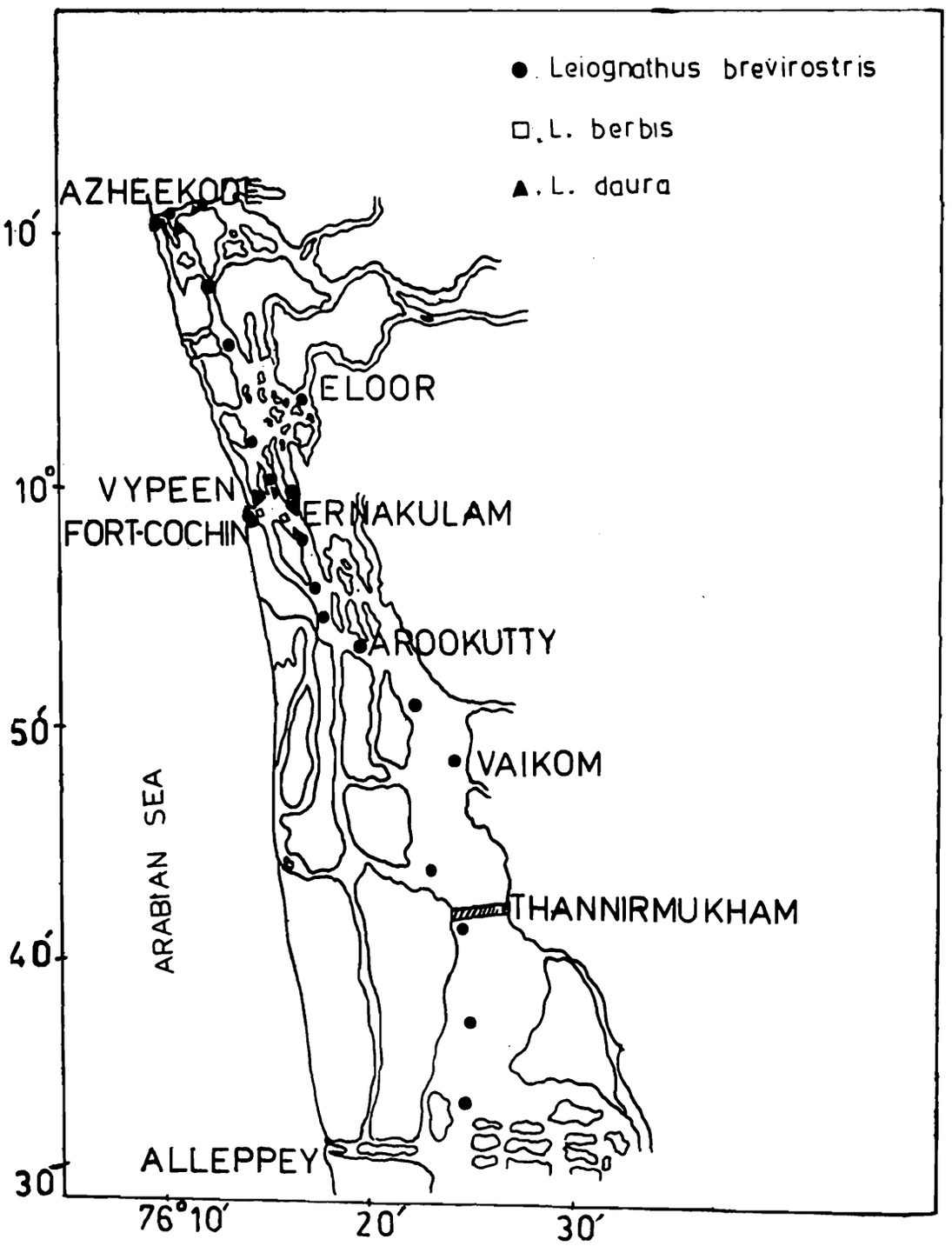


Figs. A. *Secutor insidiator* (Bloch)

B. *Secutor ruconius* (Hamilton—Buchanan)

when the salinity ranges from 5.2-33.3‰ and temperature 24.1-34.2°C in the lake.

Distribution : Indo-Astralian Archipelago, China, India—East Coast : Palk Bay, Gulf of Mannar and Godavari estuary ; West Coast : Cochin.



Text-fig. 3. Geographic distribution of *Leiognathus brevirostris*, *L. berbis* and *L. daura* in Vembanad Lake (based on specimens personally examined).

7. **Secutor insidiator** (Bloch) 1787
(Plate III A)

Brief description : Based on 35 specimens ranging in size 41.0-73.0 mm S.L. (49.0-91.0 mm T.L). Morphometric data are summarized in Table 3.

TABLE 2. Body proportions of *L. daura*, *L. berbis* and *L. brevirostris* as percent of standard length and head length.

Sl. No.	Characters	*L. daura* Range	*L. daura* Mean	*L. daura* S. D.	*L. berbis* Range	*L. berbis* Mean	*L. berbis* S. D.	*L. brevirostris* Range	*L. brevirostris* Mean	*L. brevirostris* S. D.
	IN STANDARD LENGTH									
1.	Depth of body (at the origin of dorsal)	45.5-49.9	47.5	1.4	40.6-42.6	41.9	0.6	44.0-50.6	47.9	2.7
2.	Head length	28.1-30.1	29.0	0.6	27.0-29.4	28.0	0.9	29.1-32.8	30.5	1.3
3.	Dorsal origin	44.2-48.6	45.5	1.2	40.6-43.0	42.4	1.7	41.0-45.4	44.4	1.3
4.	Anal origin	53.5-56.3	55.2	0.8	54.7-57.3	55.7	1.1	49.9-55.6	53.3	2.1
5.	Pectoral origin	28.5-32.3	30.5	1.2	29.1-31.3	30.0	0.9	29.1-34.4	31.6	1.5
6.	Ventral origin	36.2-40.2	38.3	1.3	38.2-39.9	38.7	0.8	35.2-41.6	37.8	1.7
7.	D Base length	50.7-56.1	53.9	1.3	53.6-56.9	55.4	1.4	52.5-56.9	54.3	1.8
8.	A base length	42.0-45.2	44.0	1.1	41.8-46.3	43.8	2.0	43.0-48.4	45.2	1.6
9.	Pectoral length	18.8-22.5	20.5	1.4	16.8-17.1	16.9	0.1	17.1-20.6	19.2	1.2
10.	Ventral length	10.1-16.4	13.3	1.7	11.5-12.9	12.2	0.6	10.1-14.8	12.7	1.5
11.	Length—Second dorsal spine	19.4-23.8	21.5	1.2	20.9-23.5	22.6	1.1	20.3-24.6	21.5	3.1
12.	Length—Second anal spine	14.2-16.4	15.2	0.8	16.2-20.2	18.8	1.6	14.4-18.7	17.0	1.6
13.	Length—Caudal peduncle	8.5- 9.8	9.1	0.5	8.4-10.4	9.5	0.8	8.1-11.8	10.0	1.2
14.	Depth—Caudal peduncle	5.7- 8.3	7.1	0.6	6.7- 7.8	7.0	0.5	6.3- 8.2	7.0	0.7
	IN HEAD LENGTH									
1.	Eye diameter (Horizontal)	32.3-40.0	35.6	2.4	28.5-33.3	30.8	1.9	26.3-35.0	30.2	3.2
2.	Snout	27.2-35.0	31.5	2.8	32.1-34.6	33.6	1.2	29.4-37.5	34.5	3.5
3.	Inter orbital spcae	38.0-45.0	41.6	2.8	32.8-34.2	33.2	1.2	33.3-42.8	37.5	2.7

D. VIII, 16 ; A. III, 14 ; P. 16-17 ; V. I, 5 ; C.24-26.

Height of the body at D origin less than half or nearly equal to half of S.L. Snout length less than orbit diameter. Gill rakers on first arch (5-5)+(20-24)=25-30. Lateral line with 44-58 sensory tubes, extends almost upto two thirds of soft dorsal.

Occurrence and Abundance in the Lake : *S. insidiator* occurs from September to middle of June in the lake (Text-fig. 4) where salinity ranges from 14.6-33.3‰ and temperature 24.0-34.2°C. During the monsoon periods the lake is influxed by freshwater as a result of heavy rainfall, so that this species completely disappears in the catches. By examining the catch composition it is clear that from September to December it was very scarce and its occurrence was more or less confined to the mouth and lower reaches of the estuary. From January to May fairly good catches were noticed from northern half where salinity (13.8-33.3‰) and temperature (24.5-34.2°C) were comparatively high. Only very stray catches were noticed from the southern half of Vembanad Lake.

Distribution : Indo-Australian Archipelago, Gulf of Thailand, East Coast of Africa, Medagascar, Seychelles, Delagoa Bay, Natal Coast, Sri Lanka, Hongkong, Philippines, Tahiti, India—East Coast : Palk Bay, Gulf of Mannar, Coromandel Coast, Mouth of Ganges, Madura, Godavari estuary, Chilka Lake and Porto Novo ; West Coast ; Goa, Malabar and Cochin.

8. **Secutor ruconius** (Hamilton—Buchanan) 1822

(Plate III B)

Brief description : Based on 26 specimens ranging in size 33.0-78.0 mm S.L. (40.0-98.0 mm T.L.) Morphometric data are summarized in Table 3.

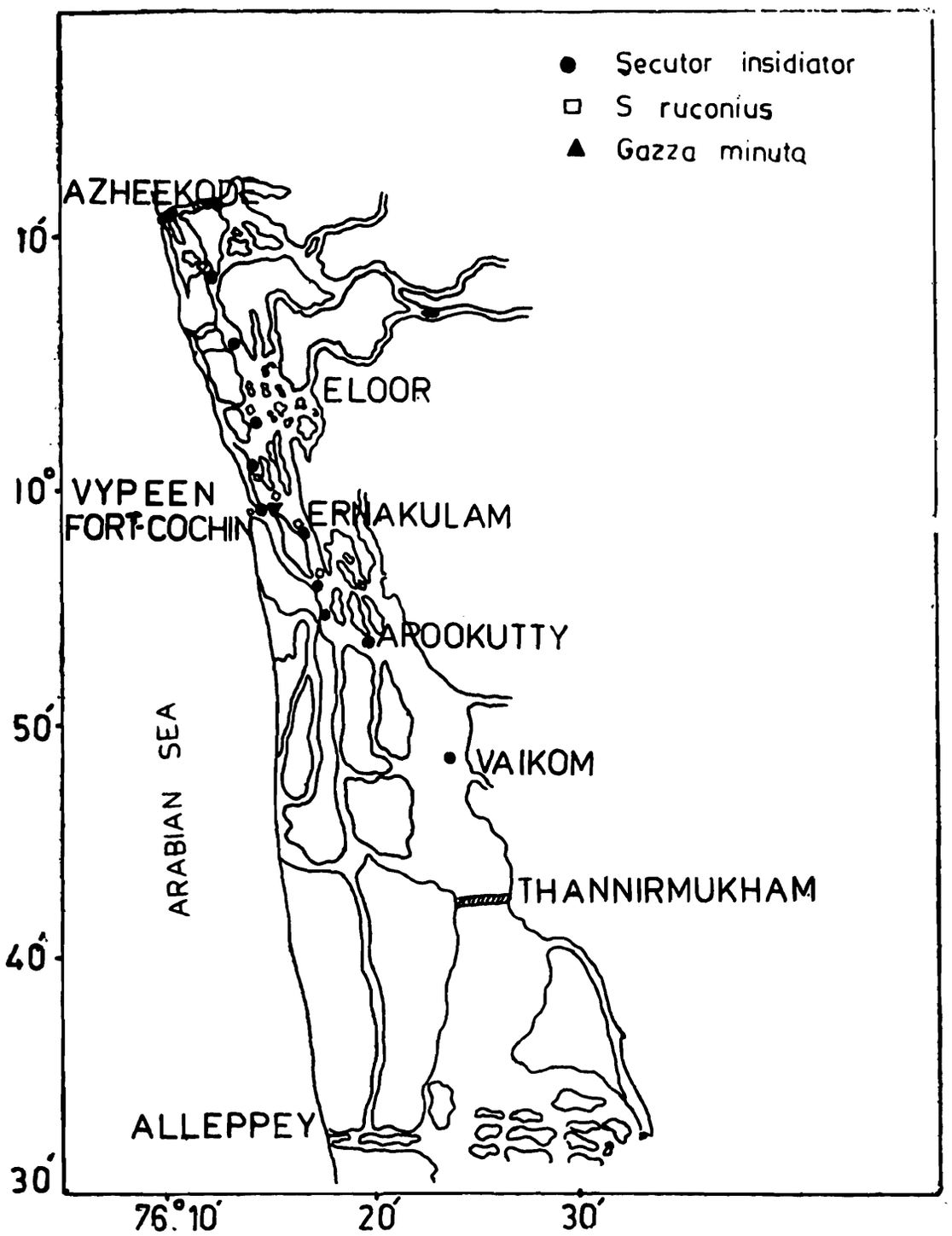
D. VIII, 16 ; A. III, 14 ; P. 16 ; V. I, 15 ; C. 24.

Height of the body at D origin more than half of S. L. Snout length less than orbit diameter. Gill rakers on first arch (5-6) (17-19)=22-25. Lateral line with 20-29 sensory tubes, extends upto middle of soft dorsal.

Occurrence and Abdundance in the Lake : *S. ruconius* occurs from February to May in the catches from the lake. During February and March only juveniles (39.0-65.0 mm S. L) were present in the estuary. It's distribution (Text-fig. 4) was mainly confined to the northern half of Vembanad Lake and only very stray occurrences were noticed upto

Thevara (South of Cochin). The occurrence of this species was noticed in those parts of the lake where the salinity (25.8-33.3‰) and temperature (30.4-34.2°C) were invariably high in the above months and nearly marine conditions were prevailing.

Distribution : Indo-Australian Archipelago, Gulf of Thailand, Westward to South Africa, South Arabia, Sri Lanka, Malayasia, China, Formosa, Philippines, India—East Coast : Palk Bay, Gulf of Mannar, Madras, Chilka lake, Porto Novo and Godavari estuary ; West coast : Goa and Cochin.



Text-fig. 4. Geographic distribution of *Secutor insidiator* *S. ruconius* and *Gazza minuta* in Vembanad Lake (based on specimens personally examined).

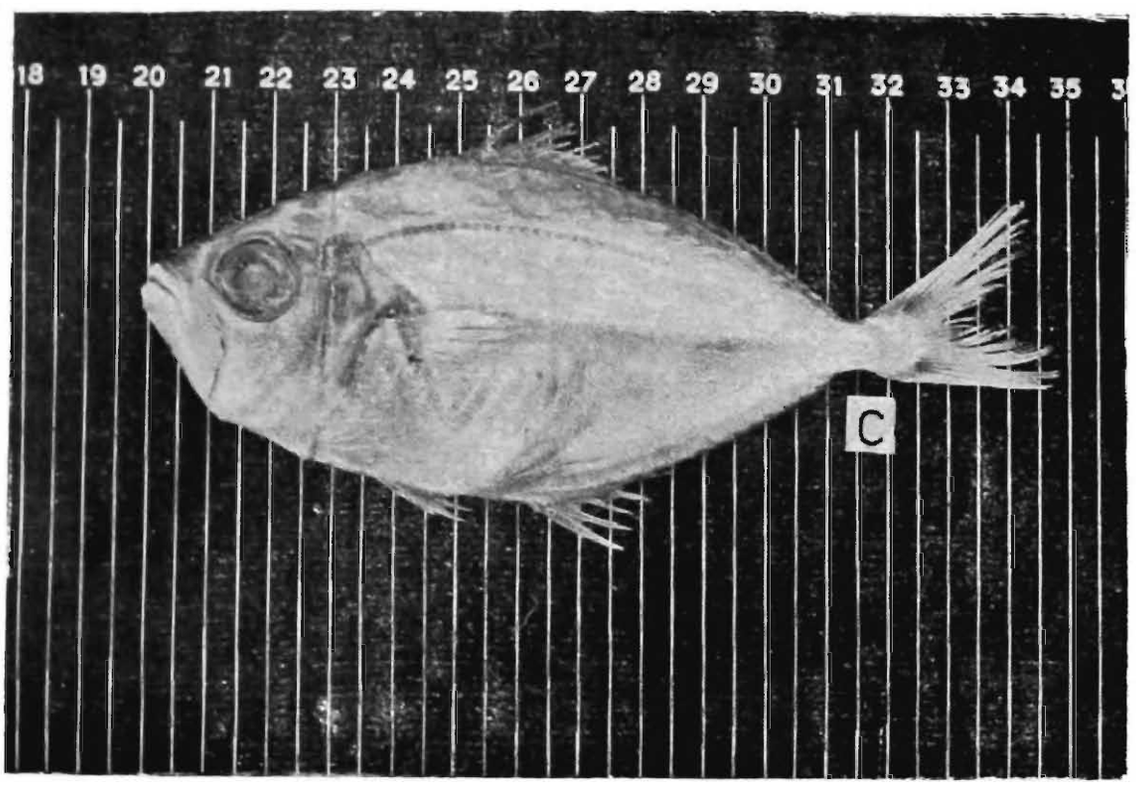


Fig. C. *Gazza minuta* (Bloch)

9. **Gazza minuta** (Bloch) 1797

(Plate III C)

Brief description : Based on 4 specimens ranging in size 107.0-116.0 mm S.L (131.0-145.0 mm T.L). Morphometric data are summarized in Table 3.

D. VIII, 16 ; A. III, 14 ; P. 20 ; V. I, 5 ; C. 24.

Height of the body at D origin less than half of S.L. Snout length less than orbit diameter. Gill rakers on first arch (3-5)+(15-16)=18-21. Lateral line with 60-62 sensory tubes.

Occurrence and Abundance in the Lake : *G. minuta* occurs very sporadically in the catches from the lake. It's occurrence was noticed only in the later half of April from the mouth of the estuary and the ship channel and was in small numbers. During the above months the estuary had a marine habitat and high salinity (32.9‰) and temperature (32.8°C) were noticed from the reported region of occurrence (Text-fig. 4).

Distribution : Indo-Australian Archipelago, Red Sea, Gulf of Thailand, Mossambique, Northern coast of Australia, Delagoa Bay, Natal coast, Medagascar, Bourbon, Mauritius, Seychelles, Andaman Islands, Minicoy Islands, Sri Lanka, Siam, Formosa, Philippines, New Guinea, Solomon Islands, New Britain, Tahiti, Tanna, Rarotonga, India—East Coast : Palk Bay, Gulf of mannar, Chilka Lake, Madras and Porto Novo ; West Coast : Cochin and Cape Comarin.

Discussion

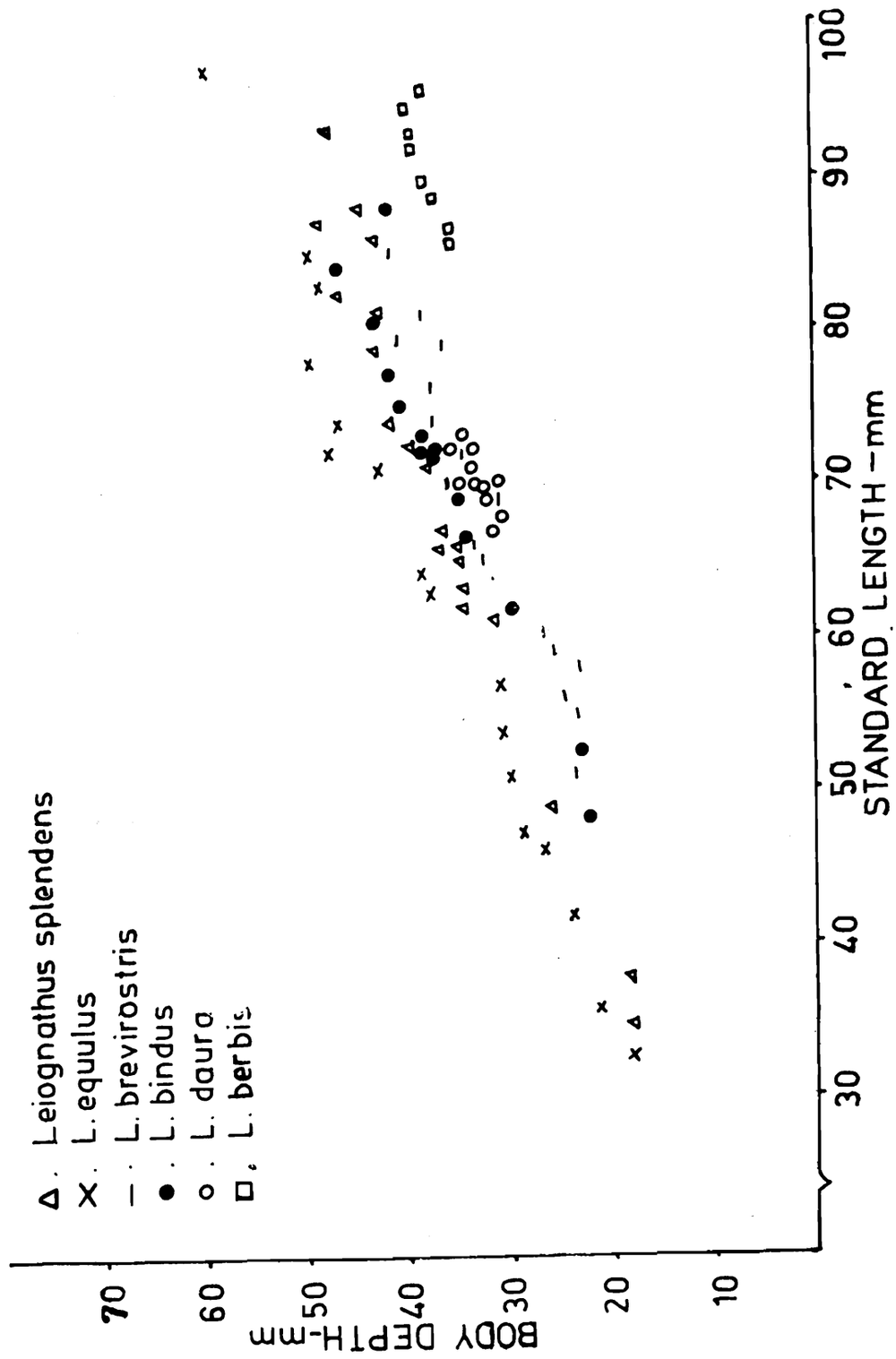
The Vembanad Lake is the largest estuarine system of Kerala and it has a rich and diversified fish fauna. The silver-belly fishes constitute an important fishery in the lake. Shetty (1963) listed only six species of leiognathid fishes from Vembanad Lake. Among those six species, *Leiognathus lineolatus* (Valenciennes) and *L. fasciatus* (Lacépède) were not collected so far by the present authors. The authors collected 9 species of silver-belly fishes from the lake which are described in this paper. Menon (1961) listed 6 species of silver-belly fishes from Chilka Lake, Visweswara Rao (1976) listed 7 species from Godavari estuary. On comparison it is clear that Vembanad Lake which is smaller than the Chilka Lake has more species of leiognathid fishes.

The distribution of fishes within any water body shows a zonal pattern, both longitudinal and transverse, due to behavioral adjustments (physiological adaptation) for optimal water currents, temperatures and

TABLE 3. Body proportions of *S. insidiator*, *S. ruconius* and *G. minuta* as percent of standard length and head length.

Sl. No.	Characters	*S. insidiator* Range	Mean	S. D.	*S. ruconius* Range	Mean	S. D.	*G. minuta* Range	Mean	S. D.
	IN STANDARD LENGTH									
1.	Depth of body (at the origin of dorsal)	42.3-52.8	47.3	2.6	56.8-63.0	59.2	2.1	42.0-46.1	44.0	2.8
2.	Head length	26.9-30.9	28.6	1.1	25.0-31.8	30.4	2.9	32.3-32.7	32.5	0.2
3.	Dorsal origin	34.6-41.4	38.1	2.0	35.4-42.8	39.8	2.1	43.9-44.8	44.3	0.6
4.	Anal origin	53.4-59.9	56.6	2.0	54.5-63.8	61.3	2.9	57.9-62.0	59.9	2.5
5.	Pectoral origin	27.8-30.9	29.5	0.9	29.5-34.3	31.6	1.5	33.6-34.4	34.0	0.5
6.	Ventral origin	41.1-47.2	44.1	2.3	45.4-54.5	51.2	2.5	39.2-43.1	41.1	2.7
7.	D base length	51.1-59.6	55.8	2.2	54.1-59.3	56.8	1.5	55.1-62.6	58.8	2.3
8.	A base length	46.3-51.9	49.7	1.8	48.5-55.5	51.7	1.9	42.9-44.8	43.8	1.3
9.	Pectoral length	19.9-24.9	22.4	1.2	21.2-26.8	24.3	1.6	18.2-19.8	19.0	1.1
10.	Ventral length	8.8-11.5	10.2	0.7	6.0- 8.6	8.2	1.0	13.7-14.0	13.8	0.2
11.	Length—Second dorsal spine	15.1-19.5	17.0	1.7	15.1-22.2	17.7	2.2	16.3-18.6	17.4	1.6
12.	Length—Second anal spine	9.2-12.7	10.7	1.0	8.9-13.0	11.3	1.2	14.6-15.8	15.2	0.8
13.	Length—Caudal peduncle	9.0-10.9	9.5	1.0	9.3-13.9	11.4	1.1	9.3- 9.4	9.3	0.7
14.	Depth—Caudal peduncle	5.8- 8.6	7.1	0.6	7.2- 9.7	8.5	0.6	7.0- 7.7	7.3	0.4
	IN HEAD LENGTH									
1.	Eye diameter (Horizontal)	33.3-42.8	37.9	4.1	33.2-40.0	37.9	3.5	30.6-34.3	32.4	2.6
2.	Snout	31.2-38.0	34.1	1.9	28.0-35.0	31.1	2.8	29.3-31.4	30.3	1.4
3.	Inter orbital space	30.0-42.8	36.1	4.3	30.7-40.0	36.2	4.0	34.3-34.6	34.4	0.2

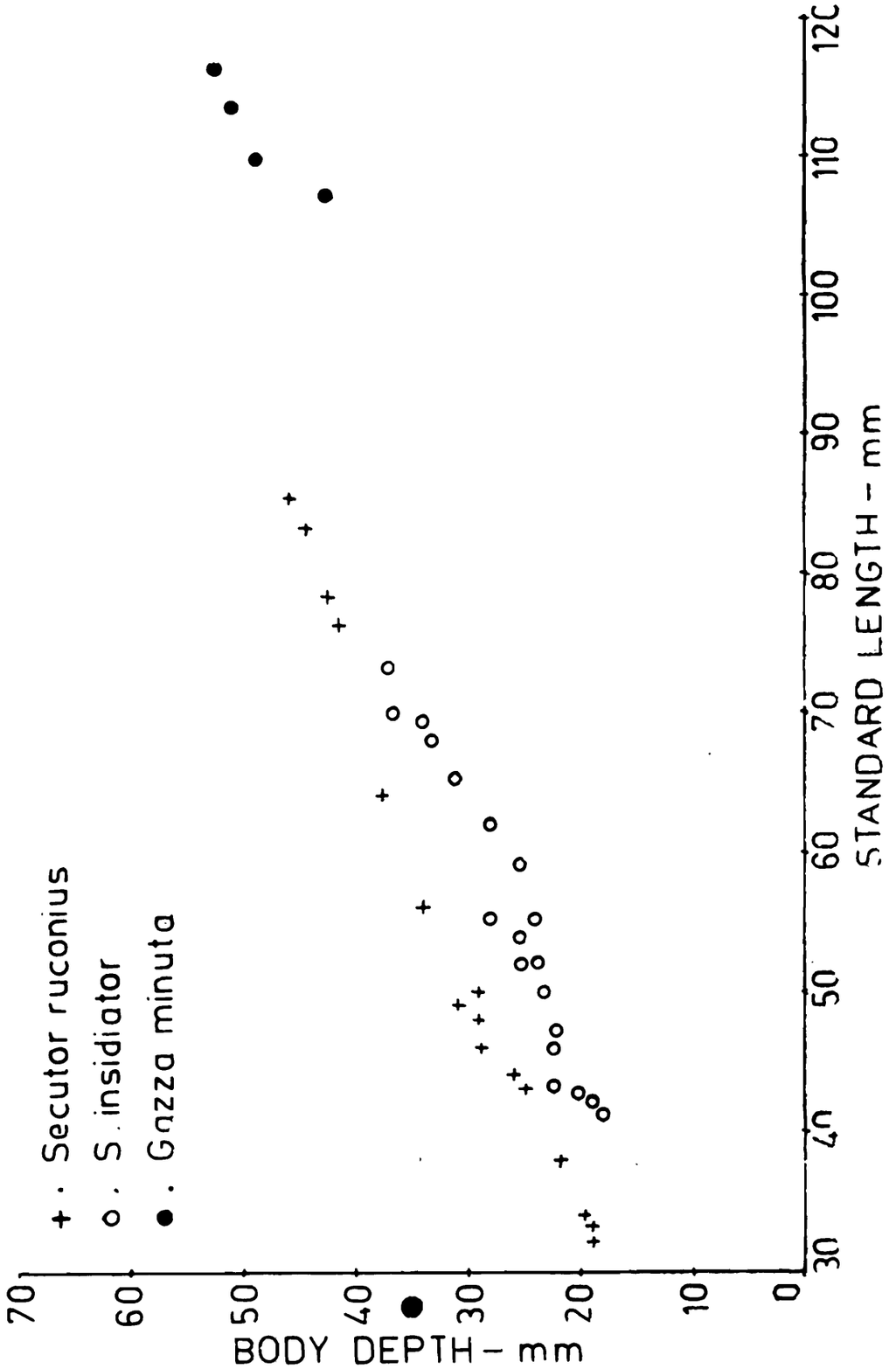
chemical concentrations (John D. Hopkrik, 1973). The study on the distribution and availability of silver-belly fishes present in the Vembanad Lake shows that they evince different patterns of distribu-



Text-fig. 5. Comparison of body depth with standard length for *Leiognathus splendens, L. equulus, L. bindus, L. daura, L. berbis* and *L. brevirostris.*

tion. The lake is permanently connected with the Arabian Sea. So there is a regular ingress and egress of marine fishes into and from

the Lake, caused in part, atleast, by tidal flow. The seasonal influence on the occurrence and abundance of leiognathid fishes in the lake



Text-fig. 6. Comparison of body depth with standard length for *Secutor insidiator*, *S. ruconius* and *Gazza minuta*.

appears to be mainly dependent on prevailing hydrographical conditions. Mergalef (1964) has argued that species diversity increases with

increasing oligotrophy. Since most of the fishes are known to perform either short or long term migrations, it becomes necessary for fishery biologists to consider the distribution of population in the estuaries and adjoining seas simultaneously (Jhingran and Gopalakrishnan, 1973). During pre-monsoon periods, the rainfall is negligible and so the conditions of salinity, temperature, water currents and food items prevalent in the lake are fovourable with the result that of catadromous fishes get into the lake. The entire estuary becomes saline and rich in animal life during the premonsoon period. About 90% of the common species occuring in the estuary registered their peak of abundance during this period (Rao and Madhu Pratap, 1975). During late June as a reault of heavy rainfall there is a heavy influx of freshwater ; so most of the marine fishes migrate towards the sea. By the end of September, brackish water conditions are established and gradual increase in salinity was noticed in the Lake. It has been reported that the maximum fishery occurs during the intermonsoon months of October-April (Silas and Parameswaran Pillai, 1975).

TABLE 4. Occurrence, Season and Frequency of the 9 species of "Leiognathid Fishes" of Vembanad Lake.

Species	Occurrence	Season	Frequency
Leiognathus splendens	Migrant	January-May	Not very common
L. equulus	Resident	All year	Fairly common
L. bindus	Migrant	March-May	Rare
L. daura	Migrant	March-May	Common
L. berbis	Vagrant	May	Very rare
L. brevirostris	Resident	All year	Fairly common
Secutor insidiator	Migrant	All year except June—August.	Common
S. ruconius	Migrant	February—May	Not very common
Gazza minuta	Vagrant	April	Very rare

Lake fish faunas characteristically falls into distinct inshore and offshore species association (Keast and Harker, 1977). Of the 9 species of silver-belly collected from the lake, *Leiognathus brevirostris* (Valenciennes) and *L. equulus* (Forskål) are euryhaline, and are undoubtedly able to utilize all regions in the lake. The occurrence of *S. insidiator* (Bloch) and *L. splendens* (Cuvier) were noticed during pre-monsoon and post-monsoon periods in the lake. The presence of *S. ruconius* (Hamilton—Buchanan), *L. bindus* (Valenciennes) and *L. daura* (Cuvier) were noticed during premonsoon periods and they maintain very small population in the lake. But only very sporadic occurrences are noticed

of *L. berbis* (Valenciennes) and *Gazza minuta* (Bloch) and they are unable to maintain large population in the lake.

In the several areas of the Indo-Pacific region, fishes of the marine origin move into estuaries and constitute local fisheries of considerable importance (Gopalakrishnan, 1973). Of the nine species of leiognathid fishes, 5 species or about 56% of the total number can be characterized as migrants i. e., they are undergoing migration from the nearby inshore areas into the lake during pre and post-monsoon periods of the year (Table 4) ; 2 species (about 23%) are vagrants i. e., they come to lake only accidently and 2 species (about 23%) are residents i. e., they constitute the stock of permanent lacustrine fishes. The data on the species composition and the pattern of distribution of leiognathid fishes in the Vembanad Lake clearly indicates that most of them have a marine origin.

SUMMARY

Nine species of silver-belly fishes (Family : Leiognathidae) are reported from Vembanad Lake (Kerala, S. India) ; *Leiognathus splendens*, *L. equulus*, *L. bindus*, *L. daura*, *L. berbis*, *L. brevirostris*, *Secutor insidiator*, *S. ruconius* and *Gazza minuta*. Notes on the occurrence of different species in the Lake, their seasonal abundance and distribution in relation to varying environmental characteristics and geographical distribution are included. Tables of morphometric characters, black-and-white photographs, distribution maps and a key are also provided.

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References

ALLEN KEAST AND JENNIFER HARKER, 1977. Fish distribution and benthic invertebrates biomass relative to depth in the Ontario Lake. *Env. Biol. Fish.*, **2** (3) : 235-240.

ARORA, H. L. 1951. A contribution to the biology of the silver-belly, *Leiognathus splendens* (Cuv.). *Proc. Indo-Pacif. Fish. Coun.*, 3rd Meeting, Madras, Sec. II : 75-80.

BALAN, V. 1967. Biology of silver-belly, *Leiognathus bindus* (Valenciennes) of the Calicut coast. *Adv. Abstr. Contr. Fish. Aquat. Sci. India*, **1** (1) : 14.

CANTOR, T. E. 1849. *Catalogue of Malayan Fishes.* Asher and Co. Amsterdam. Reproduced in 1966 p. 1128-1136.

DAY, F. 1878. *The fishes of India : being a natural history of the fishes known to inhabit the seas and freshwaters of India, Burma & Ceylon.* Reproduced in 1958. London : William Dawson and Sons. **1** : 778 pp.

DAY, F. 1889. *The Fauna of British India, including Ceylon and Burma.* Fishes. London, **2** : 509 pp.

*EBALING, A. (in press). Systematics and distribution of fishes of the genus *Malamphaes* (S. S.) *Dana. Rep.*

GEORGE, M. J. AND KARTA K. N. 1963. Surface salinity of the Cochin backwaters with reference to tide. *J. mar. biol. Ass. India*, **5** : 178-184.

GAPALAKRISHNAYA, CH. 1972. Fisheries of brackish water lakes-Chilka, Pulicat and Vembanad. In : *Cent. Inl. Fish. Res. Inst. Silver Jubiles Souvenir* : 159-164.

GAOPALAKRISHNAN, V. 1973. Fishery resources of the Hooghly—Matlah estuarine system and its relation to Fisheries of the Bay of Bengal *Proc. Symp. living resources of the seas around India. Spl. Publication* CMFRI : 373-386.

GÜNTHER, A. 1860. *Catalogue of the Acanthopterygian fishes in the collection of the British Museum* **2** : 548 pp. London.

HILLE GEORGE KUHLMORGEN, 1968. An illustrated field key to the fish family Leiognathidae in the Gulf of Thailand. *Mar. Fish Lab. Bangkok, Federal Research Institute for Fisheries, Hamberg, Contribution* No. **12** : 1-7.

HILLS GEORGE KUHLMORGEN, 1974. F. A. O. *Sp. identification sheets for fishery purposes. Famiilies from* C (in part) to L. (Eastern Indian Ocean and Western Central Pacific). F. A. O. Rome 2.

HOLDEN, M. J. 1967. The systematics of the genus *Lates* (Taleosti : Centropomidae) in Lake Albart, East Africa. *J. zool. Soc. London.* **151** : 329-342.

JAMES, P. S. B. R. 1967. *Leiognathus leuciscus* (Günther) and *Leiognathus smithursti* (Ramasay and Ogilby) (Family Leiognathidae : Pisces). Two new records from the Indian Seas. *J. mar. biol. Ass. India,* **9** (2) : 300-302.

JAMES, P. S. B. R. AND BARUDEEN, M. 1968. On certain anomalies in the fishes of the family Leiognathidae. *J. mar. biol. Ass. India,* **10** (1) : 109-113.

JAMES, P. S. B. R., 1969. A new species of silver-belly *Leiognathus jonesi* (Family Leiognathidae : Pisces) from Indian seas. *J. mar. biol. Ass. India,* **11** (1 & 2) : 316-319.

JAMES, P. S. B. R., 1973. The fishery potential of silver-bellies. *Proc. Symp. living resources of the seas around India, Spl. publication* CMFRI : 434-444.

JAMES, P. S. B. R., 1975. A systematic review of the fishes of the family Leiognathidae. *J. mar. biol. Ass. India,* **17** (1) : 138-172.

JAYABALAN, N. AND RAMAMOORTHI, K. 1977. A reappraisal of the family Leiognathidae (Pisces). *Matsya,* **3** : 87-88.

JHINGRAN, V. G. AND NATARAJAN A. V. 1973. Fishery resources of the Chilka Lake and its bearing on fisheries in adjacent areas of Bay of Bengal. *Proc. Symp. living resources of the Seas around India. Spl.* Publication. CMFRI : 3o5-372.

JOHNSON, L. 1975. Distribution of Fish species in Great Bear Lakes, North West Territories with reference to Zooplankton, Benthic Invertebrates and Environmental conditions. *J. Fish. Res. Bd. Can.,* **32** (11) : 1989-2004.

JONES, S. AND SUJANSINGANII, K. H. 1954. Fish and Fisheries of Chilka Lake with statistics of fish catches for the years 1948-50. *Indian J. Fish.,* **1** (1 & 2) : 256-344.

JOSANTO, V. 1971. The bottom salinity characters and the factors that influences the salt water penetration in Vembanad Lake. *Bull. Dept. Mar. Biol. Oceanogr.,* **5** : 1-16.

MC CONNELL LOWE, R. H. 1976. *Fish communities in Tropical Fresh waters.* 337 pp.

Mc CONNELL LOWE, R. H. 1978. Identification of Freshwater fishes. In IBP *Hand Book* No. 30. Blackwell Scientific publications: 48-83.

Mc CULLOCH, ALLAN, R. 1929. Check list of fishes recorded from Australia. *Mem. Aust. Mus.*, **5** (1-4) : 1-534.

MENON, M. A. S. 1961. On a collection of fish from Lake Chilka, Orissa. *Rec. Indian Mus.*, **59** (1 & 2) : 41-69.

MONKOLPRASIT SUPAP, 1973. The fishes of the Leiognathid Genus *Secutor* with the description of a new species from Thailand. *Kesetsart Univ. Fish. Res. Bull.*, 6 : 10-17.

MUNRO, IAN, S. R. 1955. *The Marine and Freshwater fishes of Ceylon* Canberra : 144-145.

RAO RAMA, K. V. 1972. On collection of shore fishes from the Coromandal coast, Palk Bay and Gulf of Mannar. *Rec. zool. Surv. India*, **67** : 15-57.

RAO VISWESWARA, V. 1976. The non clupeoid fishes of Godavari estuary. *Matsya*, **2** : 54-62.

ROBIN MAHON AND EUGENE K. BALAN, 1977. Fish community structure in Lakeshore Lagoons on Long Point, Lake Eric Canada. *Env. Biol. Fish.*, **2** (1) : 71-82.

RASALAM, E. J. 1976. The molluscan fishery of Vembanad Lake. *Bull. dept. Fish. Kerala*, **1** (1) : 41-44.

RASMUSSEN ERIK, 1973. Systematics and ecology of the Isefjord Marine Fauna (Denmark). *Ophelia*, **11** : 341-365.

SHETTY, H. P. C. 1963. A preliminary fishery survey of the Vembanad backwaters, Kerala. *Surv. Rep. Cent. Inl. Fish. Res. Inst.*, (2) : 24 p (Mimeo).

SHETTY, H. P. C. 1965. Observations on the fish and fisheries of the Vembanad backwaters, Kerala. *Proc. natn. Acad. Sci. India*, **35** (1) : 115-130.

SILAS, E. G. AND PARAMESWARAN PILLAI P. 1975. Dynamics of Zooplankton in a tropical estuary (Cochin Backwater) with a review of the plankton fauna of the environment. *Bull. Dept. Mar. Sci.*, 7 (2) : 329-356.

SMITH, J. L. B. 1949 (1961). *The sea Fishes of Southern Africa.* 4th Ed. Central News Agency Ltd. S. Africa 580 pp.

SMITH, J. L. B. 1963. *The fishes of seychells* p. 25 pl. 16.

*SPRINGER, V. 1958. Systematics and zoogeography of the Clinid fishes of the subtribe *Labrisomini* Hubbs. *Publs Inst. mar. Sci. Univ. Tex.*, **5** : 417-492.

SRI RAMACHANDRA MURTHY, V. 1969. Catalogue of fishes (excluding from Laccadives) in the reference collections of the Central Marine Fisheries Research Institute. *Bull. cent. mar. Fish. Res. Inst.*, **10** : 18-19.

TALWAR, P. K. AND SEN, T. K. 1967. On some fishes from the Madras coast with description of a new species of the family Clinidae. *Rec. Indian Mus.*, **65** (1-4) : 243-252.

TALWAR, P. K. 1972. On the shore fishes of Goa. *Rec. zool. surv. India*, **67** : 191-232.

WALKER, B. W. 1960. The distribution and affinities of the marine fish fauna of the Gulf of California. *Systematic Zool.*, **9** (3-4) : 123-133.

WEBER, M. AND BEAUFORT, L. F. DE. 1931. *The fishes of the Indo-Australian Archipelogo.* Leiden : E. J. Brill Ltd. 6 : 448 pp.

WILLIAMS, F. AND VENKATARAMANI, V. K. 1978. Notes on the Indo-Pacific Carangid fishes of the genus *Carangoides* Bleeker 1. *Carangoides malabaricus* group. *Bull. Mar. Sci.*, **28** (3) : 501-511.

* Original not seen.