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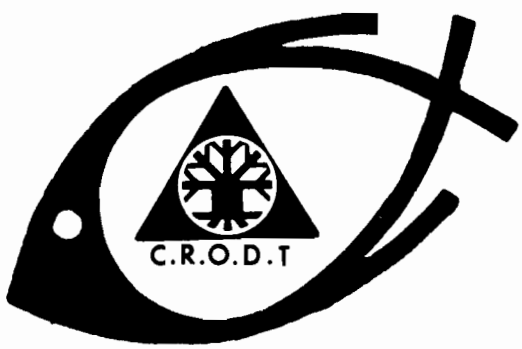
3 rd note : The Biology of the Ethmalosa in the Gambian Waters



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A STUDY ON ETHMALOSA FIMBRIATA (BOWDICH) IN THE SENEGAMBIAN REGION

3rd note : THE BIOLOGY OF THE ETHMALOSA IN THE GAMBIAN WATERS

by

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Abstract

This paper forms a part of the study on Ethmalosa fimbriata "bonga" in the senegambian region and deals with ethmalosa in the gambian waters.

For the various areas, length-weight regressions are calculated, and vertebral countings effected. The differences are discussed.

Catch compositions have been analysed for the growth and the migration of ethmalosa.

The reproduction has been studied by the observation, of the variation of the gonado-somatic index, the breeding cycle of the gonads, and the occurence and abundance of the planktonic larvae in the river and the estuary. It can be pointed out, that : the ethmalosa matures after around one and half year at a length of 18 cm ; spawning takes place in the sea and the estuary the whole year round with maxima in March, June-July and October-November, while in the river it only occurs during the intrusion of the saline water from January to July.

A comparison is made between the results of the present study and the ones obtained from the Saint Louis region.

Résumé

Cet article est une contribution à l'étude de l'Ethmalosa fimbriata "cobo" dans la région sénégambienne, et traite de l'ethmalose dans les eaux gambiennes.

Pour les diverses régions, les calculs des régressions taille-poids sont effectués ainsi que les numérations vertébrales. Les différences sont discutées.

La composition des captures est analysée pour étudier la croissance et la migration des poissons.

La reproduction est étudiée par l'observation de la variation du rapport gonado-somatique, du cycle de maturité des gonades, et de la présence et l'abondance des larves planctoniques dans le fleuve et l'estuaire. Il a été mis en évidence : que l'ethmalose atteint sa maturité à un an et demi environ à une taille de 18 cm; que la ponte a lieu pendant toute l'année en mer et dans l'estuaire avec des maxima en mars, juin-juillet, octobre-novembre, alors que dans le fleuve elle n'a lieu que pendant l'intrusion des eaux salées de janvier à juillet.

Une comparaison a été faite entre les résultats de cette étude et ceux obtenus précédemment dans la région de Saint-Louis.

1. INTRODUCTION

In the senegambian region, landings by the canoe fisheries, of ethmalosa - Ethmalosa fimbriata - are very important and represent yearly around 25,000 tons. The biggest part of the catch is for fresh consumption the rest is smoked or dried.

To evaluate this important coastal pelagic stock and to study its biology, landings and samples have been analysed and plankton surveys effected, in different centers in Senegal and Gambia. Some of the results have already been published (Scheffers et al., 1972 ; Scheffers, 1971, 1973, 1974) others are in preparation.

This article deals with biology and reproduction of the ethmalosa from the gambian waters.

2. HYDROLOGY.

Hydrologically the gambian waters follow the same pattern as the senegalese waters and according to Rossignol and Aboussouan (1965) three hydrological seasons can be distinguished.

The cold and saline water season "upwelling waters" : December - April

$T < 24°C$ and $S > 35$ ‰

The warm and saline water season "tropical waters" : May - September

$T > 24°C$ and $S > 35$ ‰

The warm and unsaline water season "guinean waters" : Octobrer - November

$T > 24°C$ and $S < 35$ ‰

The cold season, from December to April, is influenced by the trade winds which are during these months well established and blow very regularly. They induce along the coast south from Dakar a strong upwelling which moves up saline ($S > 35$ ‰) and cold waters ($T < 24°C$) with the characteristics of Central South Atlantic waters. In May when the trade winds blow irregularly and finally end, they are replaced by the "tropical waters" ($T > 24°C$; $S > 35$ ‰), which ones cover the whole continental shelf in July. From September the "tropical waters" are removed by the "guinean waters". ($T > 24°C$; $S < 35$ ‰) coming from the South. In November the cooling of the water begins with the arrival of the trade winds and the coastal upwelling and in December the "guinean waters" are pushed off-shore and to the South.

The hydrology of the river Gambia has been studied by the Project "Hydrological and topographical studies in the Gambia river bassin" (UNDP/U/OTC, Reg 60). The river Gambia has its source in the Fouta Djallon in Guinea and its total length is 1100 km. It has a depth of 2 to 5 m and a width of 150 m at the border between Senegal and Gambia while at the mouth the depth is about 25 m and the width 20 km with a pass of 4.2 km across Banjul. Along the 600 km of the upstream part the gradient average 1.5 m per km, in the Gambia however the river shows no slope.

The flow of the river is of a pure tropical type with a period of high water from July to November and a period of low water from January to June when the flow is negligible. Given the topography of the estuary, the saline water penetrates very deep during the low water periods; in Balingho (135 km) the salinity in June 1974 was about 22‰, and in Kanikunda (130 km) about 13 ‰, while the 1‰ boundary moved up till 260 km. At the moment of the flood the brackish water is pushed back to the sea, the 1‰ boundary moves down to 80 km and in Banjul the salinity can go down to 25‰ in September - October, and even lower in years with abundant rains (Scheffers, 1975 ; Scheffers and Jones, 1976).

3. MATERIAL AND METHODS

Samples of Ethmalosa fimbriata mainly from gill nets were taken every two months from canoe fishery landings along the Atlantic coast of the Gambia and from the river during the period September 1970-71. Length frequencies (fork length at one cm below) were made andsubsamples analysed. The fish were measured, weighed,and sexed. The gonads were weighed, and their maturity stages determined according to the scale of Fontana (Scheffers et al., 1972). In 1973 and 1974 in the same areas irregular sampling has been done and only length frequencies were made and maturity stages noted. The results of the analyses were grouped for the Atlantic coastal area and for the river.

Fish larvae and especially ethmalosa have been sorted from the plankton collected monthly in the river and the estuary during 1974 and 1975. In 1974 the collections have been done with a conical net of 1960 cm^2 surface openong and length 3 m, while in 1975 a net with a surface opening of 7850 cm^2 and 4 m length was used. The mesh opening of both nets was about 700 microns. Horizontal tows, against the tide, are applied at 1 or 2 m depth, lasting 15 to 20 minutes at a speed of 2 to 3 knots. The nets were provided with a flowmeter which enabled an estimation of the volume of the water filtered. For each haul the number of larvae has been calculated in relation to the volume of the strained water.
Since only nocturnal fishing allows a satisfactory catch of larvae, the surveys have been effected at night during the new moon period. To cover a tidal cycle tows have been done every two hours beginning at 20.00h and ending at 06.00h. The collections have been regularly carried out in Banjul during 1974 and 1975 while other stations up river were only visited during the period of saline water intrusion in 1974. These stations were :

- Tankular (km 80) from January to August
- Balingho (km 135) from February to July
- Kanikunda(km 180) in May, June and July

The collections fixed in formalin were sorted in the laboratory. During each plankton survey, hydrological surface observations, salinity (S‰) and temperature (T°C), have deen done.

4. LENGTH - WEIGHT RELATIONSHIP.

The length-weight relationships have been calculated for ethmalosa from different areas in the senegambian region.

For the gambian area 2567 fishes (1199 females, 1051 males and 317 non determined individuals) sampled during the period 1970-71 from landings on the river and coast of The Gambia, have been weighed in grams and measured (fork lengths) in centimeters (Annex I).

For the calculation of the equation $W = aL^b$, the median of each length class and the mean weight of the fresh fish of each length class have been used.

The equation of the length - weight relation for all individuals from the gambian area is :

$$W = 0{,}013\ L^{3.1112}$$

Figure 1 gives the graphical representation of this equation.

The respectives equations for other areas are :

Area	Equation
Saint Louis	$W = 0.012\ L^{3.0934}$
Joal-Fadiouth ("Petite Côte")	$W = 0.009\ L^{3.2444}$

A comparison test of the different regression coefficients (b) has been effected.

Area	$\frac{db}{Sdb}$	Result
Saint Louis - "Petite Côte"	3.86	Very highly significant
Saint Louis - Gambia	0.288	Not significant
"Petite Côte" -Gambia	3.04	Highly significant

A difference in the length-weight relation between Saint Louis and The Gambia cannot be concluded. On the other hand we can conclude that there is a difference between Saint Louis and "Petite Côte" and between "Petite Côte" and Gambia. A reason can be different maturity stages proportion in the analysed samples for the different areas; Other reasons can be differences in the hydrological and the food situation in the areas.

5. VERTEBRAL COUNTINGS

In different areas in the senegambian region vertebral countings from ethmalosa have been done for eventual racial differences (Scheffers, . 1971).

Area	Number of vertebrae					Total	Average	2.6x σ	Length range (cm)	No. of Samples
	40	41	42	43	44					
River Senegal	1	-	70	928	129	1128	43.049	±0.110	9-34	14
"Petite Côte"	-	1	63	923	68	1055	43.008	±0.086	16-34	13
River Saloum	-	1	27	405	52	485	43.061	±0.240	16-24	5
The Gambia River coast	-	1	75	950	59	1085	42.983	±0.082	5-24	9
River Casamance	-	3	57	1011	79	1150	43.013	±0.069	7-23	7
Total	1	6	292	4217	387	4903	43.016	±0.381	5-34	48

Table 1 : Vertebral countings in different regions in Senegal and Gambia during 1970-1971.

It was impossible to study the normality of the samples because the variable number of vertebrae is discontinous and of a small extent (40-44) for that reason no analysis of variance has been effected but nevertheless the confidence intervals of the averages have been calculated, supposing this normality (fig.2).

It shows that the vertebral averages of each region are inside the confidence intervals (99%) of the the averages of the other regions.

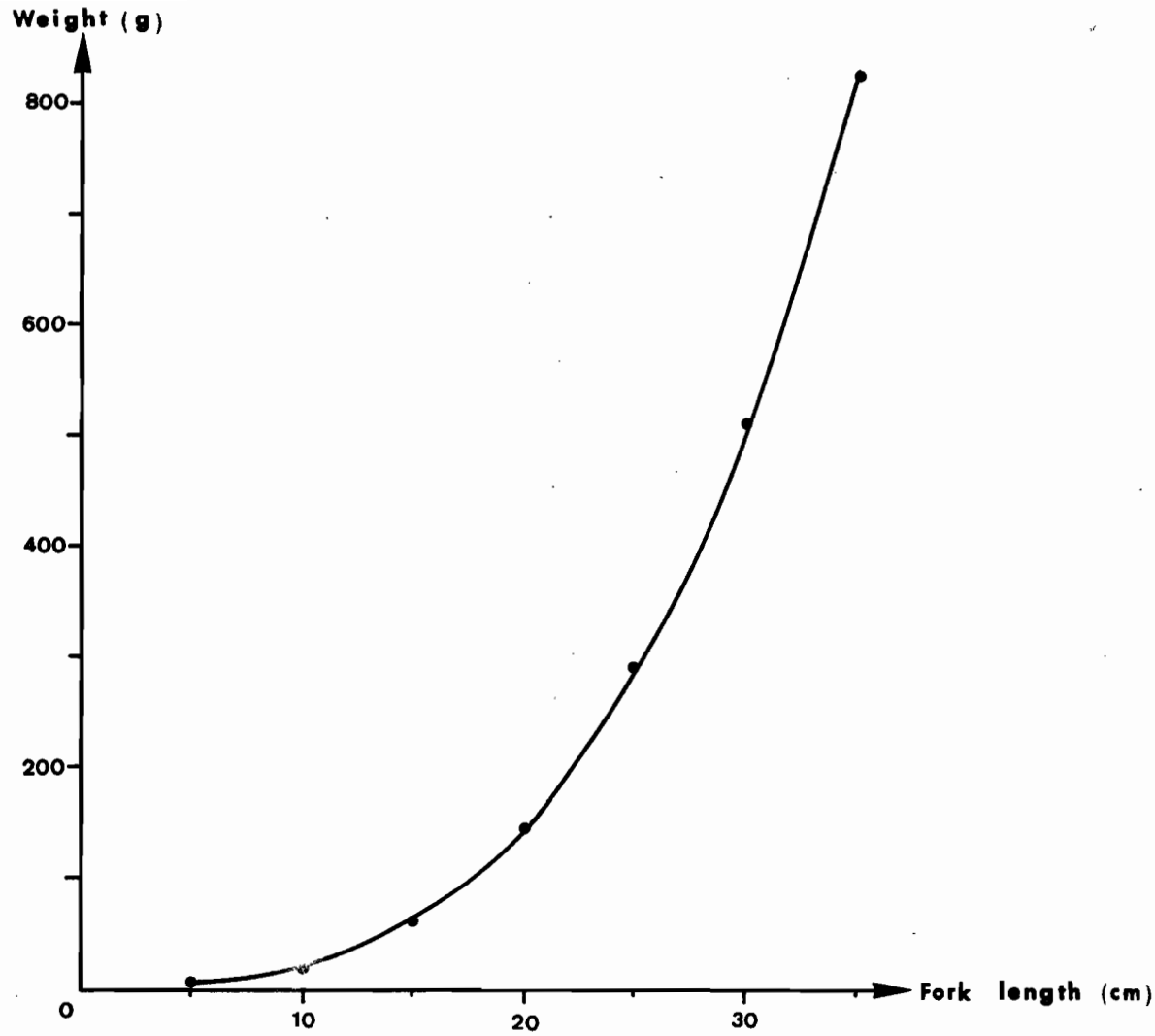

Fig. N°1 Length-weight relationship for Ethmalosa fimbriata from gambian waters.

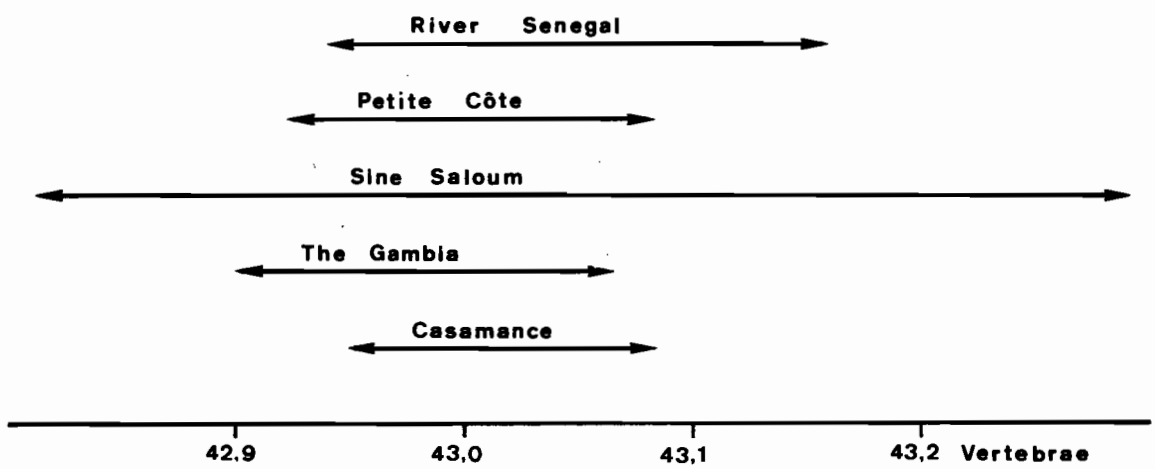

Fig. N°2 Average number of vertebrae and its confidence intervals (99%) for different areas in the senegambian region.

6. CATCH COMPOSITION AND MIGRATION

To study the growth and the migration of Ethmalosa fimbriata, length frequencies (percentages) have been made, and monthly grouped, on samples from landings along the Atlantic coast and the river.

For the Atlantic coastal area the monthly length frequencies are presented in fig. 3 (Annexes II, III). All diagrams (except Aug. 72) have a mode between 20 and 25 cm. Smaller modes at respectively 8, 11-12 and 15 cm are observed in January, August and September, and bigger modes around 30 cm in January, March and May.

For the river (fig. 4 ; Annex IV) modes are at 20 cm from January to March-April while modes at 13-14 and 16-17cm are found in May, June and July.

In January with the intrusion of the saline water the population of ethmalosa with a modal length of 20 cm and an age of around 2 years (Scheffers, 1973) moves river up to 200 km, they are followed in March by the fish born the previous year during the spring and summer spawning period, with modal lengths of resp. 13-14 cm and 16-17 cm. In July-August, with the fresh water flow, the ethmalosa returns to the sea where modal lengths are found at 8-9 cm and 11-12 cm, representing individuals born that year. The bigger fishes stay in the coastal area. The recooling of the coastal waters in November-December, and the low temperature till March can be one of the reasons for the the migration of the ethmalosa river up where the temperature of the water is always higher (Scheffers, 1975). However in spite of the cold water period, the values of the condition factor $K = W.100/L^3$ for females from 18-22 cm sampled along the atlantic coast do not vary, through the year (Annex VA) and the food situation does not appear to be the principal reason for the migration. The feeding area of the river is rather limited and the competition for food with other species will be higher than in the sea. The values of K for individuals from the river may be for this reason lower than the ones from the sea (Annex VB).

The most important reason for the migration up river seems to be the reproduction in the spawning places of the river.

7. REPRODUCTION

7.1 SEX RATIO

Monthly sex ratios (percentages) of Ethmalosa fimbriata sampled in the coastal area show a predominance of females from November to February, and of males from May to September (Annex VI). In samples from the river

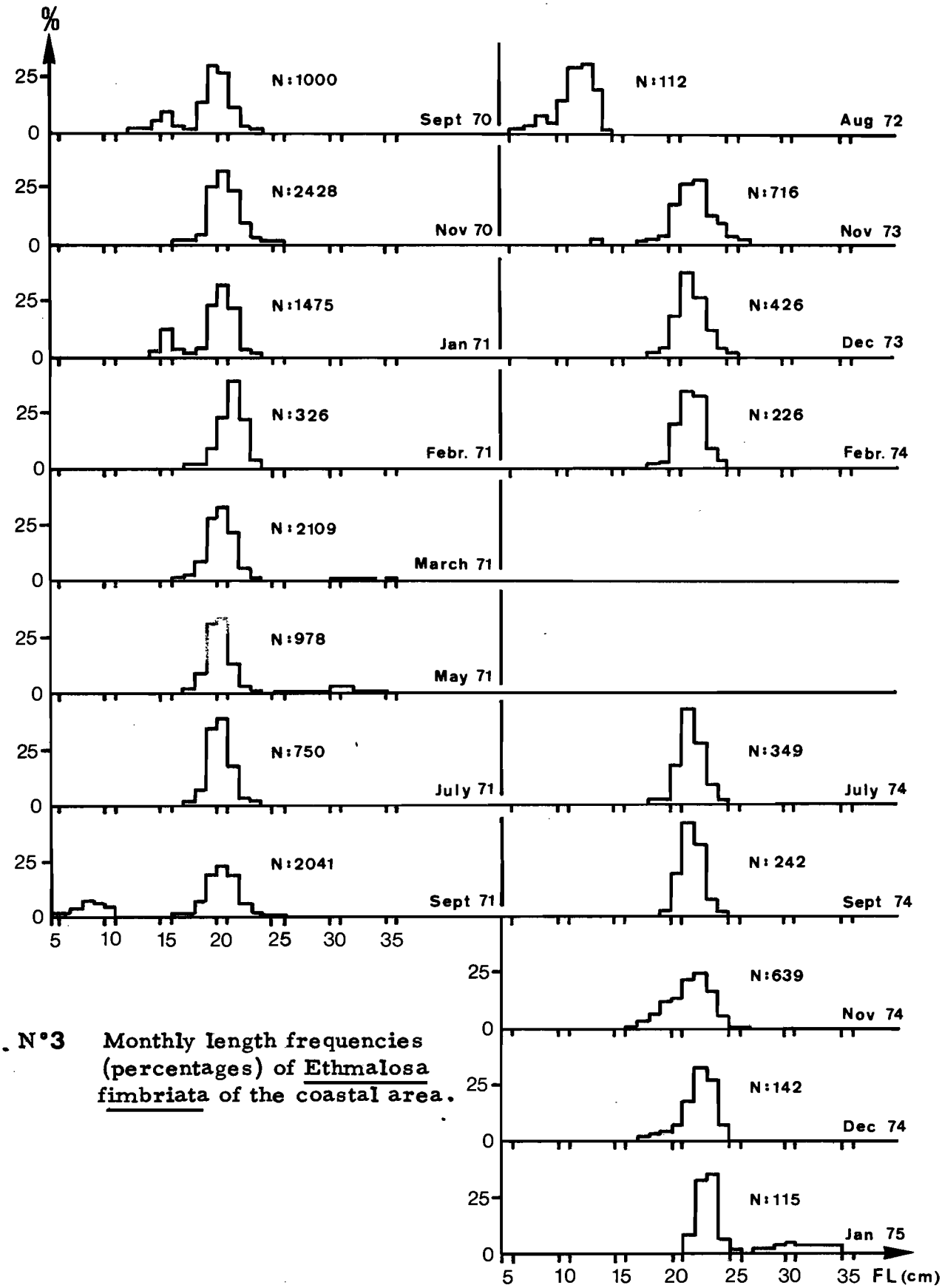

Fig. N°3 Monthly length frequencies (percentages) of Ethmalosa fimbriata of the coastal area.

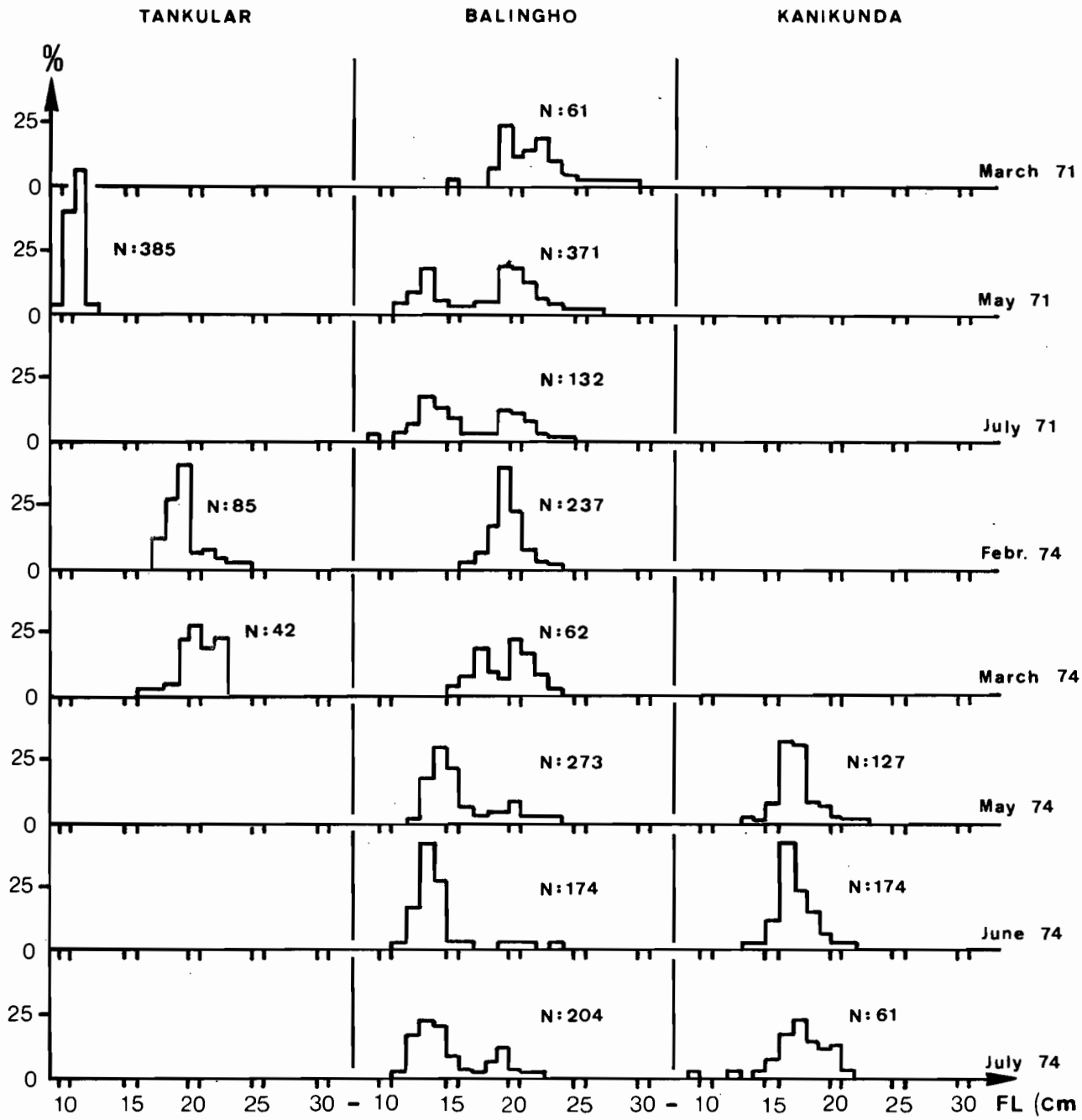

Fig. N°4 Monthly length frequencies (percentage) of Ethmalosa fimbriata from different places along the river Gambia.

the females are more abundant from March to July, while in February the males dominate. On the total of the 13,184 examined fishes from catches in the atlantic coastal area during 1970-1975, 6,850 (51.96 %) were females and 6,334 (48.04 %) males with 0.95 as confidence limits.

7.2. LENGTH AT FIRST REPRODUCTION

All analysed females from both coastal and river are grouped according to their maturity stage and length class (Annex VII). A graph (fig. 5) presents the percentages of the grouped maturity stages (IV, V, VI and VI-III) against the length classes. It passes the 1 % between 14 and 15 cm, the 50 % between 18 and 19 cm, and reaches its maximum (81 %) at 21 cm. To conclude, the females of the ethmalosa from gambian waters are immature up till 15 cm, maturing from 14 to 17 cm and at a length of 18 cm able to spawn.

7.3. SPAWNING PERIOD AND AREA

To determine the spawning period and area, the following have been studied :

- The bimonthly variation of the gonado-somatic index (G.S.I.)

- The gonad breeding cycle

- The monthly percentage of females in maturity stage V

- The results of the larval collections from the river and estuary.

OBSERVATIONS ON ADULTS

For the coastal area the G.S.I. is high from January to May, decreases sharply in June, July and stays low till November (fig.6 Annex VIII A). The G.S.I. of the females in the length class 18 cm which have its first spawning, reaches its maximum only in May (Annex VIII B). The wholes year round females in maturity stage V are present, with the appearance of the post spawning stages (fig. 7 ; Annex IX).

Females in spawning stage V are found in the river from February to May with a maximum in March (fig.7) and in the same month the G.S.I. for the females shows its maximal value (Annex VIII A).

OCCURENCE AND ABUNDANCE OF THE LARVAE IN THE PLANKTON

Due to their rapid growth, the larvae are only caught by the plankton net during a small period of their life ; between hatching and about a fortnight. Their presence and abundance is therefore a good index of reproduction and its intensity in the prospected region.

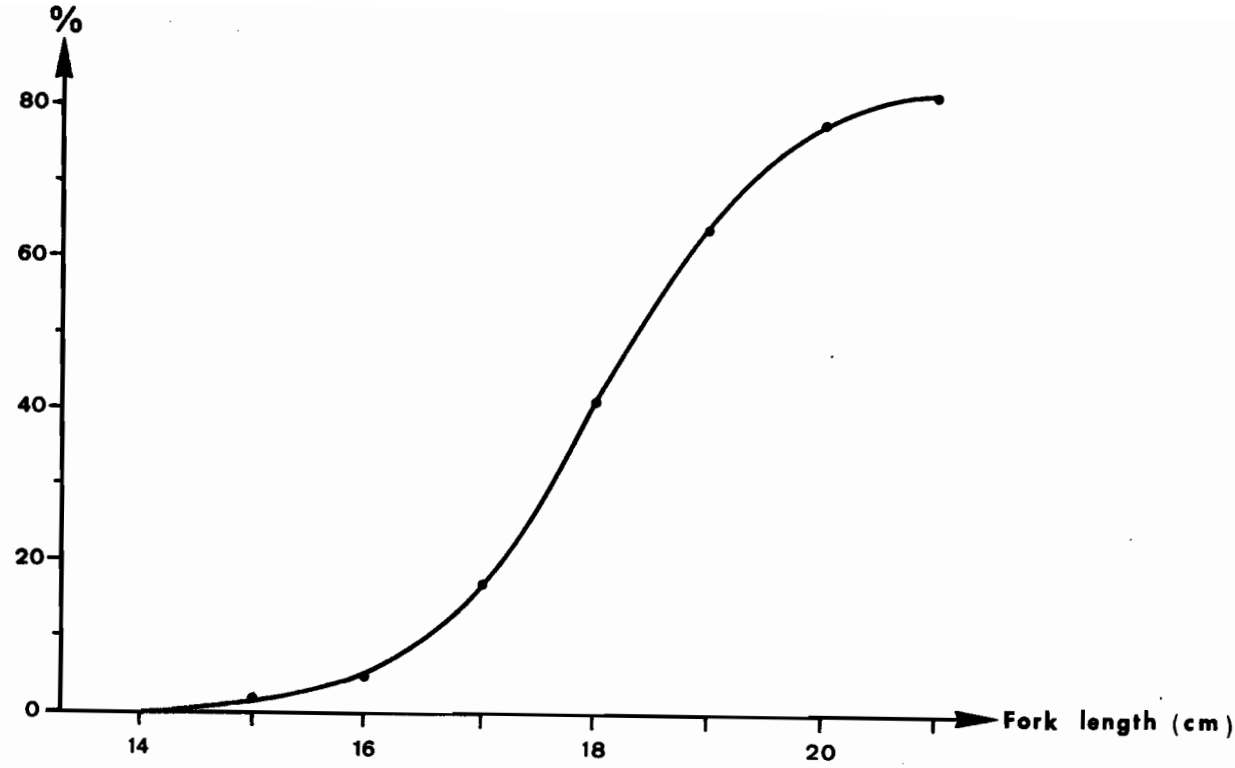

Fig. N°5 Percentages of grouped maturity stages (stages IV, V, VI, VI-III) of females in different length classes.

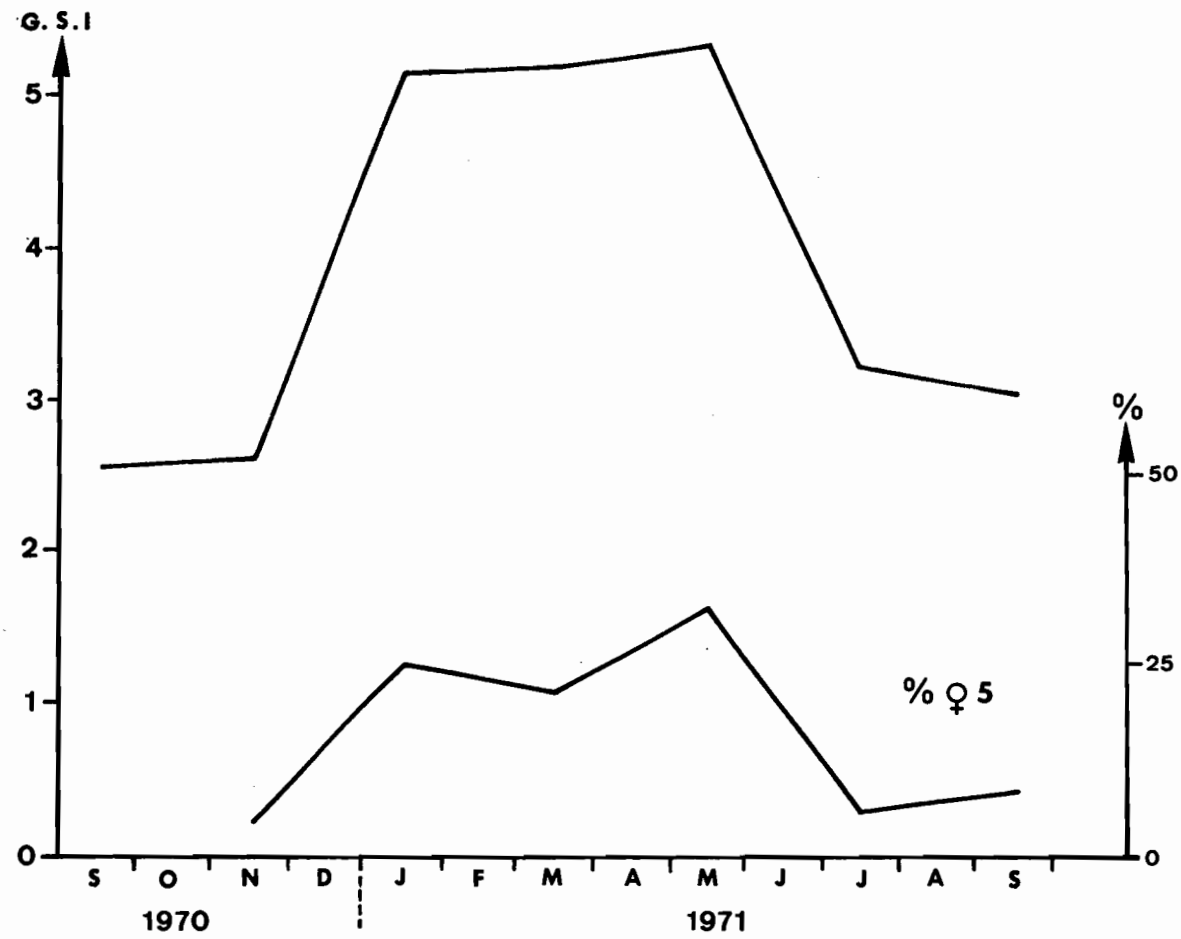

Fig. N°6 The bimonthly gonadosomatic index(G.S.I.) of ethmalosa (females) from the coastal area of The Gambia.
The bimonthly percentages of females in maturity stage V.

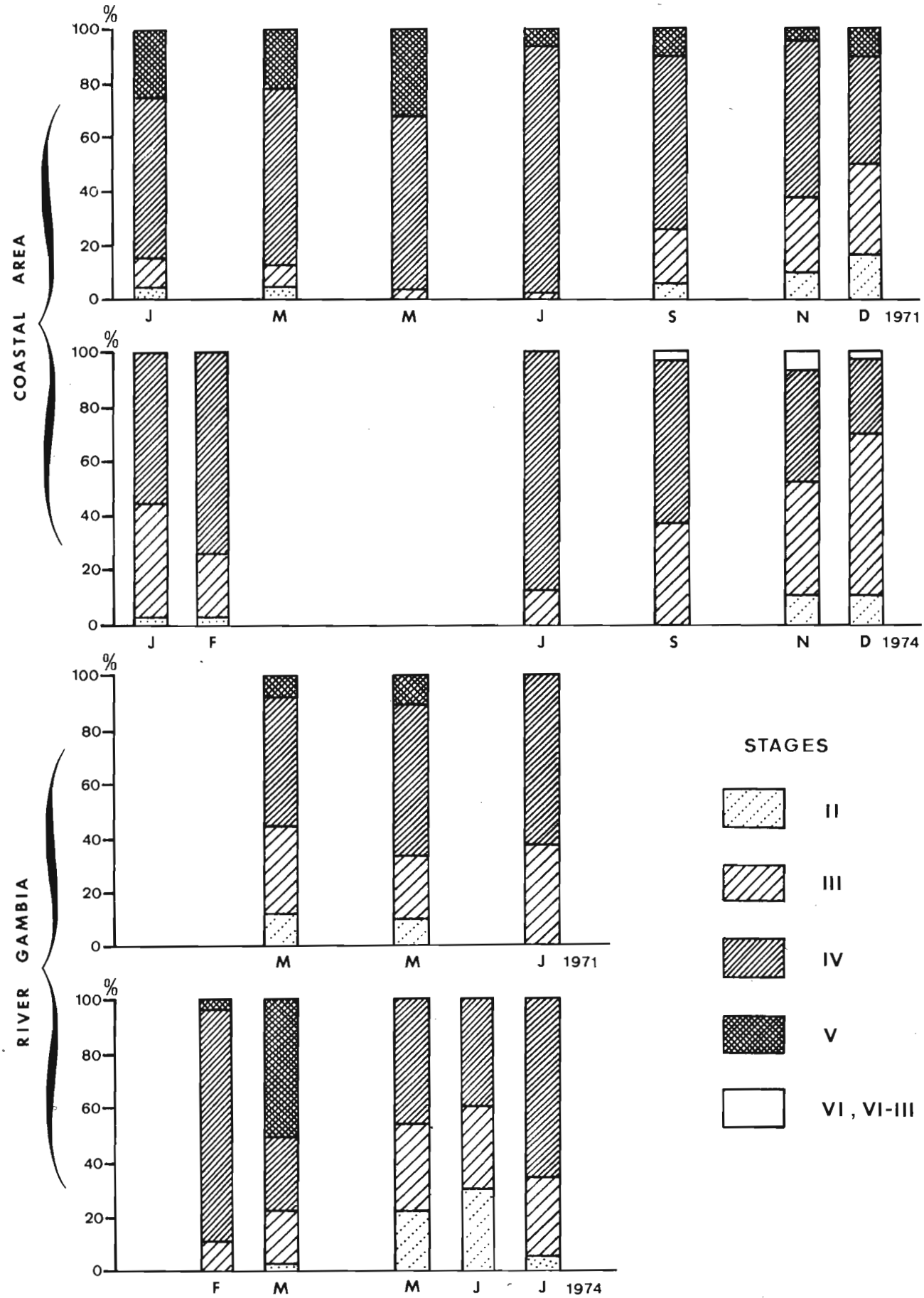

Fig. N°7 Monthly percentages of different maturity stages of Ethmalosa fimbriata from samples of the coastal area and the river Gambia.

Two types of variation are possible, one connected with the hour, the tidal current, and the lunar period of collecting, the other with seasonal and geographical variations.

Influence of the hour, tidal current and the lunar period of collecting.

Collections of plankton in Banjul have been done monthly in 1975 at the time of new moon. For each night of collecting, the number of larvae of ethmalosa caught every two hours is analysed. The results are expressed in Table 2.

Hours	J	F	M	A	M	J	J	A	S	O	N	D
20	13	12	748	162	92	388	975	422	186	211	282	161
22	22	0	1350	92	162	6	2656	308	129	207	997	47
0	1	0	1691	1691	609	354	1064	155	554	643	654	21
2	4	14	2151	1202	941	158	2020	329	92	394	347	3
4	8	0	1077	1432	712	0	1849	22	100	69	866	25
6	0	0	282	260	105	22	687	66	315	196	307	33
Total	43	26	7299	4776	2621	628	9251	1302	1376	1720	3953	340

Table 2.- Number of larvae of ethmalosa collected monthly (values are given per 1000 cubic meter).

An analysis of variance shows that there is no evidence, at the 95 percent of confidence level, for the catch to be dependent on the hour.

Then to see if there is a difference in density according to the different stages of the moon, in June 1975, at a moment of intensive reproduction, four nights of collections have been done : at the new moon (NM), the first quarter (FQ), the full moon (FM), and the last quarter (LQ). The results are expressed in Table 3. An analysis of these observations is very difficult due to the influence on the catch, on one hand of the moon period the light and the tidal current, and on the other hand the variation of the population itself during the month. No evident correlation seems to occur. However, it is probably safer to do the surveys as have been done, at the same stage of the moon.

Finally we have taken as a monthly index of abundance, the total catch of larvae per night divided by the total volume of the strained water.

Hours	LQ	NM	FQ	FM
20	↙ 131	↗ 388	↙ 156	↗ 372
22	↙ 16	↗ 6	↙ 47	↗ 253
0	↙ 6	↙ 354	↗ 84	↙ 71
2	↗ 11	↙ 158	↗ 363	↙ 97
4	↗ 44	↙ 0	↗ 430	↙ 162
6	↙ 88	↗ 22	↙ 212	↙ 93
Total	296	928	1292	1048

Table 3.- Number of larvae of ethmalosa collected every two hours at different stages of the moon, (values are given per 1000 cubic meter : ↗ Floodstream ; ↙Ebbstream)

Seasonal and geographical distribution

The results are given for all fish larvae on a family level in Annex X A,B. Concerning the ethmalosa they are presented in figures 8,9 and 10. It can be pointed out that :

- In Banjul the reproduction is continous however with a minimum in December, January and February ($T < 23°C$; $S > 35$ ‰), and with periodical peaks in March, June-July and October-November (fig. 9). The region of the estuary with mixing waters may be a good nursery ground for the species.

The spring and summer reproduction periods occur both in waters with a high salinity ($S > 35$ ‰) and with an increasing water temperature (20° to 28°C). The autumn reproduction takes place after the flood of the river when the salinity is low($S < 25$ ‰) while the water temperature is high ($28 < T < 29°C$). The low reproduction intensity during spring 1974 is probably due to the low temperature in the previous months (Annex XI).

- In Tankular the number of ethmalosa larvae was always low, and with the arrival of the fresh water July - August, they disappear completely. The ethmalosa larvae were replaced by those of Pellonula afzeliuzi.

- In Balingho during the first surveys in February the larvae of ethmalosa were already abundant. The water temperature was at that time 23-24°C and the salinity of the surface water about 10 ‰. The peak of abundance occures in May, onemonth earlier than in Banjul, in waters with temperature of about 28°C and salinity about 20 ‰ (fig.10).

- In Kanikunda the collection has been done only from May to July at the maximum of saline water penetration. In June we found the larvae

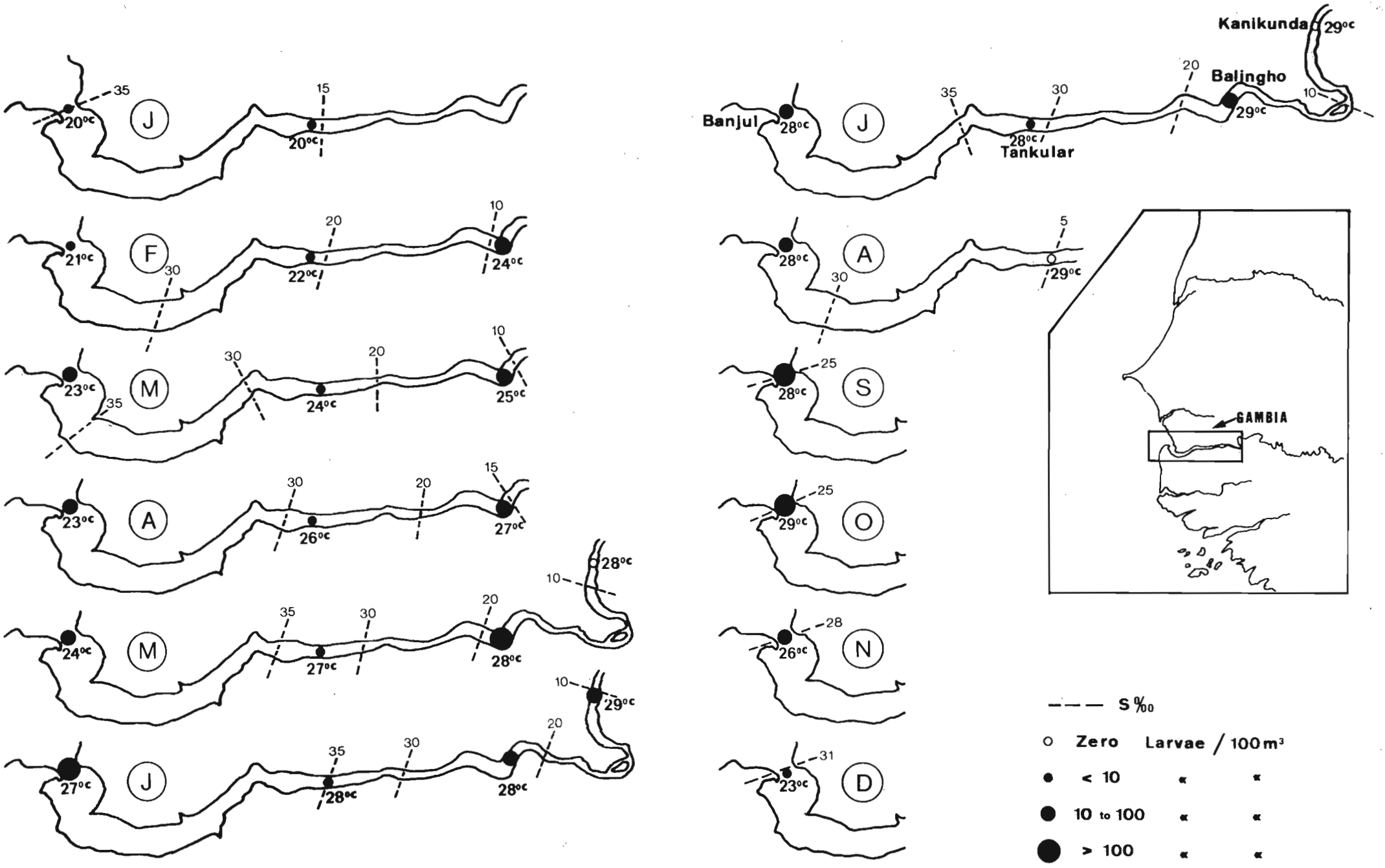

Fig. N°8 Abundance of Ethmalosa fimbriata larvae in the Gambia during 1974.

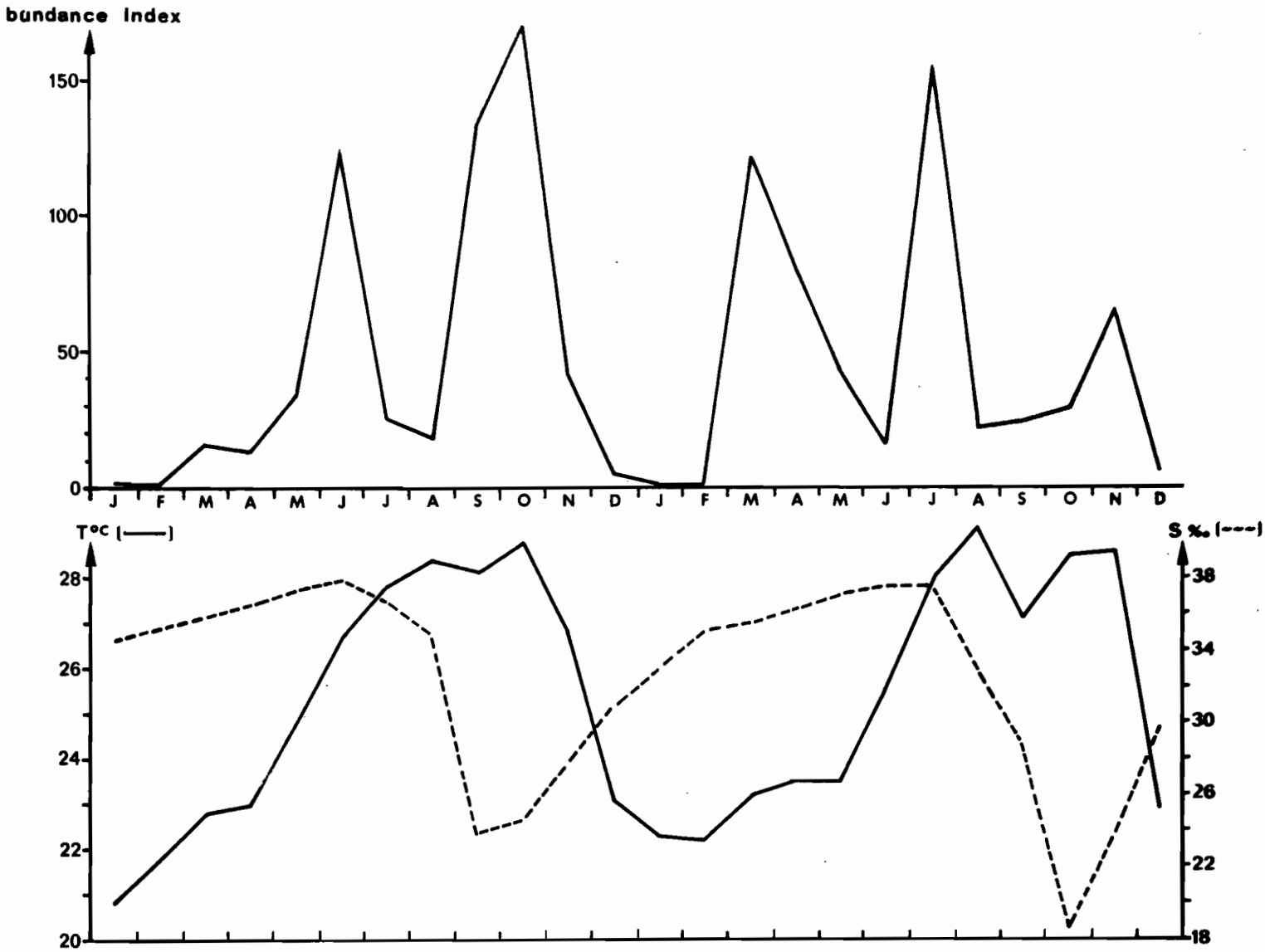

Fig. N°9 Monthly abundance of ethmalosa larvae, and surface observations of temperature and salinity, in Banjul in 1974 and 1975

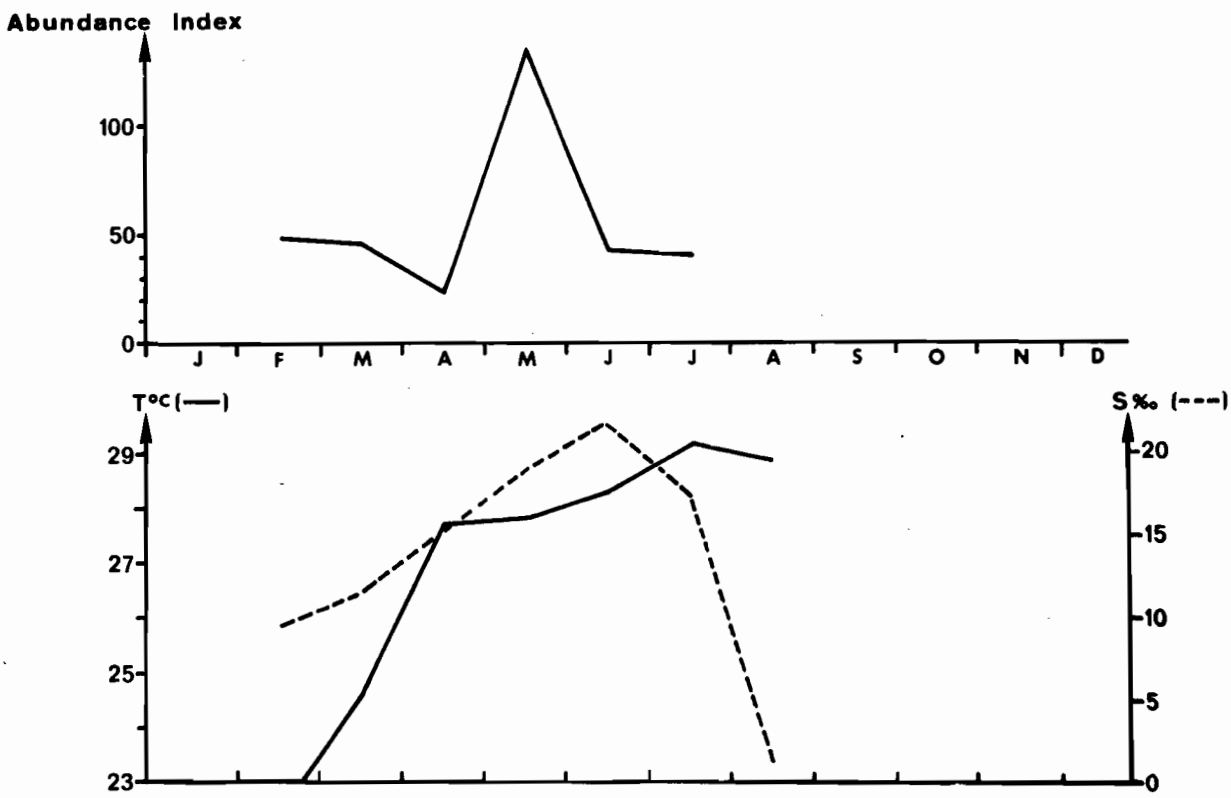

Fig. N°10 Monthly abundance of ethmalosa larvae and surface observations of temperature and salinity, in Balingho in 1974.

of ethmalosa mixed with the pellonula. At that time the salinity was above 10 ‰. In May when the salinity was lower only pellonula larvae were caught.

In the coastal area, females in post-spawning stages first appears only in September which may indicate a partial spawning of the females before that time. The individuals around 18 cm which arrive at first maturation, do not participate in the spring spawning period according to their gonado-somatic index cycle.

8. CONCLUSIONS AND COMPARISON OF THE RESULTS WITH THE ETHMALOSA FIMBRIATA POPULATION IN THE SAINT LOUIS REGION.

The results concerning the ethmalosa population in the Saint Louis region (Scheffers et al., 1972 ; Scheffers, 1973) are compared with the ones of the present paper.

- The length-weight relationship is very similar in spite of the difference in the sea water temperature.

- No significant difference exists between the number of vertebrae.

- Both populations show the same anadromous migration during the intrusion of the seawater in the dry season.

- The sex ratio for both population is very close to 1.

- The minimal reproduction length was 17 cm for the females and 15 cm for the males, in Saint Louis. For the gambian area however the minimal reproduction length for the females was 18 cm.

- The spawning begins in both areas, in the river, and longs until the arrival of the flood. In the estuary and in the sea the spawning continues the whole year round with a minimum during the cold season (December to February). Beyond the two spawning periods observed inSaint Louis ; one in spring ("poussée printanière) and one in summer ("poussée estivale") a thirdone was observed for the gambian area in autumn.

- Spawning takes place in water with salinity between 3.5-38 ‰.

- The temperature which is lower in Saint Louis during the winter time (December to February) influences the spawning. A temperature of 22-23°C is necessary for the beginning of the first spawning period in spring time.

- The construction of dams in both rivers will influence the migration and spawning pattern of ethmalosa and other sea fish species. The salinity boundary will be changed and fixed. An intense study has to be done especially before, and also after the construction of the dams, inorder to see the conequencies on the different fish populations of sea and freshwater species.

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Annex I : Number and mean weight (g) per length class of 1 cm for ethmalosa from the coastal area and the river Gambia during 1970/71.

Fork length (cm)	FEMALES		MALES		NOT DETERMINED		TOTAL	
	number of Fishes	mean weight	number of fishes	mean weight	number of fishes	mean weight	number of fishes	mean weight
					2	15	2	15
10					33	19	33	19
11					52	24	52	24
12	2	35	1	32	30	31	33	32
13			4	38	27	40	31	40
14	3	51	5	59	65	53	73	53
15	7	58	4	61	86	63	97	63
16	3	86	7	81	22	82	32	82
17	24	110	51	103			75	106
18	77	125	212	127			289	126
19	186	146	316	144			502	145
20	266	170	221	163			487	166
21	326	197	125	188			451	194
22	214	220	47	211			261	219
23	64	242	13	241			77	242
24	16	267	2	281			18	269
25	5	302	2	327			7	309
26	1	284	4	351			5	338
27	1	395	6	399			7	398
28	1	412	9	425			10	423
29	2	499	7	482			9	486
30	1	527	8	498			9	501
31			7	562			7	562
32								
33								
34								
35								
TOTAL	1199		1051		317		2567	

Annex II : Monthly length distributions (percentages) of ethmalosa from the coastal area of the Gambia.

Year - Month								
Length class Fork-length(cm)	1970 IX	1970 XI	1971 I	1971 II	1971 III	1971 V	1971 VII	1971 IX
5								
6								0.9
7								3.4
8								7.2
9								6.1
10								3.1
11								0.3
12	0.1							
13	0.3							
14	5.1		1.5					
15	8.2		11.1					
16	2.1		3.8					0.1
17	1.4	0.4	0.1	0.3	1.4	0.6	0.5	0.9
18	13.5	5.1	2.7	0.3	8.0	9.8	6.7	7.8
19	29.7	25.2	23.9	9.2	27.9	31.6	34.0	19.5
20	27.1	33.8	31.4	23.3	33.8	33.2	39.3	24.2
21	10.6	24.0	20.7	39.3	21.1	13.7	17.5	19.2
22	1.7	9.1	4.5	22.7	5.5	3.3	1.9	5.5
23	0.2	2.0	0.3	4.9	0.8	0.5	0.1	1.5
24		0.4						0.1
25		0.1				0.2		
26						0.3		
27						0.6		
28						0.9		
29						0.8		
30					0.2	1.6		
31					0.5	1.2		
32					0.5	0.7		
33					0.1	0.7		
34						0.1		
35								
No.of Fishes	1000	2428	1475	326	2109	978	750	2041

Annex III : Monthly length distributions (percentages) of ethmalosa from the coastal area of The Gambia.

Length class Fork-length (cm)	Year 1972	1973		1974					1975
	Month VIII	XI	XII	II	VII	IX	XI	XII	I
5									
6	0.9								
7	1.8								
8	5.4								
9	3.6								
10	12.5								
11	28.6								
12	29.5								
13	17.0	0.1							
14	0.9	-							
15		-							
16		-					0.2		
17		0.7					2.2	0.7	
18		1.3	1.2	0.4	0.3		5.8	2.1	
19		3.5	4.5	2.2	1.1	2.5	11.7	3.5	
20		16.8	17.1	18.6	16.9	18.6	13.9	7.7	
21		26.4	35.2	34.1	43.8	43.8	20.3	16.9	9.6
22		27.7	25.8	32.3	28.9	26.4	23.0	33.8	31.3
23		13.1	11.0	9.7	8.6	7.9	16.3	26.8	35.7
24		8.5	4.5	2.7	0.3	0.8	5.6	8.5	5.2
25		1.4	0.7				0.8		0.9
26		0.6					0.2		-
27									0.9
28									0.9
29									2.6
30									3.5
31									2.6
32									2.6
33									3.5
34									0.9
35									
No. of Fishes		716	426	226	349	242	639	142	115

Annex IV : Monthly length distributions (percentages) of ethmalosa from different centers along the river Gambia

Year	1971				1974									
Month	III	V		VII	II		III		V		VI		VII	
Fork length cm / Place	B	KE	B	B	T	B	T	B	B	K	B	K	B	K
9		0.8		0.8										1.6
10		40.8		0.0										0.0
11		55.8	3.8	2.3							1.7		2.0	0.0
12		2.6	9.2	7.5					1.5		17.2		18.1	3.3
13			16.2	17.4					18.7	1.6	43.1	0.9	22.5	0.0
14			4.6	14.4					30.4	0.8	27.6	1.7	20.1	3.3
15	1.6		1.5	9.1				4.8	21.2	8.7	2.9	11.2	8.8	8.2
16	0.0		1.9	2.3		0.4	2.4	8.1	6.2	33.1	2.3	40.5	2.9	16.4
17	0.0		3.0	2.3	12.9	7.2	2.4	19.4	2.2	32.3	0.0	23.3	2.0	23.0
18	6.6		4.6	3.0	25.9	19.4	4.8	9.7	4.8	9.4	0.0	14.7	5.4	14.8
19	24.6		19.4	13.6	40.0	38.8	21.4	6.5	4.8	7.1	2.9	5.2	10.3	11.5
20	13.1		18.9	12.9	5.9	22.8	26.2	22.6	7.3	3.9	1.1	1.7	3.9	13.1
21	14.8		12.4	9.1	7.2	7.2	19.0	16.1	1.5	1.6	0.6	0.9	2.0	4.9
22	18.0		5.9	3.0	4.8	3.0	23.8	8.1	1.1	1.6	0.0	-	2.0	-
23	9.8		1.6	1.5	2.4	1.5		4.8	0.4		0.6			
24	3.3		0.5											
25	1.6		0.3											
26	1.6		0.3											
27	1.6													
28	1.6													
29	1.6													
30														
No. of Fishes	61	385	371	132	85	237	42	62	273	127	174	116	204	61

KE. Kerewan (60 km from Banjul)
T. Tankular (80 km from Banjul)
B. Balingho (130 km from Banjul)
K. Kani kunda (180 km from Banjul)

Annex V A. Bimonthly condition factor (K) of ethmalosa during 1970-1971

Length class (cm)	Sept.	Nov.	Jan.	March	May	July	Sept.
			Coastal area (females)				
18	2.0	2.0	1.9	2.0	2.1	1.9	2.1
19	2.0	2.0	1.9	2.0	2.0	2.1	2.0
20	1.9	2.0	2.0	2.0	2.0	2.0	2.0
21	1.9	2.0	2.0	2.0	2.0	2.0	2.0
22	1.9	1.9	2.0	2.0	1.9	1.9	2.0
			River Gambia (males and females)				
19			1.8	2.0	1.6	1.6	1.7
20			1.7	1.7	1.7	1.7	1.8
21			1.7	1.9	1.7	1.7	1.8
22			1.8	1.9	1.7	1.7	1.7

B. Condition factor (K) for each cm class of ethmalosa from the river Gambia and the Coastal area

Length class	River Gambia	Coastal area
9	1.75	
10	1.64	
11	1.58	
12	1.64	1.69
13	1.59	1.79
14	1.57	1.84
15	1.61	1.69
16	1.74	1.85
17	1.72	2.03
18	1.77	2.01
19	1.73	1.97
20	1.72	1.95
21	1.73	1.97
22	1.75	1.94
23	1.64	1.91
24	1.71	1.88
25	1.74	1.91
26	1.51	2.02
27	1.90	1.92
28	1.78	1.84
29	1.83	1.90
30		1.77
31		1.80
No. of Fishes	377	2188

Annex VI. Monthly sex-ratio (%) of Ethmalosa fimbriata

1Area	Coastal area				River Gambia			
Year month	No of fishes	Females %	Males %	Not determined %	No.of fishes	Females %	Males %	Not determined %
1970 September	1000	49.4	42.6	8.0				
November	2428	57.0	43.0					
1971 January	1475	40.3	43.3	16.4				
February	326	64.7	35.3					
March	2109	51.4	48.6		69	68.1	31.9	
May	978	39.2	60.8		756	20.8	10.8	68.4
July	750	43.6	56.4		132	37.9	36.4	25.8
September	2041	42.2	36.6	21.2				
1973 November	716	56.7	43.3					
December	426	51.6	48.4					
1974 February	226	61.5	38.5		322	39.4	60.6	
March					103	54.4	45.6	
May					400	46.8	16.3	37.0
June					290	26.9	12.1	61.0
July	349	55.3	44.7		265	43.8	18.1	38.1
September	242	44.2	55.8					
November	639	47.7	52.3					
December	142	58.5	41.5					
1975 January	115	53.9	28.7	17.4				

Annex VII : Maturity stages (%) per length class of ethmalosa (females) from Gambian waters during 1970-1974.

Maturity stage / Length class (cm)	Not determined	II	III	IV	V	VI, VI-III	Grouped IV, V, VI VI-III	No. of fishes
9	100.0							4
10	100.0							32
11	100.0							57
12	93.6	6.4						47
13	93.6	6.4						47
14	72.8	27.2						81
15	62.7	32.3	2.0	2.9			2.9	102
16	25.3	59.3	10.5	4.7			4.7	86
17	3.1	57.3	22.9	16.7			16.7	96
18	0.8	37.7	20.8	36.2	2.3	2.3	40.8	130
19		10.7	26.1	11.5	4.8	4.8	63.3	272
20		5.2	17.2	61.7	11.5	4.4	77.6	384
21		2.9	16.1	65.2	12.1	3.7	81.0	454
No. of fishes	330	283	345	1007	159	58	1224	2182

Annex : VIII A : Bimonthly gonado-somatic index (G.S.I.) of ethmalosa from Gambian waters in 1970-1971.

	Month sex	Sept.	Nov.	Jan.	March	May	July	Sept.
Coastal area	Females	2.6	2.7	5.3	5.4	5.7	3.5	3.1
	Males	2.1	1.7	2.4	3.7	3.9	3.0	2.3
River	Females			1.8	3.2	2.2	1.8	
	Males			1.1	1.4	1.5	1.6	

B : Bimonthly G.S.I. per length class

	Length class(cm)	18	19	20	21	22
Coastal area	Sept. 1970	2.3	2.5	2.5	2.1	2.8
	Nov.	1.1	2.3	2.4	3.2	3.0
	Jan. 1971	1.3	3.8	4.8	6.0	6.0
	March	2.6	4.2	5.5	6.1	6.0
	May	4.3	3.9	5.8	6.1	5.6
	July	2.9	2.9	3.6	3.8	3.6
	Sept.	1.9	2.5	3.1	3.5	3.0
River	March 1971	1.3	1.6	2.2	3.3	5.2
	May	1.7	1.7	2.8	1.8	3.8
	July	1.8	1.5	1.7	2.9	2.0

Annex IX : Monthly maturity stages distributions (%) of females of ethmalosa from 18 cm

Coastal area

Stages	II	III	IV	V	VI VI-III	No. of Fishes
Sept. 1970	1	14	53			168
Nov.	10	27	60	4		272
Jan. 1971	4	9	62	25		142
March	4	8	66	22		190
May	1	2	65	33		123
July		2	91	6		82
Sept.	6	24	61	9		130
Nov. 1973	15	40	45			124
Dec.	16	35	39	10		31
Jan. 1974	3	41	56			32
Feb.	1	26	73			70
July		12	88			67
Sept.		38	58		5	40
Nov.	10	42	41		7	98
Dec.	11	60	26			35
Jan. 1975		37	63			19

River Gambia

Stages	II	III	VI	V	VI	No. of Fishes
March 1971	12	33	49	7		43
May	10	23	58	10		40
July		39	61			23
February 1974		11	87	2		54
March	2	21	28	49		47
May	23	30	47			47
June	30	30	39			23
July	5	29	67			42

Annex X A : Monthly abundance of fish larvae in 1974.
(values are expressed by the total catch of the night, divided by the total volume of water filtered in 100 of cubic meters)

	J	F	M	A	M	J	J	A	S	O	N	D
Banjul												
Clupeidae Ethmalosa	1,5	1,3	16	12	33	123	26	18	133	171	43	5
Ilisha					5	0,1		0,2			0,1	
Apodes		0,1	0,2	0,1								
Blennidae					0,1			0,1				0,4
Carangidae			0,1		3	0,3	0,2	0,2	0,1		0,1	0,1
Cybiidae					0,2							
Cynoglossidae			0,2	0,1	0,4	0,1	0,2		0,2		0,2	0,3
Elopidae	0,1	0,1						1	0,1	0,1		
Gobiidae	0,8	0,4	1	3	14	13	11	3	8	9	2	3
Hemirhamphidae			0,2	0,2	0,5	0,3						
Mugilidae		0,1	1	0,5	2			0,1			0,1	
Pomadasyidae					0,2	0,1						
Sciaenidae	1,7	0,8	2	1	25	2	2	1	1	6	2	
Soleidae		0,1	0,1	0,1	0,2	0,1						0,1
Sparidae							0,1					
Syngnathidae	0,1		0,1			0,1	0,1		0,1		0,2	0,1
Tetraodontidae					0,2					0,1	0,3	
Tankular												
Clupeidae Ethmalosa	3,5	0,5	1	2	0,6	0,5	6					
Ilisha			0,1	0,1	0,8							
Pellonula		0,1						360				
Apodes												
Cynoglossidae			0,2	0,1			0,1	0,5				
Elopidae				0,1								
Gobiidae	0,2	0,4	4	16	16	18	5	79				
Hemirhamphidae					0,1							
Mugilidae		0,1	1	0,2	0,2							
Sciaenidae			6		4	0,8	0,1	2				
Syngnathidae		0,2		0,2	0,1		0,1					
Balingho												
Clupeidae Ethmalosa		49	45	23	134	42	41					
Carangidae					0,7	0,1	0,1					
Cynoglossidae						0,1	0,1					
Elopidae		0,1										
Gobiidae		7	4	2	11	4	5					
Scianidae				0,2	0,1							
Syngnathidae			0,3									
Kanikunda												
Clupeidae Ethmalosa						63						
Pellonula					139		96					
Cynoglossidae						0,1	0,1					
Gobiidae					6	2	2					
Scianidae							0,1					
Syngnathidae						0,1	0,3					

Annex X. B. Monthly abundance of fish larvae in 1975.
(values are expressed by the total catch of the night, divided by the total volume of water filtered in 100 of cubic meters).

	J	F	M	A	M	J	J	A	S	O	N	D
Banjul												
Clup.Ethmalosa	0,8	0,4	121,6	79,7	43,7	15,5	15,2	21,7	22,9	28,7	65,9	7,0
Ilisha	0,1			1,3	1,6	6,4	9,9	0,3	0,6	0,1		
Apodes				0,1		0,1	0,3	0,2			0,1	
Blenniidae	0,1										0,1	
Carangidae				0,4	0,3		5,8	0,2	0,1	0,1	0,5	
Cybiidae					0,1				0,1			
Cynoglossidae	0,1		0,1	0,3	0,3	1,2	0,8	0,1	0,1	0,1	0,1	
Elopidae	0,4	0,1				0,1		0,2	0,7	0,1	0,1	0,1
Engraulidae	0,1		0,1								0,1	
Gobiidae	0,5	1,2	1,7	18,9	9,1	10,8	23,5	3,0	0,5	0,9	4,0	0,8
Hemirhamphidae			0,1		0,1			0,1	0,1			
Mugilidae	0,2	0,1	1,8	1,6	0,4	0,9	0,6	0,1	0,1			
Pomadasyidae*				0,1		0,6	1,9	0,4	0,1	0,1	0,1	
Sciaenidae	0,1	0,3	4,7	6,2	7,9	26,1	18,8	2,5	0,3	0,7	1,6	
Soleidae	0,1	0,1	0,1	0,3	0,1	0,1						0,1
Sphyraenidae									0,1			
Syngnathidae	0,1	0,1		0,4	0,1	0,3	0,1	0,1	0,1	0,1	0,3	0,1
Tetraodontidae		0,1			0,1	0,1	0,1	0,1	0,1		0,1	

* Unable to separate the young larvae of Polynemidae and Sciaenidae, we have grouped them under this name.

Annex : XI Surface observations, salinity (S‰) and temperature (T°C) done during the monthly plankton surveys in 1975

Place Distance	Month Year		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Banjul 0 km	1974	T°C	20.8	-	22.8	23.0	24.8	26.7	27.8	28.4	28.1	28.8	26.8	23.1
		S‰	34.39	35.12	35.84	36.47	37.30	37.79	36.68	34.90	23.88	24.65	27.70	30.95
	1975	T°C	22.3	22.2	23.2	-	23.5	25.5	28.0	29.1	27.1	28.5	28.6	22.9
		S‰	33.02	35.07	35.50	36.34	36.93	37.50	37.51	32.88	28.88	18.60	23.85	29.60
Tankular 80 km	1974	T°C	20.4	-	23.8	25.8	26.7	28.0	28.5	29.0				
		S‰	15.62	22.19	25.27	30.60	33.78	35.29	33.07	3.75				
Balingho 135 km	1974	T°C			24.6	27.7	27.8	28.3	29.2	28.9				
		S‰		9.53	11.51	15.39	19.06	21.86	17.31	1.4				
Kani Kunda 180 km	1974	T°C					27.6	29.1	29.5					
		S‰				9.19	12.82	7.76						