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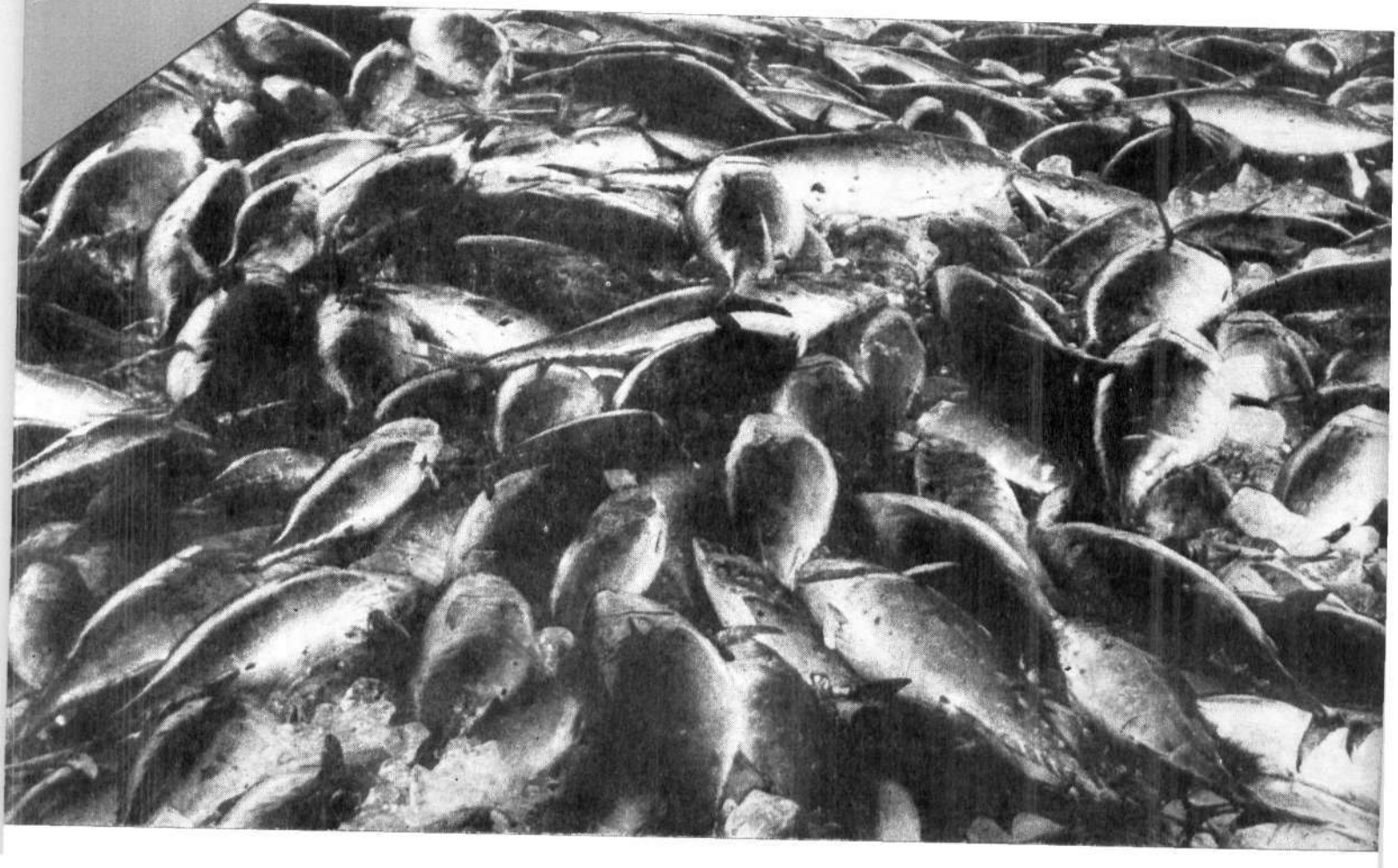
# TUNA FISHERIES OF THE EXCLUSIVE ECONOMIC ZONE OF INDIA: Biology and Stock Assessment

Edited by : E. G. SILAS



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# ON THE OCCURRENCE, SIZE DISTRIBUTION, MORPHOMETRY AND FEEDING HABITS OF THE JUVENILES OF *EUTHYNNUS AFFINIS* (CANTOR), *AUXIS THAZARD* (LACEPEDE), AND *SARDA ORIENTALIS* (TEMMINCK AND SCHLEGEL), ALONG THE TUTICORIN COAST, GULF OF MANNAR

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Very little information is available on the fishery and bionomics of juvenile tunas from Indian waters. In the present account the juveniles of three species of tuna-like fishes occurring in the fishery along the Tuticorin coast have been studied and the results presented. Morphometric and meristic characteristics, the biology as well as the food and feeding habits of *E. affinis*, *A. thazard* and *S. orientalis* are dealt with in the report.

Based on the data collected during the years 1976-'78 it may be stated that the peak season for tuna fishery at Tuticorin was from June to September. Heavy landings were noticed only at Veerapandianpatnam. Stray catches of the juveniles of *E. affinis*, *A. thazard* and *S. orientalis* were collected from Veerapandianpatnam, Kayalpatnam, Punnakayal and Tuticorin from the sardine gill net operations ('salavalai' of mesh size 3 to 3.2 cm) off Manapad from the 30-50 m depth zone.

During the year 1976, 1977 and 1978 seasons, 106, 115 and 106 specimens of the juveniles of *E. affinis*, *A. thazard* and *S. orientalis* in the size range of 6.2 to 19.8 cm, 12.9 to 19.6 cm and 9.8 to 19.9 cm in fork length and weighing from 3 to 100 gm, 20 to 100 gm and 7 to 95 gm respectively were recorded and examined Table 1. The specimens were collected during the fishing season July to September (Fig. 1).

*Size distribution*

The size range of the juveniles of *E. affinis* ranged from 6.2 to 19.8 cm (FL). The size range of *A. thazard* was recorded at 12.9 to 19.6 cm and *S. orientalis* from 9.8 to 19.9 cm. Most of the specimens come under the size group 12-16 cm (FL). The size distributions of the juveniles of *E. affinis*, *A. thazard* and *S. orientalis* are shown in Figs. 2 & 3. The percentage composition of *E. affinis* recorded was 13.3, 27.5 and 36.3 during the year 1976, 1977 and 1978 respectively. *A.thazard* recorded as 64.5, 31.5 and 49.1 per cent during 1976, 1977 and 1978 respectively. The percentage of *S. orientalis* was 22.2, 41.0 and 14.6 during the year 1976, 1977 and 1978 respectively (Fig. 4).

*Length-weight relationship*

The length-weight relationship of early juveniles of *E. affinis*, *A. thazard* and *S. orientalis* in the size

TABLE 1. *Occurrence of juveniles of*, E. affinis, A. thazard, and S. orientalis *at Tuticorin*, 1976-'78

| Species | 1976 | | | 1977 | | | 1978 | | |
|---|---|---|---|---|---|---|---|---|---|
| | July | August | September | July | August | September | July | August | September |
| *E. affinis* | .. .. | 42 | 1 | .. | 26 | .. | .. | 36 | 1 |
| *A. thazard* | .. 30 | 17 | .. | 15 | 14 | .. | 20 | 19 | .. |
| *S. orientalis* | .. .. | 39 | .. | .. | 48 | .. | .. | 19 | .. |

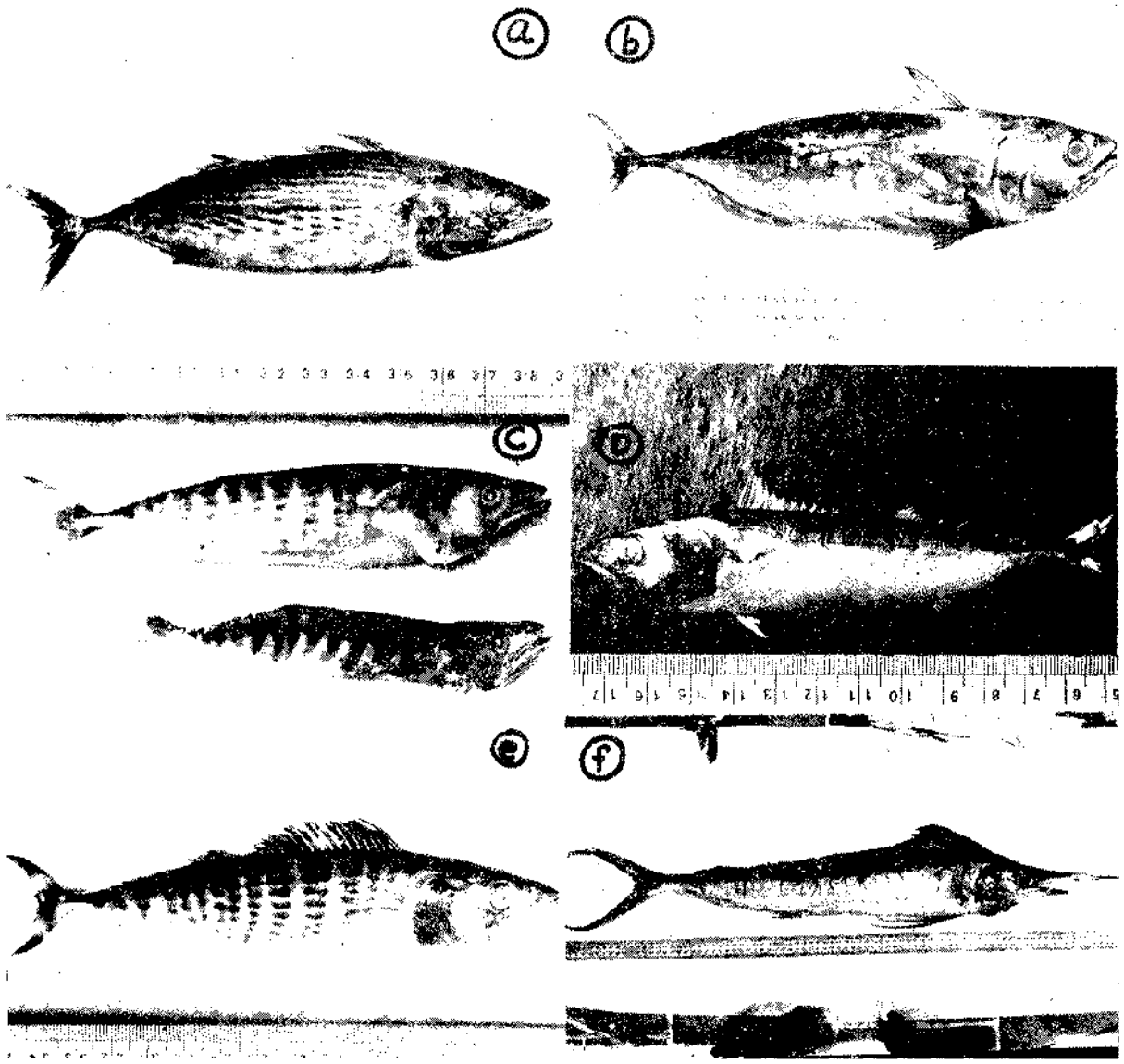


Plate 1. Young specimens of tunas and sailfish landed at Tuticorin. *a, c* and *e. Sarda orientalis. b. Euthynnus affinis. d. Auxis thazard. f. Istiophorus platypterus.*

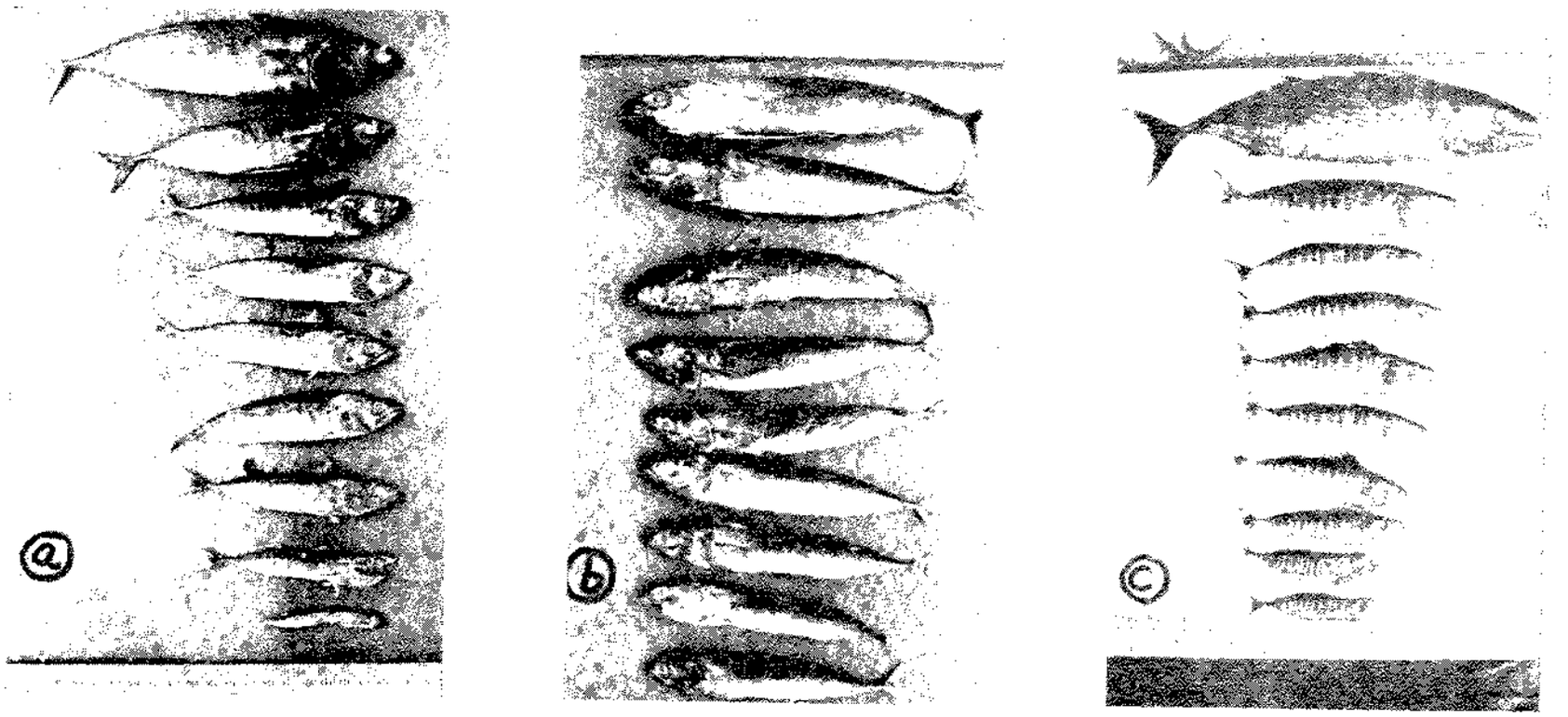


Plate II. Juveniles and young specimens of tunas landed at Tuticorin. *(a) Euthynnus affinis. (b) Auxis thazard. (c) Sarda orientalis.*

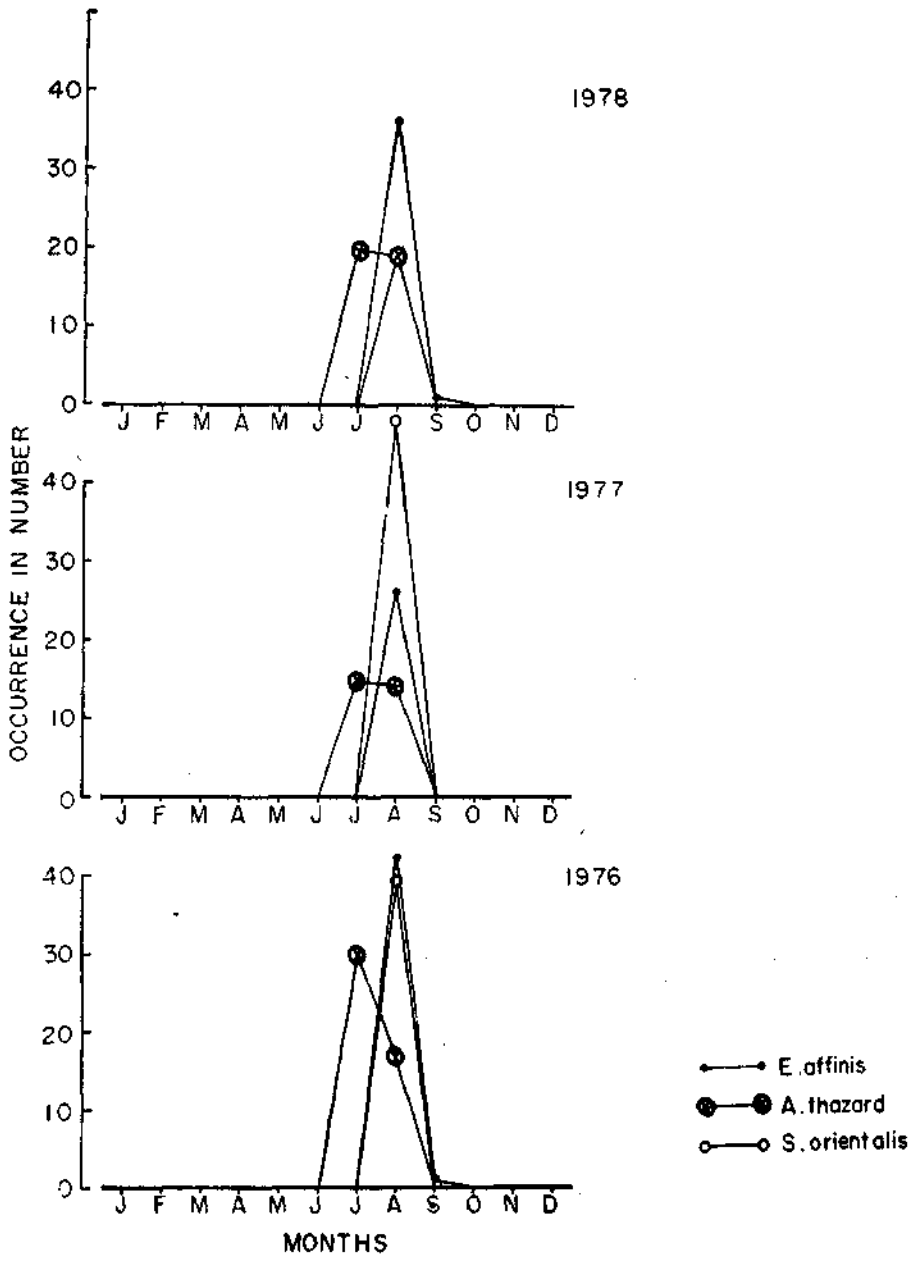


Fig. 1. Occurrence of juveniles of tunas in different months at Tuticorin, 1976-78.

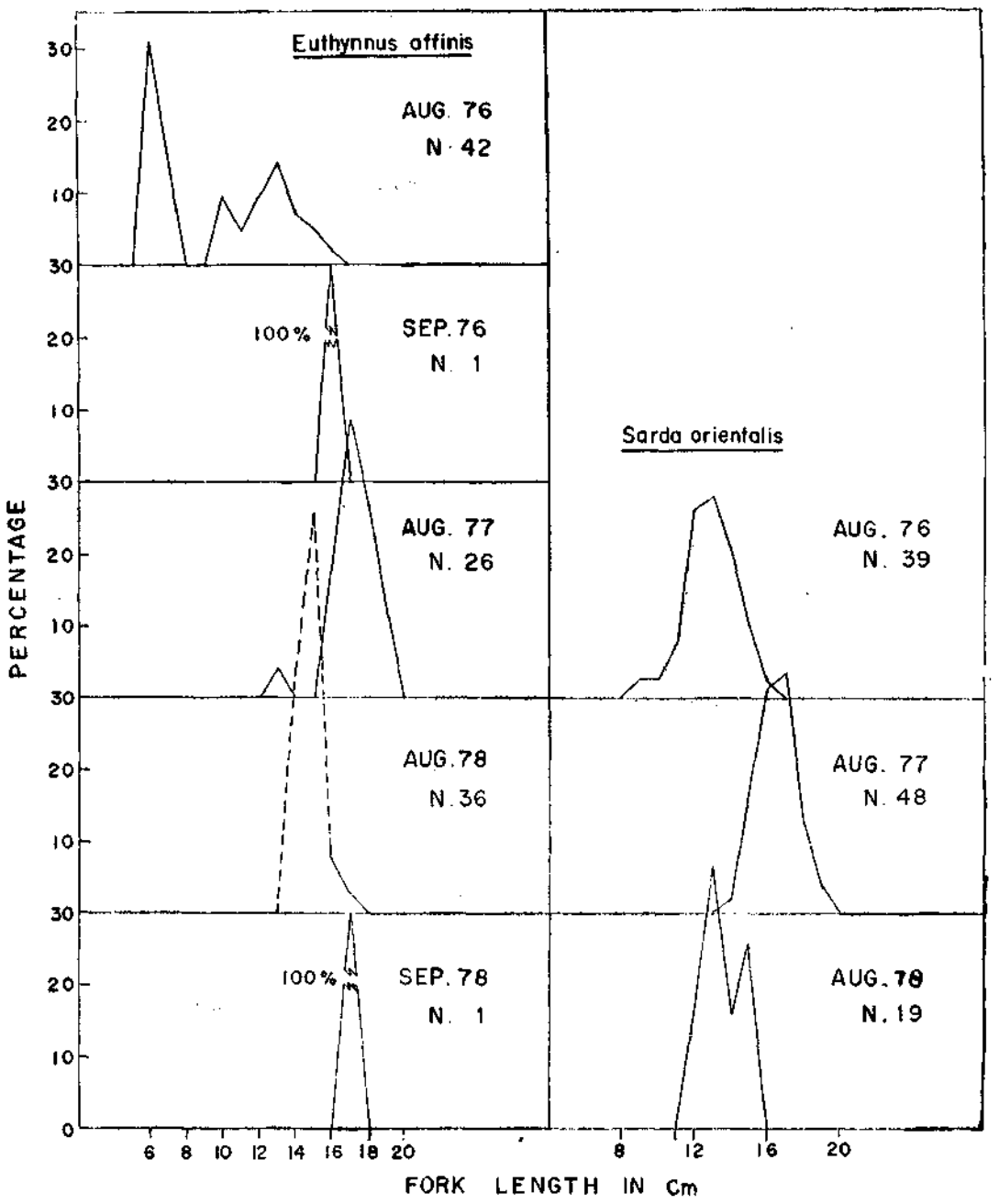


Fig. 2. Monthly length frequency distribution of the juveniles of *E. affinis* and *S. orientalis* at Tuticorin.

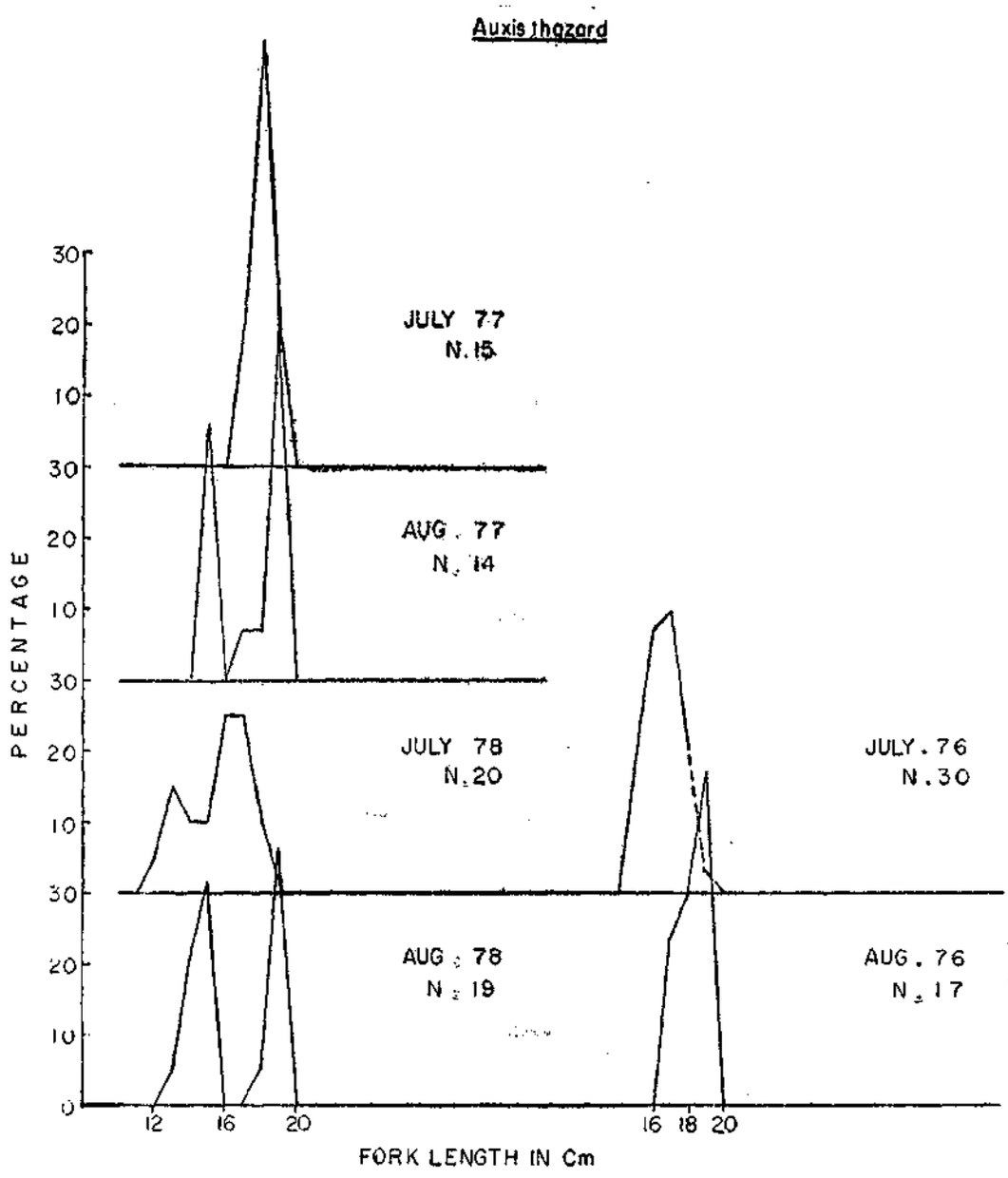


**Fig. 3. Monthly length frequency distribution of the juveniles of *A. thazard* at Tuticorin.**

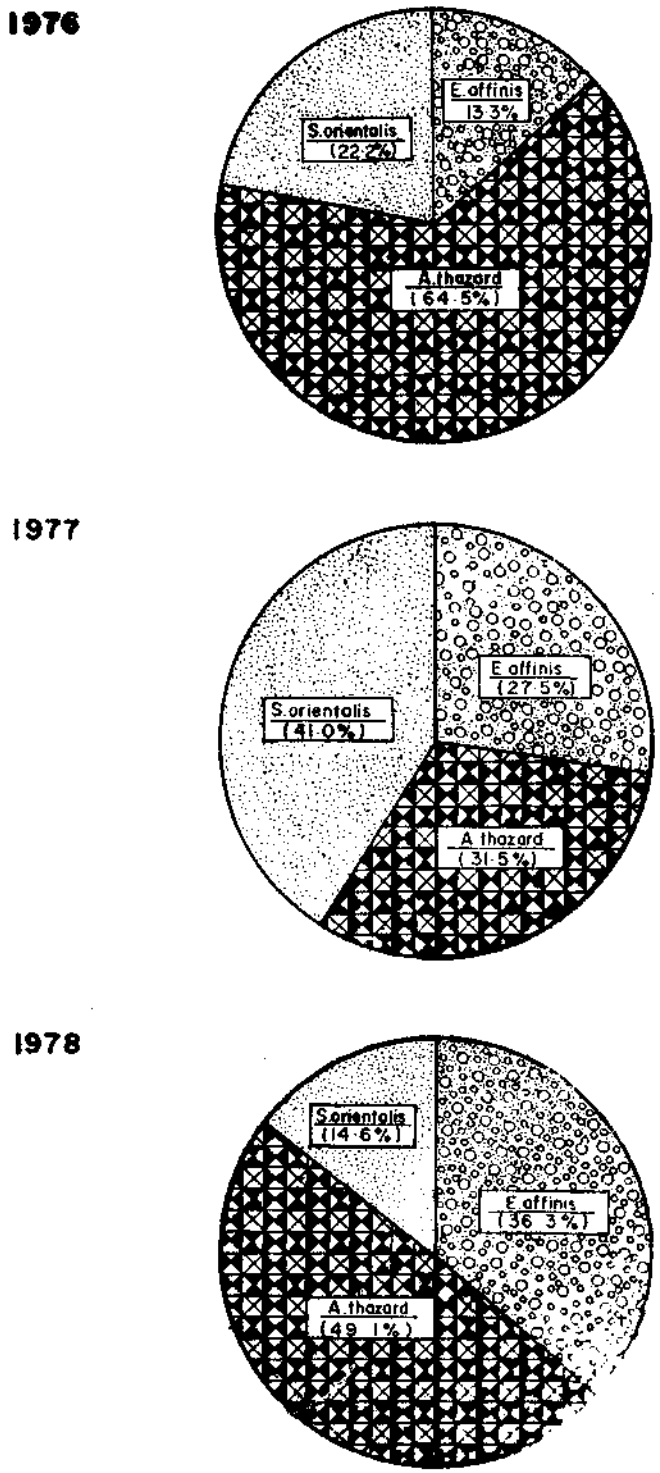


Fig. 4. Percentage composition of the juveniles of tunas at Tuticorin, 1976-'78.

range 6.2 to 19.9 cm in fork length are presented in Fig. 5.

Applying the formula $W = {}_cL^n$ the calculated length-weight relationship of the present materials of *E. affinis*, *A. thazard* and *S. orientalis* were found to be $W = 0.001039807.\ L^{3.85887}$, $W = 0.002208062.\ L^{3.56754}$ and $W = 0.003136932.\ L^{3.45514}$ respectively. In each case the fit was found to be good.

It may be noted, however, that the rate of increment in weight per unit length of tuna is very slow upto a size of 6 to 12 cm, after which the growth rate increases rapidly (Fig. 5).

The correlation between the different characters of the juveniles of *E. affinis*, *A. thazard* and *S. orientalis* are given in the form of trellis diagram (Fig. 6).

In this diagram, the values of the correlation between the different characters have been given in the form of symbols : '+', '—' and '0'. The '+' and '—' are positive values and '0' for negative value. The symbol '+' indicates the values of 0.5 and above but less than 1.0. The symbol '—' indicates the value less than 0.5 and '0' indicates the negative value of the correlation between the particular character. It was observed only in the juveniles of *E. affinis*. It means that the particular character is not showing correlation between the other character. The correlation between the eye diameter and other characters of the juveniles of *E. affinis* were very low and insignificant.

However, for *A. thazard* and *S. orientalis* the correlation between the eye diameter and other characters were found to be positive and significant. But in *E. affinis* it is not significant eventhough it has a positive value. In *A. thazard* (juveniles) also the height of the II dorsal fin is having only the positive values but not significant.

*E. affinis*

During the year 1976, 1977 and 1978 seasons the juveniles of this species were caught during very restricted periods. The length frequency of the species is presented in Fig. 2.

During the year 1976, 1977 and 1978 seasons over 106 specimens in the size range 6.2 to 19.8 cm in fork length and weighing from 3 to 100 g were examined. The length frequency of 106 specimens in the above size range landed during 1976 and 1978 (from August and September) and in 1977 (August) is presented in Fig. 1.

*Meristic counts* :

D1. XIV-XVI ; D2 + finlets —+ 8 ; A + finlets —+ 7 ; gill rackers 6—9 + 16 — 22.

The frequency of gill raker counts are given in Table 3.

TABLE 2. *Frequency of gill raker counts of* A. thazard

| Counts | Upper limb 7 | 8 | 9 | 10 | No. of specimens | Lower limb 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | No. of specimens |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of specimens .. | 2 | 20 | 91 | 2 | 115 | 1 | .. | 2 | 5 | 33 | 41 | 24 | 7 | 2 | 115 |
| % .. | 1.7 | 17.4 | 79.2 | 1.7 | | 0.9 | .. | 1.7 | 4.3 | 28.7 | 35.7 | 20.9 | 6.1 | 1.7 | |

| Counts | Combined frequency 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | No. of specimens |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of specimens .. | 1 | .. | 1 | 2 | 11 | 33 | 38 | 21 | 6 | 2 | 115 |
| % .. | 0.9 | .. | 0.9 | 1.7 | 9.6 | 28.7 | 33.0 | 18.3 | 5.2 | 1.7 | |

*A. thazard*

During the year 1976, 1977 and 1978 seasons the juvenile specimens were caught only during a very restricted period. The frequency of the specimens landed during the months of July and August are shown in Fig. 2. The specimens caught measured from 12.9 to 19.9 cm in fork length and weighed from 20 to 100 g.

*Meristic counts*

D1 X-XI ; D2 + finlets —+ 7 — 8 ; A + finlets —+ 7 (only) gill rakers 7 — 10 + 19 — 27.

The frequency of gill raker counts are given in Table 2.

*S. orientalis*

Juveniles of *S. orientalis* were recorded in very few numbers only in the month of August during the year

TABLE 3. *Frequency of gill raker counts in E.* affinis

| Counts | Upper limb 6 | 7 | 8 | 9 | No. of specimens | Lower limb 16 | 17 | 18 | 19 | 20 | 21 | 22 | No. of specimens |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of specimens .. | 11 | 72 | 4 | 1 | 88 | 1 | 1 | 7 | 68 | 9 | .. | 2 | 88 |
| % .. | 2.5 | 81.8 | 4.6 | 1.1 | | 1.1 | 1.1 | 8.0 | 77.3 | 10.2 | .. | 2.3 | |

| Counts | Combined frequency 23 | 24 | 25 | 26 | 27 | 28 | 29 | No. of specimens |
|---|---|---|---|---|---|---|---|---|
| No. of specimens .. | 1 | 5 | 9 | 62 | 5 | 5 | 1 | 88 |
| % .. | 1.1 | 5.7 | 10.2 | 70.5 | 5.7 | 5.7 | 1.1 | |

1976, 1977 and 1978, taken by sardine gill nets. The length frequencies of the specimens landed for the months of August during the above period are shown in Fig. 2. The specimens caught measured from 9.8 to 19.9 cm in fork length and weighed from 7 to 95 g.

*Meristic counts*

D1 XVII – XIX ; D2 + finlets –+ 7 – 9 ; A + finlets –+ 5 – 7 ; gill rakers ; 2 – 5 + 5 – 9.

The frequency of gill raker counts is presented in Table 4.

TABLE 4. *Frequency of gill raker counts of* S. orientalis

| Counts | Upper limb 2 | 3 | 4 | 5 | No. of specimens | Lower limb 5 | 6 | 7 | 8 | 9 | No. of specimens |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of specimens .. | 3 | 5 | 95 | 3 | 106 | 1 | .. | 15 | 89 | 1 | 106 |
| % .. | 2.8 | 4.7 | 89.6 | 2.8 | | 0.9 | .. | 14.2 | 84.0 | 0.9 | |

| Counts | Combined frequency 8 | 9 | 10 | 11 | 12 | 13 | No. of specimens |
|---|---|---|---|---|---|---|---|
| No. of specimens .. | 1 | 2 | 2 | 14 | 84 | 3 | 106 |
| % .. | 1.0 | 1.9 | 1.9 | 13.2 | 79.2 | 2.8 | |

*Food and feeding habits* :

In waters around Sri Lanka, *E. affinis* are found in schools with *A. thazard*, and presumably these two species are directly competing for food (Williams 1963). The feeding habits of *E. affinis* may vary throughout the year (Kishinouye 1895). According to Magnuson and Heitz (1971), the gill raker gap is greater in *S. orientalis*. Therefore, it would be expected that the diet of *A. thazard* would contain a large proportion of smaller organisms than that of *S. orientalis*.

*E. affinis*

Totally 88 specimens were examined during 1976-1978. The visual grading of the fullness of the stomach for the 88 specimens was as follows :

| Grading | | Percentage |
|---|---|---|
| Empty | .. | 76.1 |
| Trace | .. | 11.4 |
| 1/4 + or – | .. | 4.5 |
| 1/2 + or – | .. | 4.5 |
| 3/4 + or – | .. | 1.2 |
| Full (gorged) | .. | 2.3 |

From Table 5 it will be seen that both from the number of occurrence as well as the actual volume, *Anchoviella commersonii* constituted the most important food item with zooplanktonic crustaceans next in importance. Young-ones of *E. affinis* feed on zooplankton as well as small fishes like *Stolephorus*. Feeding pattern is not different from that of the adult.

TABLE 5. *Food items of* E. affinis (*juveniles*)

| Constituents | Occurrence No. | Occurrence % | Actual volume (ml) | Percentage by volume | Actual No. of food organisms |
|---|---|---|---|---|---|
| *Anchoviella commersonii* .. | 4 | 4.6 | 8.8 | 48.0 | 5 |
| Skeletal remains of fish .. | 3 | 3.5 | 3.0 | 16.4 | .. |
| Crustacean food (plankton) | | | | | |
| Decapod larvae .. | 5 | 5.7 | 0.4 | 2.2 | 70 |
| Mysids .. | 2 | 2.3 | 0.4 | 2.2 | 12 |
| Phyllosoma .. | 1 | 1.2 | 1.0 | 5.5 | 6 |
| Megalopa .. | 3 | 3.5 | 2.4 | 13.1 | 42 |
| Stomatopods .. | 1 | 1.2 | .. | .. | 2 |
| Amphipods .. | 1 | 1.2 | 0.4 | 2.2 | 8 |
| Lucifer .. | 1 | 1.2 | 0.1 | 0.5 | 3 |
| Other crustacean remains .. | 2 | 2.3 | 1.0 | 5.5 | .. |
| Unidentified zooplankton .. | 5 | 5.8 | 0.8 | 4.4 | 30 |

*A. thazard*

Altogether 115 specimens were examined during 1976-1978. The visual grading of the fullness of the stomach for 115 specimens was as follows :

| Grading | | Percentage |
|---|---|---|
| Empty | .. | 47.0 |
| Trace | .. | 10.4 |
| 1/4 + or — | .. | 37.3 |
| 1/2 + or — | .. | 3.5 |
| 3/4 + or — | .. | 0.9 |
| Full (gorged) | .. | 0.9 |

From Table 6 it is clearly seen that when compared to *E. affinis* (juveniles) it feeds mainly on the zooplanktonic organisms and both from the number of occurrence as well as the actual volume, copepods constituted the predominant item among the food organisms of *A. thazard* (juveniles). Decapod larvae were observed to be the second important food item of them.

Young-ones of *A. thazard* are exclusively plankton feeders unlike the adults. They feed mainly on crustaceans, copepods and decapod larvae.

TABLE 6. *Food items of* A. thazard (*Juveniles*)

| Constituents | Occurrence No, | Occurrence % | Actual volume | Percentage by volume | Actual No. of food organisms |
|---|---|---|---|---|---|
| Crustaceans : | | | | | |
| Copepods .. | 59 | 51.3 | 25.8 | 56.8 | 15688 |
| Decapods .. | 50 | 43.5 | 7.9 | 17.4 | 988 |
| Megalopa .. | 8 | 7.0 | 2.2 | 4.9 | 27 |
| Lucifer .. | 6 | 5.2 | 0.1 | 0.2 | 27 |
| Amphipods .. | 13 | 11.3 | 2.5 | 5.5 | 70 |
| Mysids .. | 1 | 0.9 | 0.1 | 0.2 | 9 |
| Stomatopods .. | 2 | 1.7 | 1.1 | 24 | 6 |
| Ostracods .. | 3 | 2.6 | 0.1 | 0.2 | 18 |
| Cladocerans .. | 1 | 0.9 | Trace | Trace | 6 |
| Mollusca : | | | | | |
| Gastropods .. | 2 | 1.7 | Trace | Trace | 3 |
| Lamellibranchiates .. | 9 | 7.8 | 0.2 | 0.4 | 48 |
| Ascidian : | | | | | |
| Appendicularians .. | 2 | 1.7 | 0.4 | 1.0 | 25 |
| Fish eggs & larvae : | | | | | |
| Fish eggs .. | 12 | 10.4 | 0.7 | 1.5 | 16 |
| Fish larvae .. | 9 | 7.8 | 1.8 | 4.0 | 25 |
| Unidentified zooplankton .. | 27 | 23.5 | 2.5 | 5.5 | 244 |

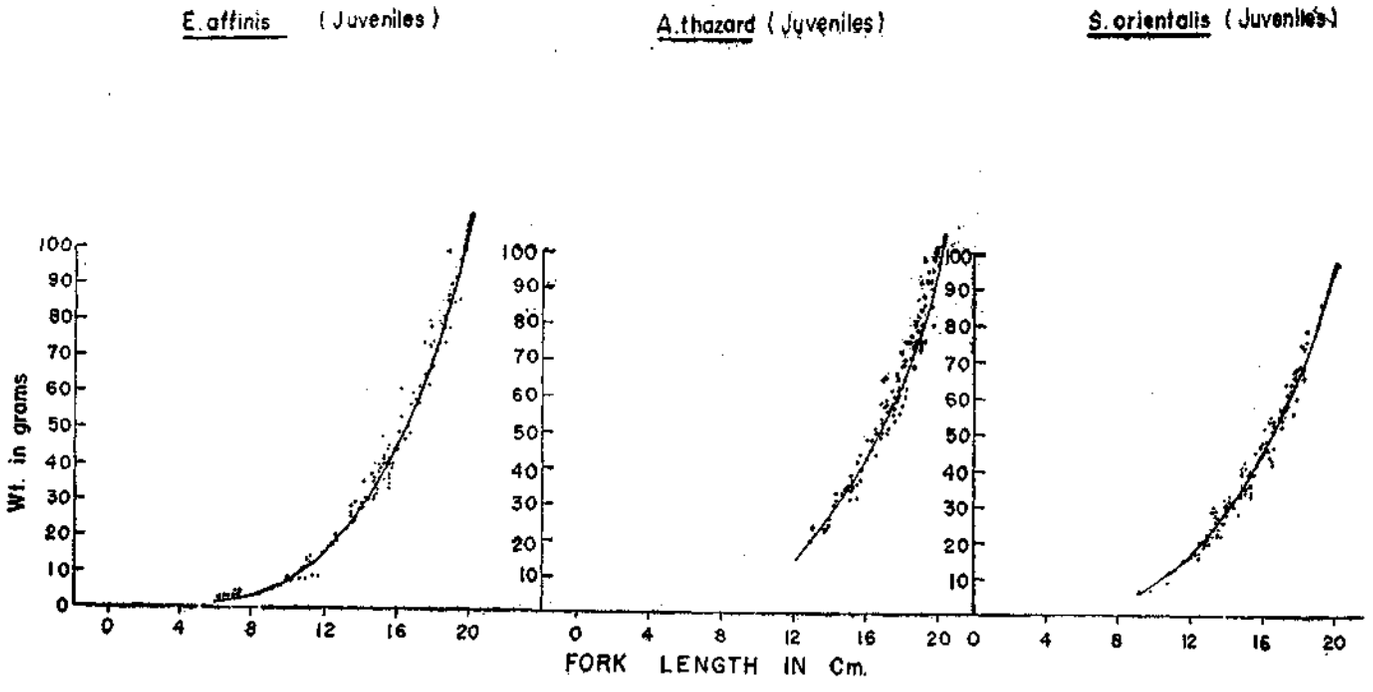


Fig. 5. Length-weight relationship of the juveniles of *E. affinis, A. thazard* and *S. orientalis* at Tuticorin.

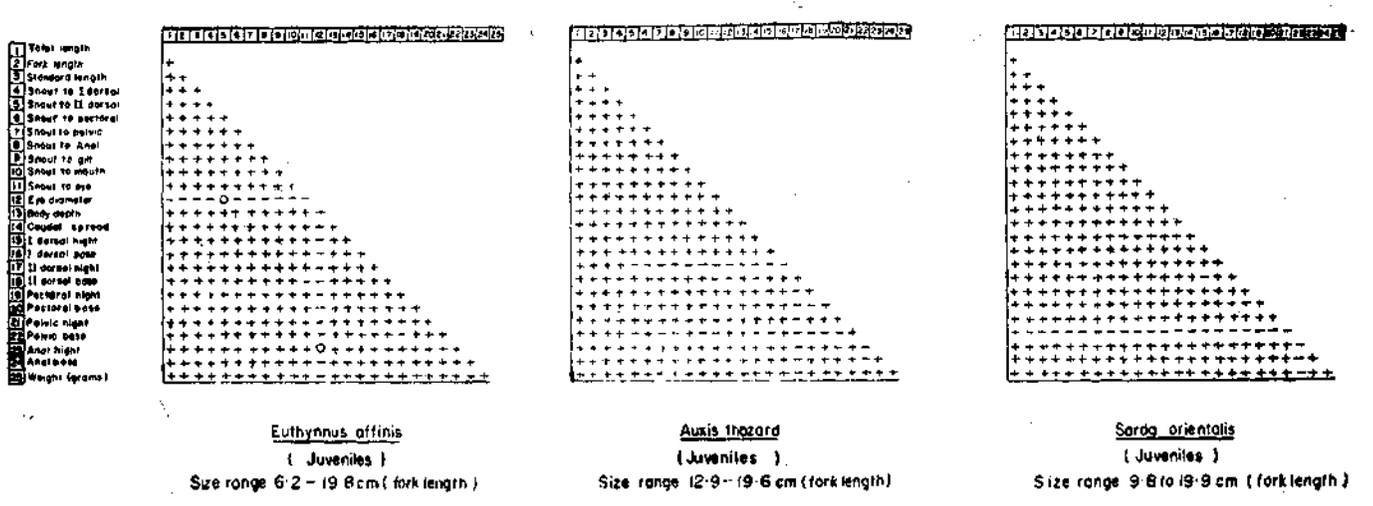


Fig. 6. Correlation matrix of different characters of the juvenile of tuna from the Tuticorin waters of Tamilnadu Coast in the Gulf of Mannar.

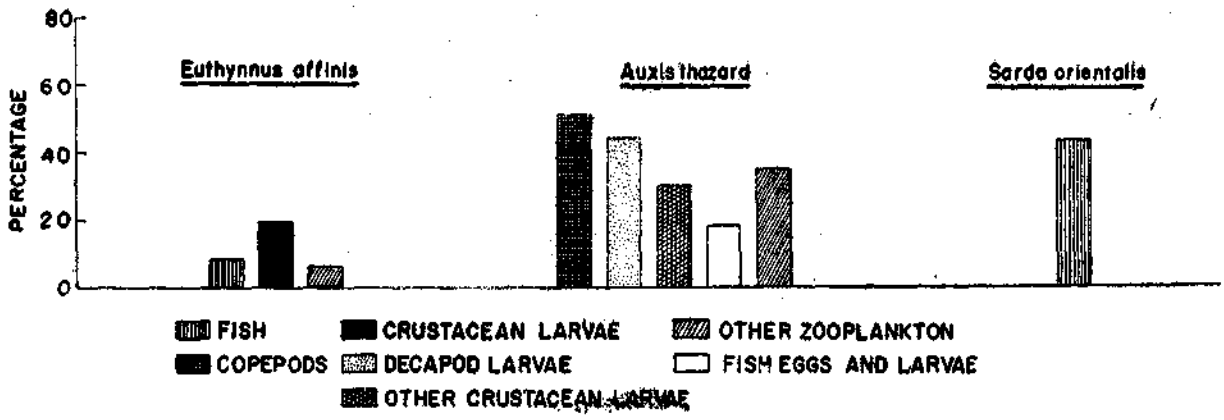


Fig. 7. Percentage composition of the occurrence of major food constituents of the juveniles of *E. affinis*, *A. thazard* and *S. orientalis* at Tuticorin.

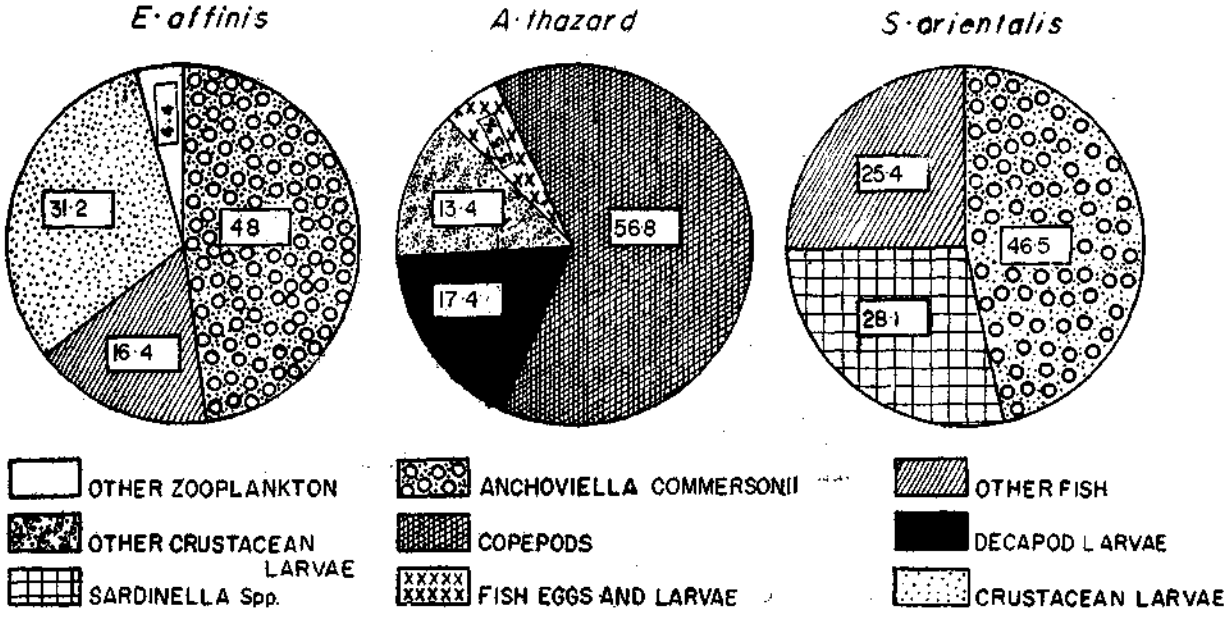


Fig. 8. Volumetric composition of the stomach contents of the juveniles of *E. affinis*, *A. thazard* and *S. orientalis* at Tuticorin.

*S. orientalis*

Totally 106 specimens were examined during 1976-1978. The visual grading of the fullness of the stomach was as follows :

| Grading | | Percentage |
|---|---|---|
| Empty | .. | 59.4 |
| Trace | .. | 13.2 |
| 1/4 + or − | .. | 17.0 |
| 1/2 + or − | .. | 3.8 |
| 3/4 + or − | .. | 1.9 |
| Full (gorged) | .. | 4.7 |

Unlike that of *E. affinis* and *A. thazard*, *S. orientalis* (juveniles) feed mainly on fishes. From Table 7 it will be seen that both from the number of occurrence as well as the actual volume, *Anchoviella commersonii* constituted the most important food item and *Sardinella* spp. comes in the next among the food organisms of *S. orientalis* (juveniles). Young ones of *S. orientalis* are carnivorous and not plankton feeders.

The percentage of occurrence and volumetric composition of major food constituents of *E. affinis*, *A. thazard* and *S. orientalis* are presented in Figs. 7 & 8.

TABLE 7. *Food items of* S. orientalis *(juveniles)*

| Constituents | | Occurrence number | Occurrence Percentage | Actual volume (ml) | Percentage by volume | Actual No. of food organisms |
|---|---|---|---|---|---|---|
| Vertebrates (Fishes) : | | | | | | |
| *Sardinella* spp. | .. | 2 | 1.9 | 13.5 | 28.1 | 4 |
| *Anchoviella commersonii* | .. | 19 | 17.9 | 22.3 | 46.5 | 22 |
| Unidentified fish | .. | 4 | 3.8 | 4.0 | 8.3 | 6 |
| Fish remains | .. | 21 | 19.8 | 8.2 | 17.1 | Trace |

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