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Aspects of the Biology of the Major Tuna Baitfishes from The Seychelles

by

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SUMMARY

Several resource survey have been carried out on the Seychelles tuna baitfishes in the past with the main objective of developping a locally based pole-and-line fishery which will exploit the rich tuna fishing grounds around Seychelles.

On the Mahe Plateau, the area of concentration and seasonality *Decapturus maruadsi* and *D. macrosoma* were studied as well as the main biological characteristics of the two species : reproduction, growth and stock assessment.

The area of occurence, the reproductive cycle and the growth of the two main tuna bait species, *Herklotsichthys punctatus* and *Atherinomorus lacunosus* distributed inshore around Mahe, the principal island are presented.

These analysis revealed that overall a Seychelles based pole-and-line fishery would probably have its development hampered by the availability of baitfish

1. SEYCHELLES MAIN CHARACTERISTICS

The Seychelles are an archipelago situated in the South-West Indian Ocean from 3°45' South to 10°20'S and from 46°10'E to 56°10' East (Figure 1). Land area is very limited (453 km2) but the islands are spread on a very wide oceanic zone which gives to the Republic of Seychelles an Economic Exclusive Zone (EEZ) of more than 1 million km2.

Island geology is of two types:

- mountanious islands made of granite which are all in the north of the archipelago and lying on the 27,500 km2 Mahe Plateau whose depth varies from 10 to 80 metres.

- flat islands made of coral and sands which are either isolated, and rising from the bottom floor of the ocean (Coetivy, Platte), or on the edge of the Seychelles Plateau (Bird, Denis) or grouped together in smaller archipelago such as Amirantes, Farquhar or Providence.

All Seychelles islands are influenced by the monsoon system typical to the Indian Ocean. Winds are blowing from the south-west from May to September and from the north-west from November to March.

The two monsoons are separated by the inter-monsoon periods: April-May and September-October with very little wind.

Being mostly equatorial, Seychelles receives plenty of rain (yearly average 2000mm) especially on the elevated granitic islands where small streams are numerous, the largest receiving high precipitation despite the small size of the island (145 km2 for Mahe, the largest island). However, a dry season (June - September) does exist mainly on the low lying islands especially for the southern islands groups (Assomption, Cosmoledo, Aldabra, Farquhar). More than 95% of the 66 000 Seychellois are found on the three granitic islands Mahe, Praslin and La Digue. Mahe, where the capital Victoria is located, accounts alone for 55,000 inhabitants.

The Mahe Plateau lies from 3°45'S to 5°45'S and stands in the path of the Equatorial Counter Current which flows east from December to April. This Plateau is relatively rich and supports an artisanal fishery with landings of 4000 tonnes thus supplementing the high local demand of fish as Seychellois are among the highest fish consumers in the world.

Presently Seychelles is the centre of a 200 000t tuna purse seine fishery making Victoria the first tuna fishing port of the Indian Ocean.

Fishing in general and tuna fishing in particular have always been the prime concern of the Seychelles Government. In view of this fact, several tuna surveys have been conducted in the past around Seychelles. Purse seine trials were performed from 1980 to 1983, pole-and-line trials in 1980-81 with 4 French-built vessels and in 1981-82 with 2 Spanish-built vessels.

In order to support a pole-and-line fishery data on tuna baitfish resources in Seychelles have been gathered through different surveys and research programmes.

2. TUNA BAITFISH SURVEYS

These surveys were of two types according to the different areas they cover:

- the open sea of the Mahe Plateau
- the coastal areas

2.1 Baitfish surveys on the Plateau

These surveys were mainly performed by Research Vessels using accoustic methods for the assessment of the biomass and pelagic or bottom trawling to catch the corresponding fishes:

- R.V. Professeur Metsyatsev in July 1976 and October 1977 (Shubnikov, 1978),

- R.V. Fridtjof Nansen in July 1978 (Anon, 1978),

- R.V. Nauka in February-March 1979,

- R.V. CORIOLIS in September-November 1979 and August-September 1980 (Marchal and al, 1979, 1981). This vessel made also few trials with lamparo and bouki-ami,

- German trawlers Ostsee and Nordsee from January to November 1981 (Steinberg and al 1982).

Other data were gathered during the pole-and-line surveys by the French vessels from January 1980 to March 1981 and the Spanish vessels from July 1981 to March 1982.

French pole-and-line vessels caught bait using lamparo and bouki-ami type of net.

Spanish pole-and-line vessels were targetting baitfishes from the Plateau by fishing at night without lamparo, spotting and catching the fish using sonar and a 380 x 65m purse seine.

On the Plateau, species caught were mainly small Carangidae (Decapturus sp. selar crumenophtalmus), mixed with small amounts of clupeidae (Sardinella sirm) and scombridae (Rastrelliger kanagurta).

Ideal size for tuna baitfish is related to the tuna size and species targeted, however, it is generally considered that 6 to 8 cm baitfish is adequate for skipjack (Katsuwonus pelamis) and 10 to 15 cm baitfish for yellowfin (Thunnus albacares) (Yuen in Shomura, 1977). Tuna baitfish over 15cm are rarely utilised.

2.2. Baitfish survey along the coasts.

Day-time fish surveys were conducted either from the beaches using beach net or from small vessels with a purse seine. Purse seine was also used at night as well as bouke-ami, baitfishes being attracted to the above by underwater lights. These trials were made by the Seychelles Fisheries Division (Ratcliffe, 1974, 1978) and by ORSTOM (French Scientific Research Institute for Development through Cooperation) under an agreement between Seychelles Government and ORSTOM. This last research programme was conducted from March 1982 to February 1983 along the coasts of Mahe Island.

3. SEYCHELLES BAITFISH BIOLOGY

Some of the data used in these studies are coming from surveys conducted by the different research vessels. But most data are from the two cruises of the ORSTOM R.V. CORIOLIS for the baitfishes of the Mahe Plateau (Marchal and al, 1979, 1981) and from the ORSTOM - Seychelles Fisheries Division baitfish research programme for the coastal baitfishes (Anon, 1983 and de Moussac et Poupon, 1986).

3.1. Baitfishes of the Mahe Plateau

3.1.1. Species

The two main species studied are *Decapturus maruadsi* and *D. macrosoma* as they are the most abundant small pelagic fishes of the Seychelles Plateau.

3.1.2 Areas and periods of occurrence

Decapturus maruadsi schools densely near the bottom during the day and tend to disperse in mid-water during the night.

Decapturus macrosoma is always close to the bottom; therefore trawling yields are the same day or night.

Spatial distribution on the Mahe Plateau for the two species from March to November is shown in figure 2.

D. macrosoma appears to be present all year round in every location surveyed but in small amounts. While *D. maruadsi* seems to undergo large seasonal fluctuations in its abundance and is more limited to the edges of the Plateau where it is present in greater quantities.

3.1.3 Baitfish size distribution (figure 3)

From figure 3, one sees that juveniles of *D. maruadsi* appear in the catch in July but often their sizes are too large to be considered as good baitfish. This is less often the case for *D. macrosoma* for which fishes less than 15 cm FL are abundant.

3.1.4. Maturity and spawning

The maturity stages for D. maruadsi male and female listed in table 1 clearly demonstrates that spawning must occur from March to June. During that period, most fish measure 19 to 22 cm. (figure 3). Spawning could either occur on the Plateau, the spawners moving afterwards outside the Plateau or spawning could take place outside the Plateau with the juveniles moving onto the Plateau in July. In our samples, mature fish of less than 20 cm were even found.

Birkett (1979) stated that D. maruadsi would reach its sexual maturity at the end of its second year when it moves in deeper water (over 100m.) to spawn.

No data was available to support this hypothesis.

For D. macrosoma, less abundant than D. maruadsi, the limited samples available suggest that spawning would occur from March-Arpil to September with a maximum in June-July (Tarbit, 1980). Contrary to D. maruadsi, D. macrosoma would spend all its life on the Plateau where spawning would occur. Size at first spawning was assessed at 16-17 cm by TARBIT (1980).

3.1.5. Growth

With the hypothesis of one spawning season in March-June, a growth curve is proposed for D. maruadsi (figure 4). Fishes born in April-May would measure about 14-15 cm after a year and would reach 21-22cm in two years when they spawn.

For D. macrosoma when following the different modes, growth seems to be slower than for D. maruadsi (figure 4) : at one year fish would only reach 10cm and 17cm for the age 2.

3.1.6. Stock assessment

Birkett (1979) using acoustic methods has estimated the Mahe Plateau small pelagic fish stock at 115,000t. This estimation comprises not only the Decapturus species but all the other small pelagic fishes, Decapturus sp being the most numerous of them.

Using the same acoustic techniques but with a more detailed analysis Marchal and al (1981) estimated the nectobenthic fish stocks at 66,000t, D. maruadsi would make the biggest part of this amount.

Using a different method (an average density of 8.6 tonnes/mile^2 multiply by a 6,600 mile^2 of trawling area), Marchal and al (1981) calculated a 57,000 tonnes biomass.

Decapturus maruadsi would represent 55,000 tonnes and Decapturus macrosoma 2,000 tonnes.

The Gulland (1971) equation C = M 0.5 B(1) can be used to assess the maximum sustainable yield as these stocks are not exploited. For short life species such as Decapturus sp. M is taken as equal to 1 and therefore MSY for *D. maruadsi* is estimated at 27 500 tonnes and at 1000 tonnes for *D. macrosma*.

3.1.7. *Decapturus* sp. as baitfishes

For baitfishing one should consider that *D. maruadsi* presents several disadvantages :

- fishes of the appropriate size as bait (6 to 15cm) are only available during part of the year,
- this species undergoes very large population fluctuations and with periods where it disappears completely on the plateau (Tarbit, 1980).

On the other hand, *D. macrosoma* appears to be a more reliable source of baitfish :

- it is present all year round (Spanish pole-and-line vessels caught it almost exclusively, (CORT, 1982)),
- it is found all over the Plateau,
- suitable baitfish sizes are available almost all year round.

However, the sustainable catch of *D. macrosoma* under 15cm FL is estimated at only 200 tonnes.

This amount could not support an important industrial pole-and-line fishery.

If these two species are ever be exploited as baitfish or for other purposes, more research will be necessary especially on:

- seasonal abundance fluctuations,
- migratory movements,
- some aspects of the biology,
- more accurate stock assessment.

3.2. Coastal baitfishes

For every fishing trial an 80 fish sample for the two main species was taken and studied for : size, sexual maturity, weight of whole fish, of liver and of gonads (Anon, 1983).

3.2.1. Species

The baitfish species caught during the day by beach or purse net or at night with lamporo and bouki-ami or purse seine nets are:

(1) C is MSY, M is the natural mortality coefficient and B is the biomass.

- Herklotsichthys punctatus or sardines
- Atherinomorus lacunosus (previously Pranesus pinquis) or hardyheads
- Spratelloides sp. or sprats
- Amblygaster sirm or sardine de France
- Selar crumenophthalmus or big eye mackerel
- Rastrelliger kanagurta or Indian mackerel

The two former species were by far the most abundant while the three last one on the list were scarce and almost always too large as baitfish. Therefore, only Herklotsichthys punctatus (H.p.) and Atherinomorus lacunosus (A.l.) are studied. Spratelloides sp. were rare except on baitfish trials made near corals islands especially in the lagoon of Desroches island. Amblygaster sirm was found in very small amount, always of large size, near both granitic and coral islands.

3.2.2. Areas and periods of occurrence

Sardines and hardyheads were found on both coasts of Mahe, the species being more abundant on the east coast, the southern and northern parts of the west coast.

A lower occurrence was noticed from June to August except on the North-West coast but this situation could be the consequence of the weather conditions : strong South-East winds are prevailing around Mahe at this season.

3.2.3. Baitflish size distribution

Monthly size distributions are given in figure 5 for Herklotsichthys punctatus (H.p.) and in figure 6 for Atherinomorus lacunosus (A.l.).

Suitable baitfish sizes are available all year round.

Marichamy (1968) in the Andaman sea found bigger size H.p. up to 145mm. For H.p. small size fishes appear in the catches in June, July while for A.l. this takes place in April, in July-August and in November.

3.2.4. Maturity, spawning and fecundity

Five maturity stages are used, the last stage, stage V, describes gonad of a fish ready to spawn. There is a great variability in the percentage of stage V H.p. female (figure 7). During six months (May, June, August, October, November and January) the percentage of stage V is greater than 30%.

Accordingly Herklotsichthys punctatus seems to spawn more or less all year round with some more active spawning periods in August, October-November and January-February, spawning activity being lower in April. Marichamy (1968) noticed in the Andaman Sea that H.p. can have several spawning periods each year but mainly in May-June and October-November.

Atherinomorus lacunosus has two well-marked and quite spread off spawning seasons in April-June and in September-December (figure 8). These periods roughly correspond to the inter-monsoon periods. Measurements of ovocyst diameters give a plurimodal distribution for both species which confirms the possibility for a particular female to spawn several times during the same spawning season or the same year (figure 9).

Fecundity was estimated for the two species as the number of ripe ovocysts (diameter >450). An important variability was recorded in both species in relation with the size of the fish but also for the same size fish.

Relations of fecundity with the size and with the weight are as follows:

- *Herklotsichthys punctatus*

  Fecundity (F) - fish size (FL in mm.) :
  $F = 9053.7 \times \text{Log } FL - 36312.0 \qquad r = 0.64$
  Fecundity (F) - fish weight (W in g.)
  $F = 3468.0 \times \text{Log } W - 3939.6 \qquad r = 0.67$

- *Atherinomorus lacunosus*

  Fecundity (F) - fish size (FL in mm) :
  $F = 5.32 \times e^{0.057\, FL}; \qquad r = 0.87$
  Fecundity (F) - fish weight (W in g.):
  $F = 95.32 \times e^{0.278\, W}; \qquad r = 0.89$

Fecundity of H.p. varies from 3,000 to 10,000 eggs, that of A.l. is much lower and comprised between 150 and 1,600 eggs.

Size at first spawning (50% females at stage V) was found to be 8 cm for H.p. and 6.4 cm for A.l.

In the Andaman Sea, this size for H.p. was estimated at 12.5 cm and the fecundity between 6,500 to 10,700 eggs (Marichamy, 1968).

3.2.5. Growth

Growth study with otolith and scale reading was tried but without success. Fish size frequency distribution was used; modes were separated utilising the Bhattacharya (1967) and the Gheno and Le Guen (1968) methods (figures 10, 11).

The Von Bertalanffy (1938) equation parameters were obtained with the Gulland and Holt (1959) graph method.

Herklotsichthys punctatus

$$Lt = 133.07 \; [1 - e^{-2.56\,(t + 0.1)}]$$
$$L\infty = 133.07 \text{ mm}$$
$$k = 2.56$$
$$t_0 = -0.10$$

Atherinomorus lacunosus

$$L_t = 97 [1 - e^{-2.556 (t - 0.18)}]$$

Loo = 97 mm
k = 2.556
to = 0.18

According to these growth curve equations, all H.p. in our sample were less than one year old but A.l. could live older than one year, however, the growth curve for the hardyheads does not fit too well to the observed size modes especially for large size ones. With insuffucient data available, no stock assessment could be made.

3.2.6. Length-weight relationship

Length-weight relationship was calculated for both species and according to the fish sex Student t test does reveal a different relationship between male and female for Atherinomorus lacunosus but no difference between sex for Herklotsichthys punctatus.

Relations are given below:

$$W = 9.5 \times 10^{-3} FL^{3.18} \quad \text{for H.p.}$$

$$W = 9 \times 10^{-3} FL^{3.12} \quad \text{for male A.l}$$

$$W = 8 \times 10^{-3} FL^{3.18} \quad \text{for female A.l.}$$

DISCUSSIONS

Decapturus maruadsi is found in large numbers mainly on the edge of the Mahe Plateau offers some limited possibility as a tuna baitfish. Moreover only juveniles (FL < 15cm) are suitable, these being available only part of the year and their abundance show high annual fluctuation.

Decapturus macrosoma The juvenile, of this species can also be used as a tuna baitfish. The species is more often available and experiences less abundant fluctuations, however the stock cannot sustain a high level of exploitation.

Overall, coastal baitfish resources are quite limited and mainly composed of two species Herklotsichthys punctatus and Atherinomorus lacunosus. The former is considered as a good baitfish, but the latter is among one of the less efficient tuna baitfish (Argue and al, 1987).

One can conclude that a Seychelles based pole-and-line tuna fishery would most probably have its development hampered by the availability of baitfish.

In view of these factors, the Seychelles Government has for the time being given up the idea of developping a tuna pole-and-line fishery. Therefore studies on the biology of the tuna baitfishes was discontinued after the completion of the 1982-83 baitfish programme whose main results have been reported above.

Since that time, a very important tuna purse seine fishery has emerged in this region. The Seychelles are therefore purchasing its own purse seine fleet in order to acquire its share of the tuna resources of the Western Indian Ocean.

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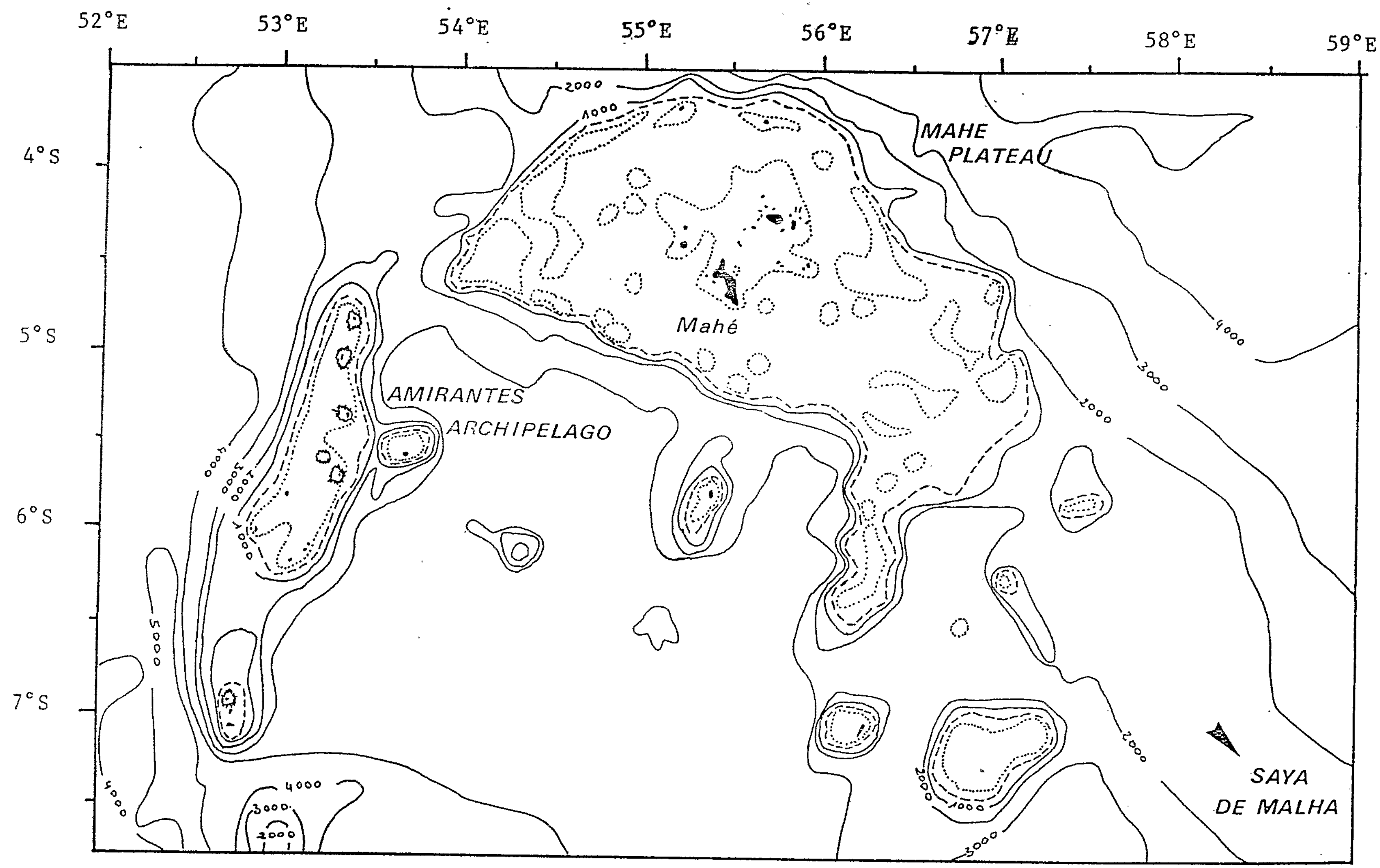

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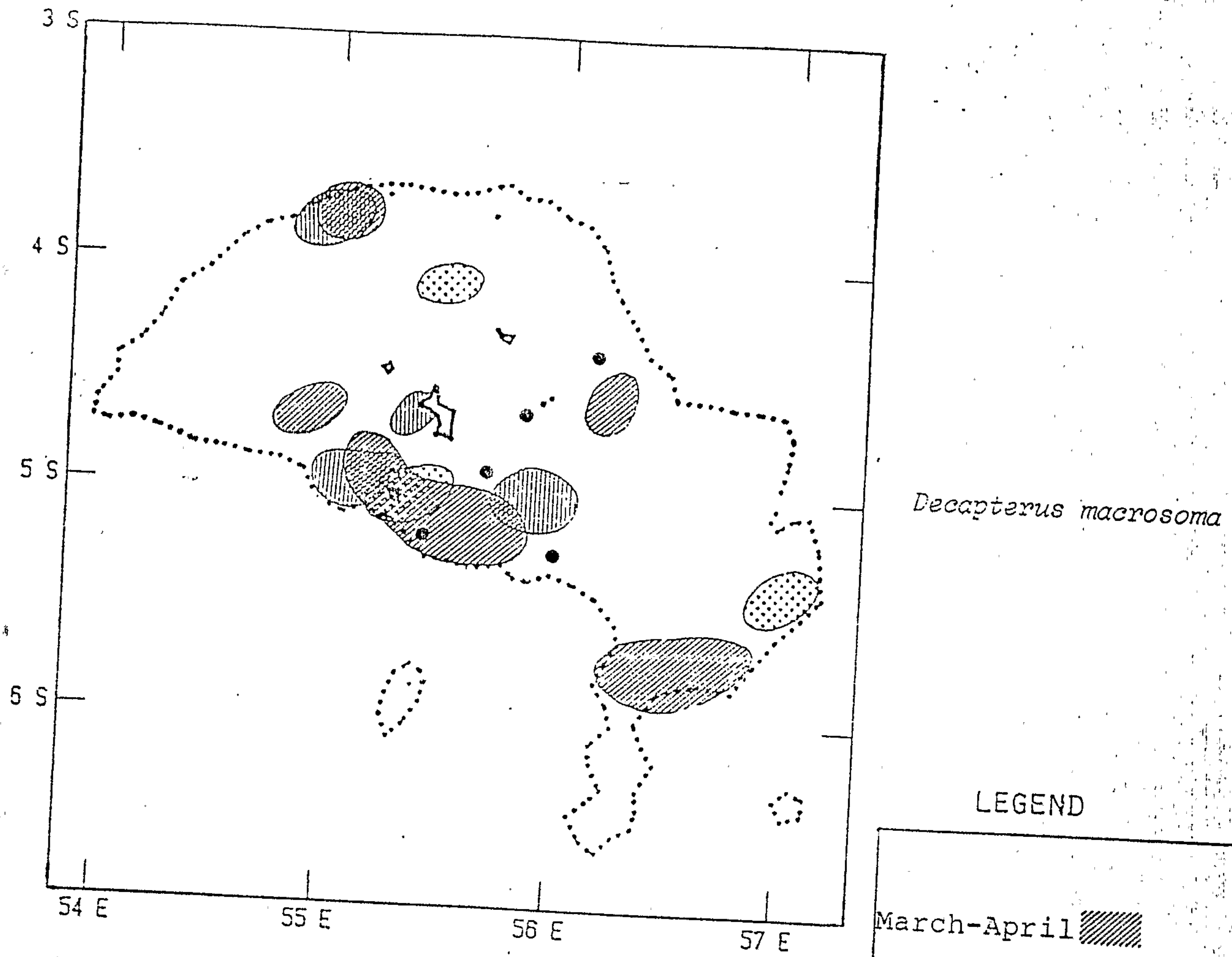
Figure 1 : Seychelles Islands and the Mahe Plateau.



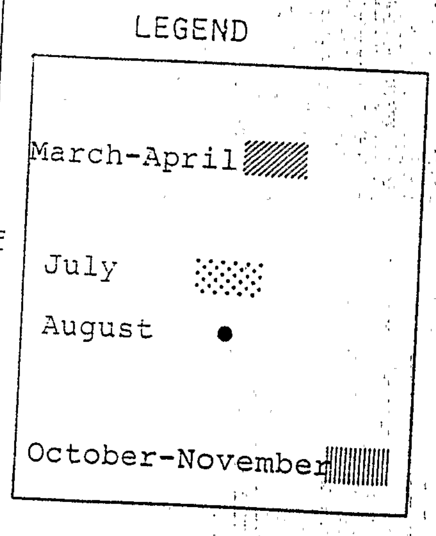
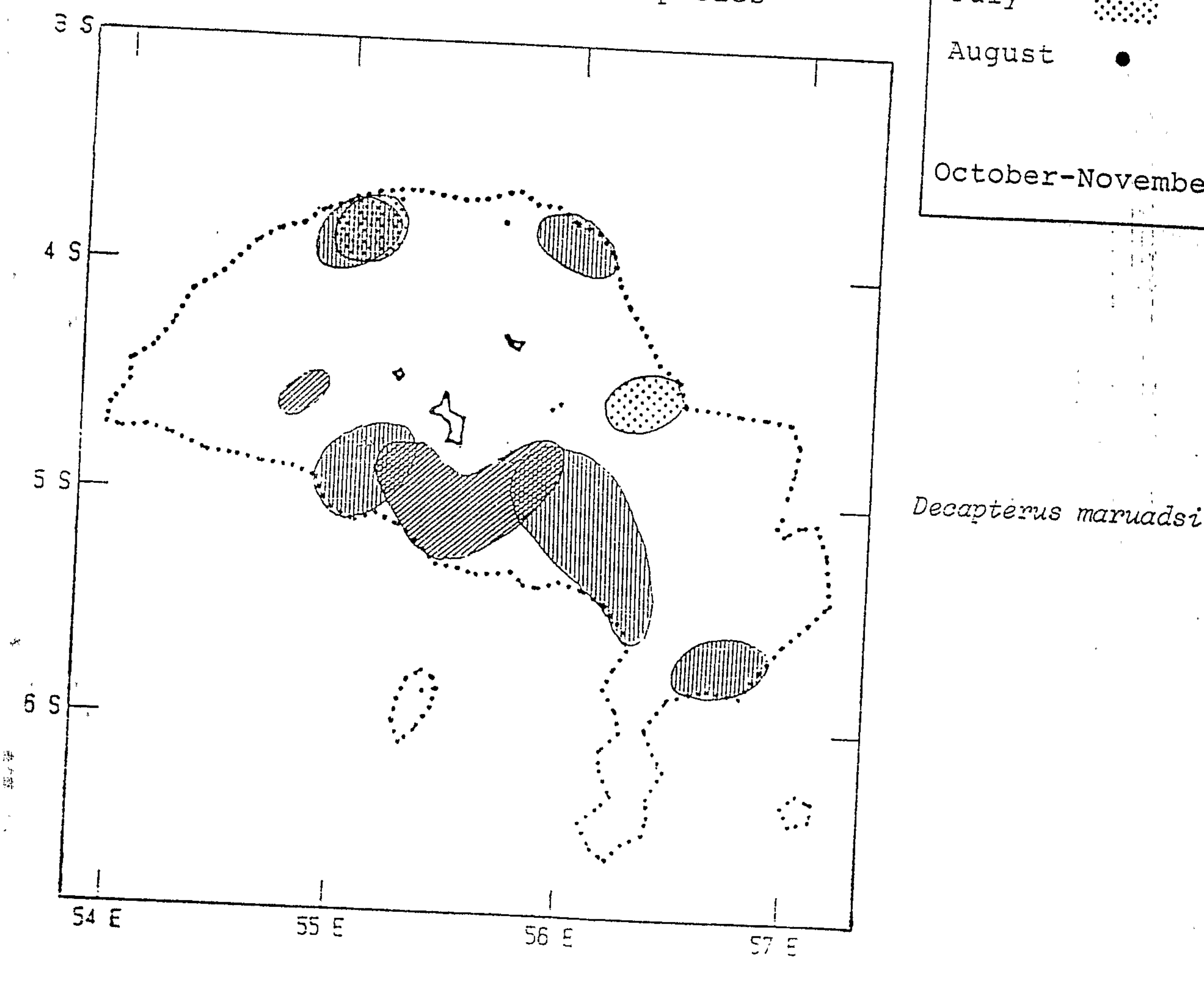


Figure 2 - Periods and areas of occurrence of the two Decapturus species



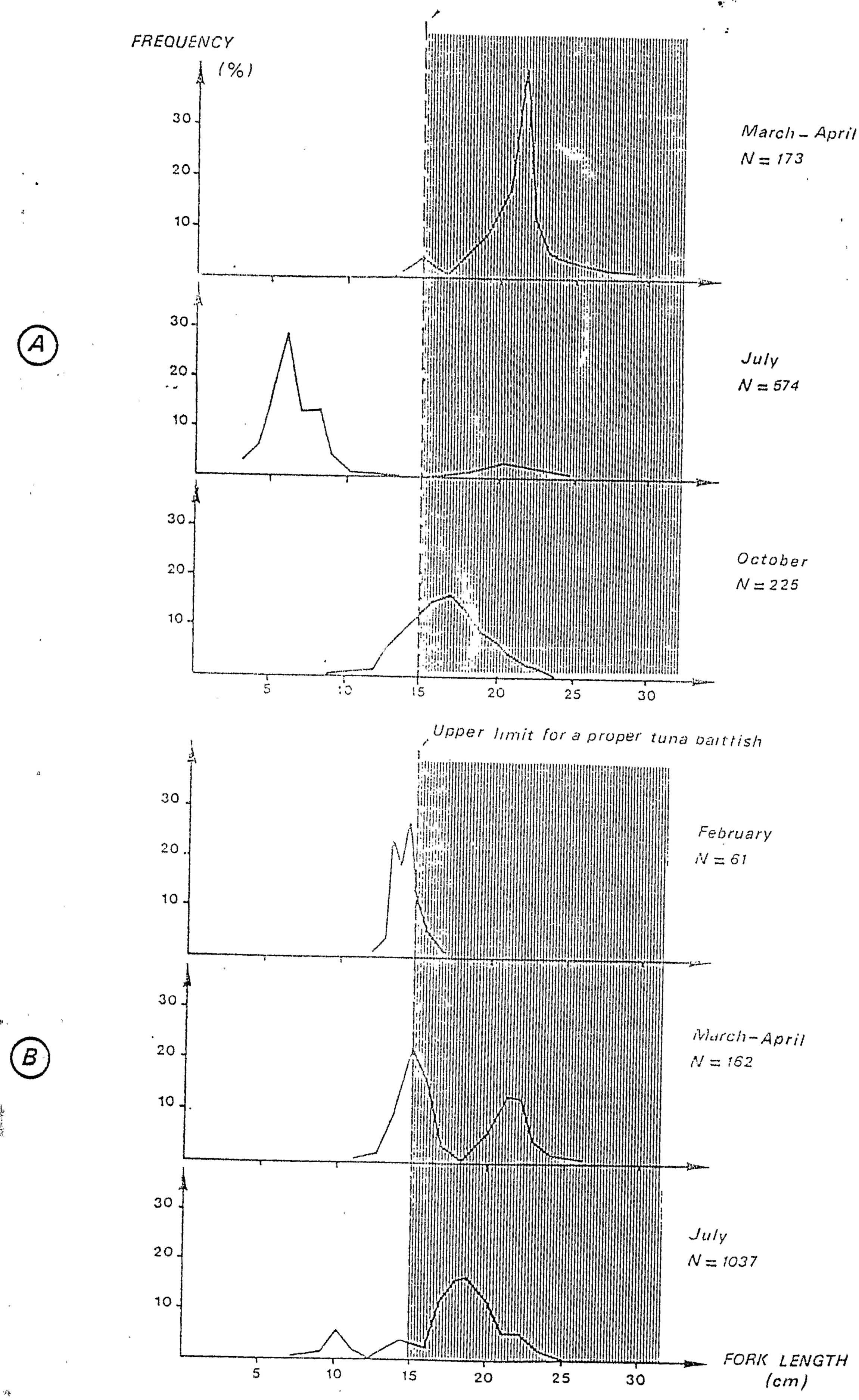


Figure 3 : Monthly size frequency distributions.
A <u>Decapturus maruadsi</u>
B <u>Decapturus macrosoma</u>

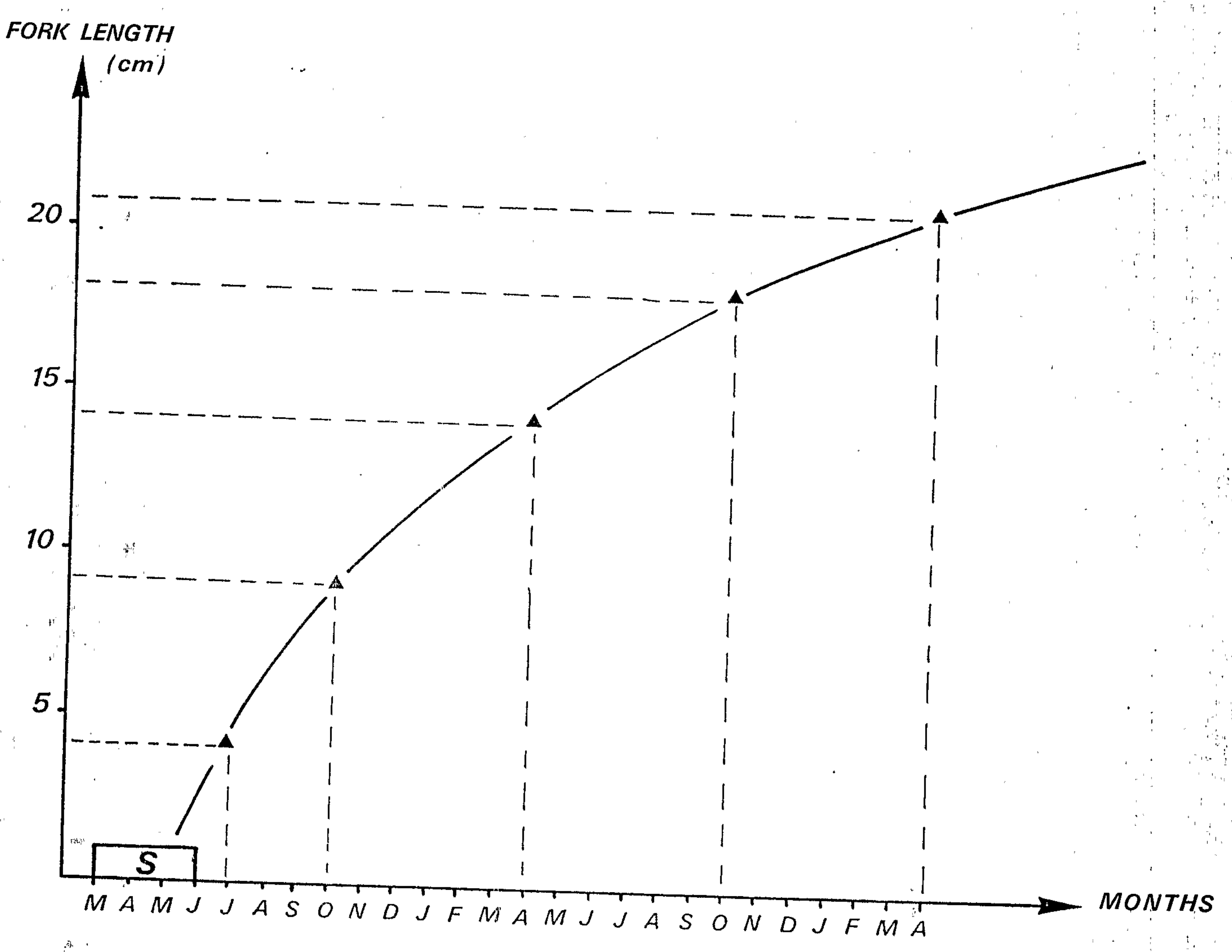


Figure 4 : Decapturus maruadsi growth curve

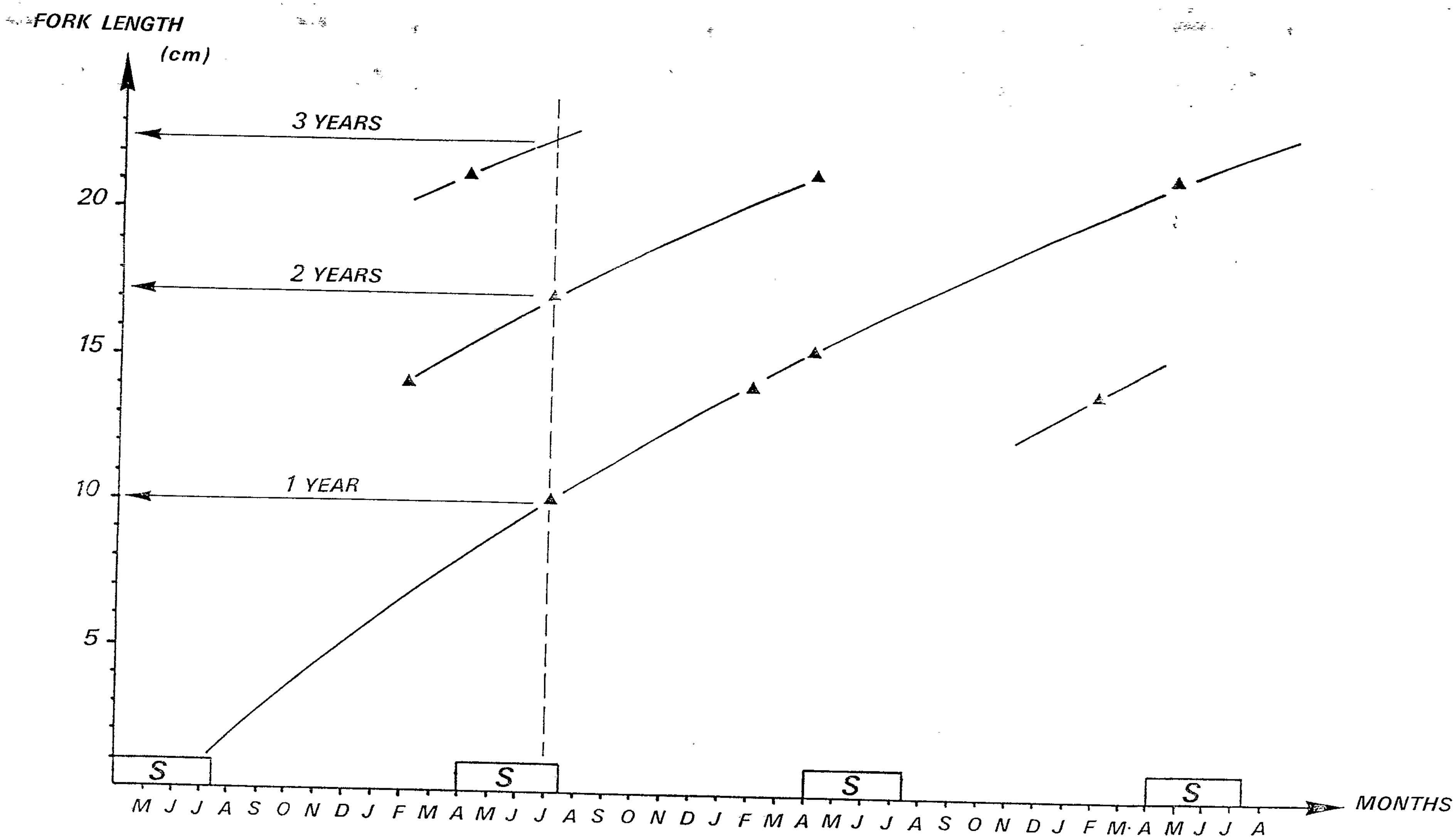
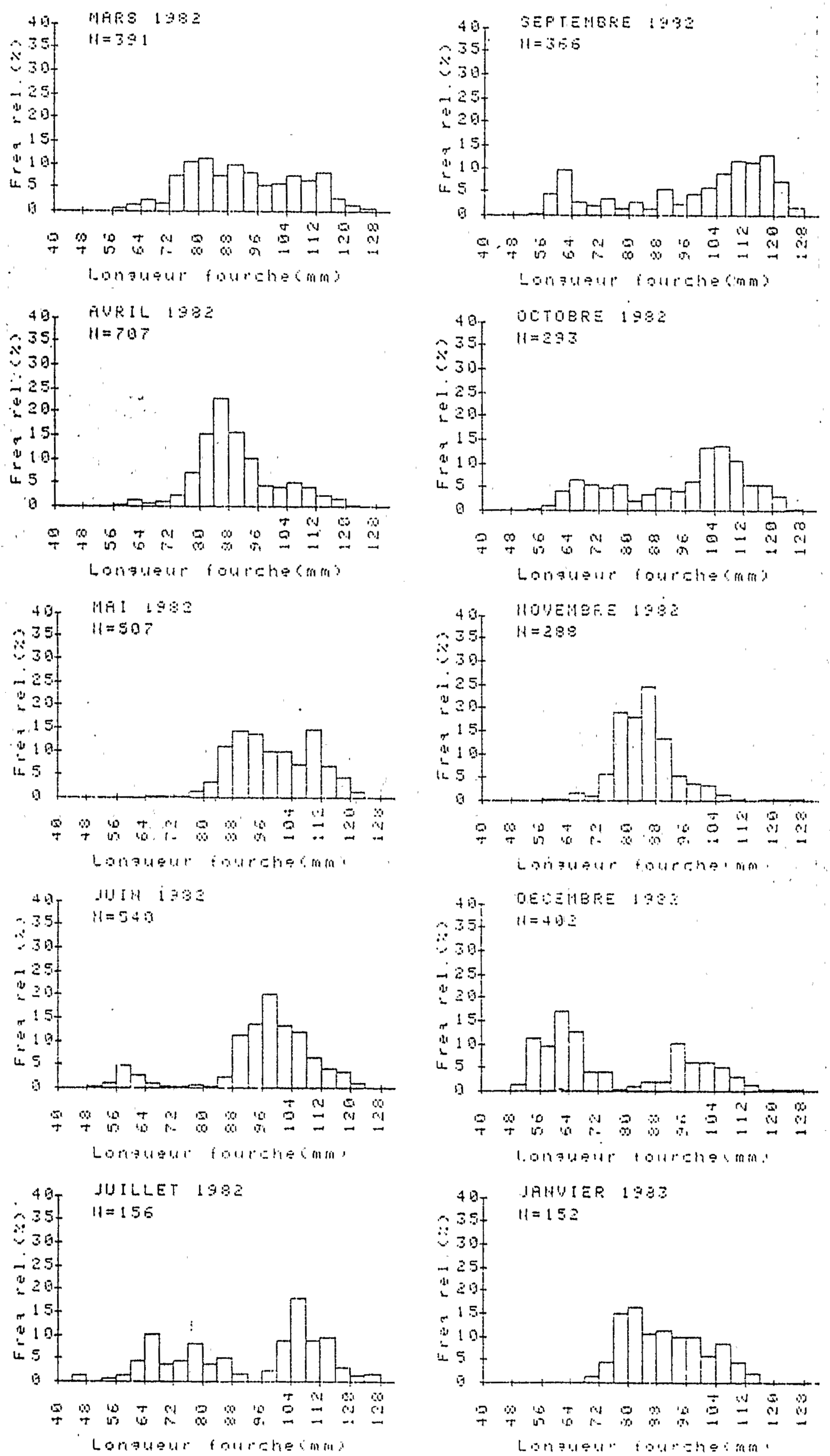


Figure 5 : Decapturus macrosoma growth curves



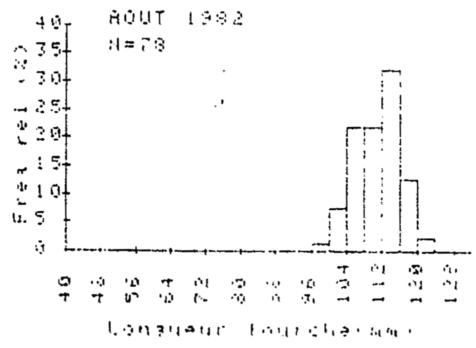
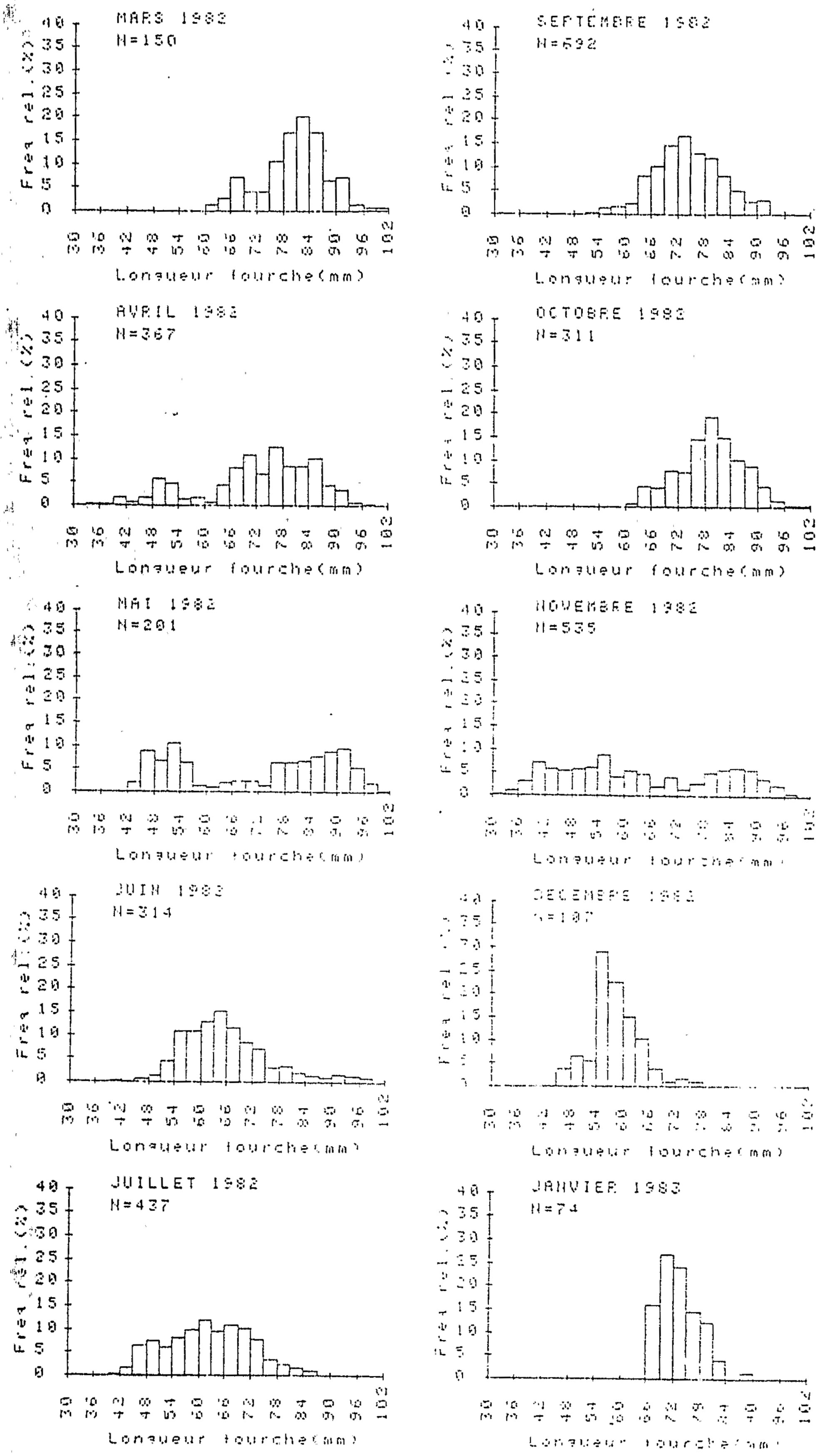


Figure 6: Monthly size distributions for <u>Herklotsichthys punctatus</u> from March 1982 to January 1983



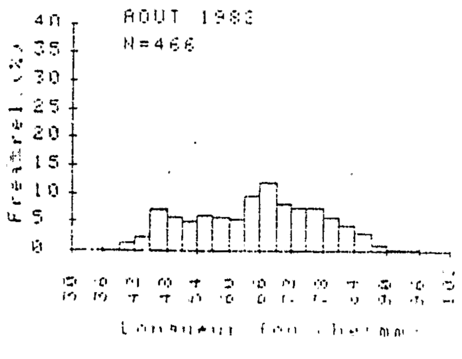


Figure 7: Monthly size distributions for Atherinomorus lacunosus from March 1982 to January 1983

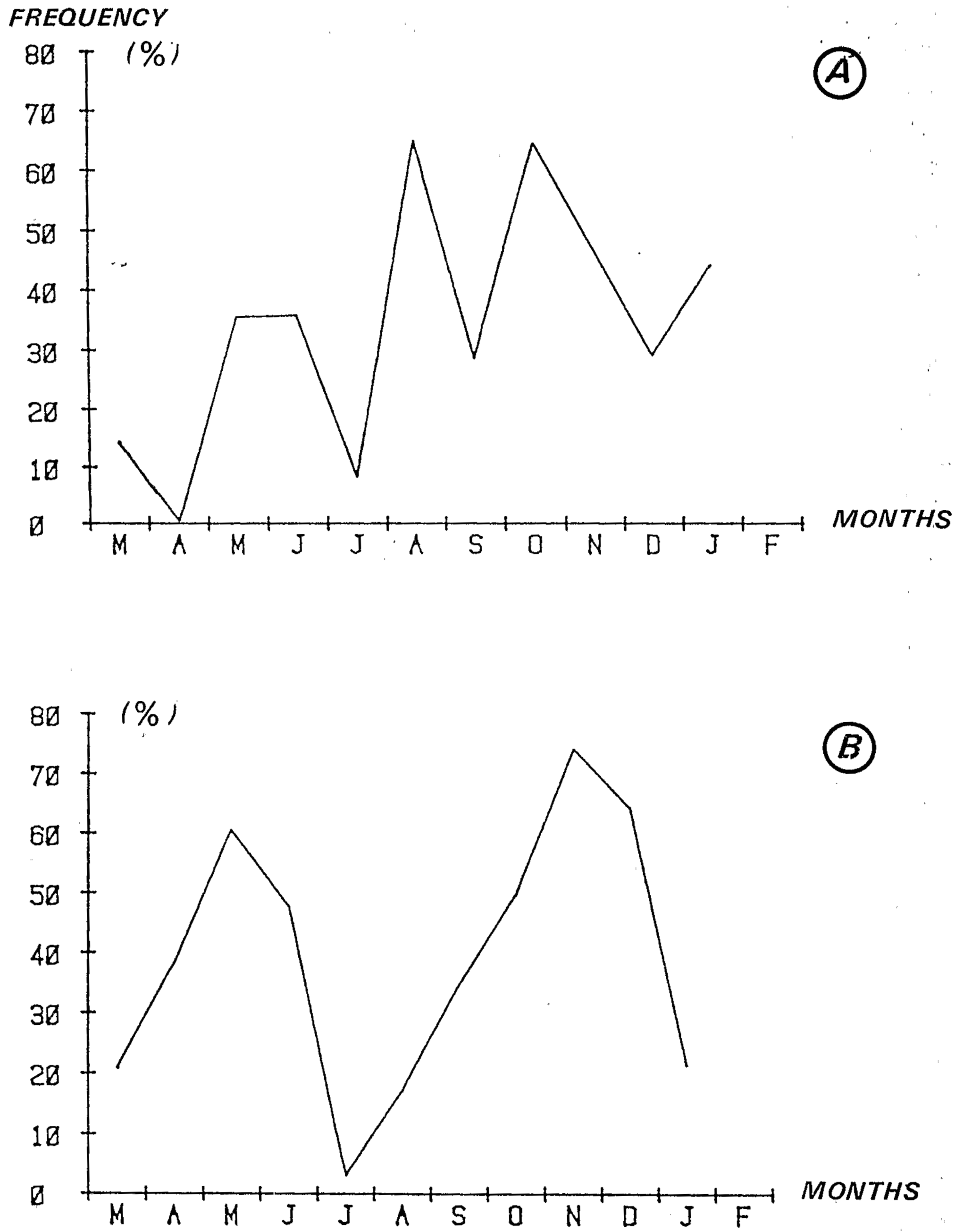


Figure 8: Frequency of stage V gonads.
A: <u>Herklotsichthys punctatus</u>
B: <u>Atherinomorus lacunosus</u>

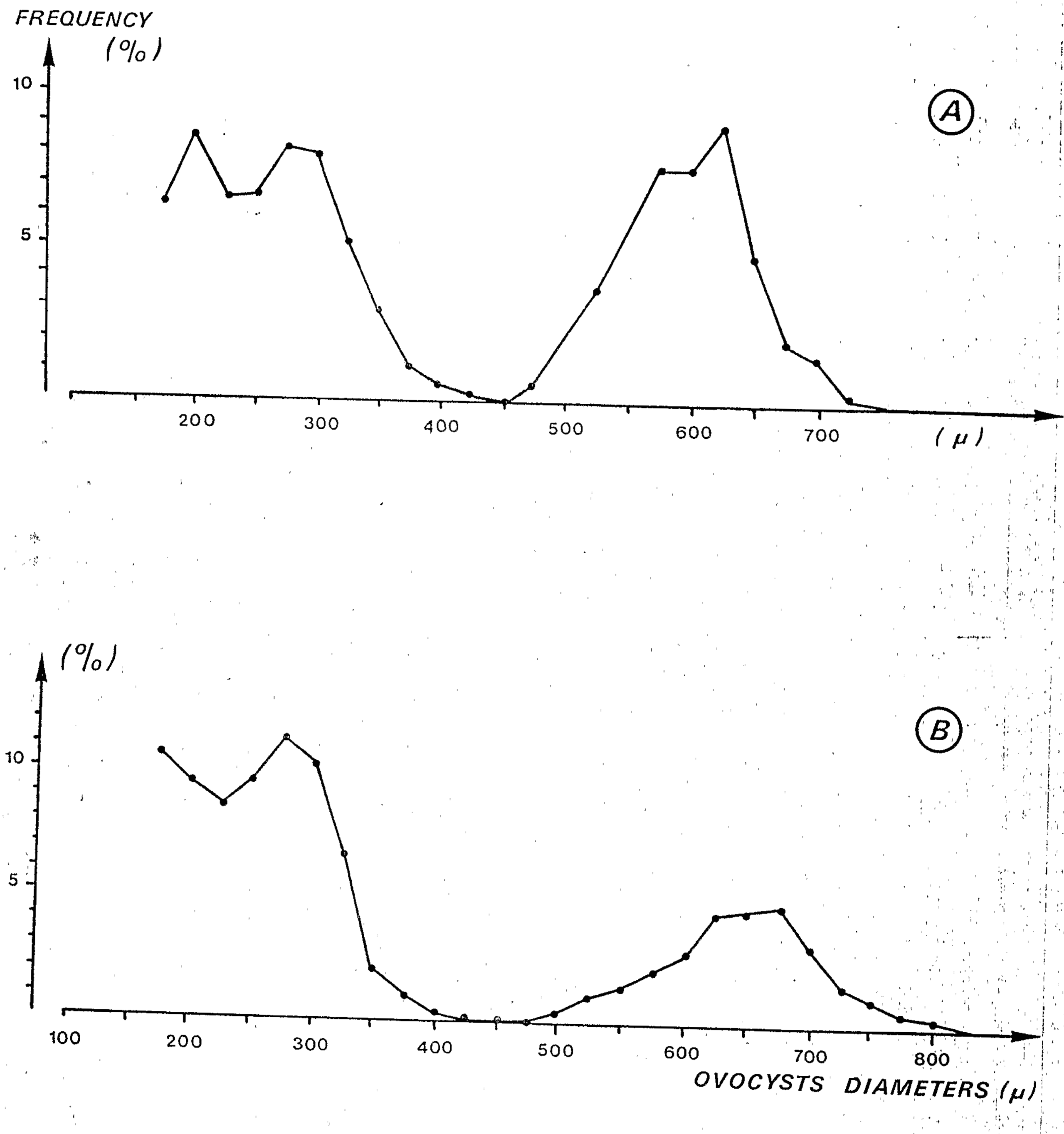


Figure 9: Ovocysts diameters distribution in the stage V gonads

A : Herklotsichthys punctatus

B : Atherinomorus lacunosus

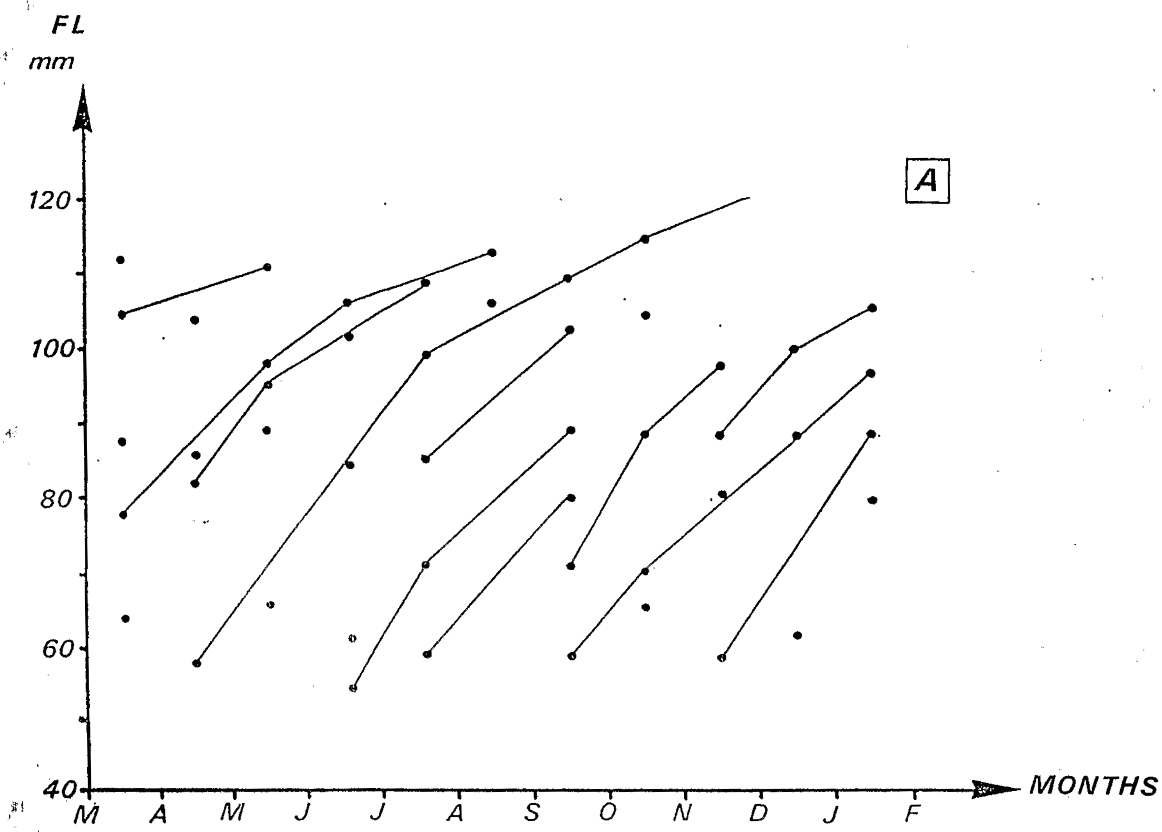


Figure 10 : Size mode relationship

A : <u>Herklotsichthys punctatus</u>

B : <u>Atherinomorus lacunosus</u>