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# REPRODUCTION, AGE AND GROWTH OF THE ROUND SCAD *Decapterus macrosoma* Blecker 1851, Carangidae FROM MOZAMBIQUE

by

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SUMMARY

ABSTRACT

Reproduction, age and growth of D. macrosoma Blecker, 1851 were studied. The data were collected in Sofala Bank from commercial bottom trawlers and surveys. A total of 5 400 individuals were examined during the period 1979--1982.

The species is caught in the same areas as D. russellii, but appears in lower quantities. Two main spawning periods a year, one in December-February and another one in June-September were found. Ageing was determined by counting daily growth rings in the otoliths. The parameter of the von Bertalanffy's growth equation were $L_\infty$ = 26 cm and K = 0,6 year $^{-1}$. Males and females seem to grow at the same rate.

RESUMO

Foi estudada a reprodução, idade e crescimento de D. macrosoma Blecker, 1851. Os dados foram colhidos no Banco de Sofala pelos arrastões comerciais e cruzeiros de investigação. No período de 1979-1982 foram analisados 5 400 indivíduos.

Esta espécie é capturada nas mesmas áreas em que ocorre D. russellii, embora em menores quantidades. Foram identificados dois períodos de desova por ano, um de Dezembro a Fevereiro e outro de Junho a Setembro. A idade foi determinada pela técnica de contagem dos anéis de crescimento diário nos otólitos. Os parâmetros de crescimento da equação de von Bertalanffy foram $L_\infty$ = 26 cm e K = 0,6 ano $^{-1}$. Os machos e as fêmeas têm a mesma taxa de crescimento.

## INTRODUCTION

The round scad, Decapterus macrosoma, is one of the commercially exploited fish species off Mozambique. For the years 1981-83 it made up about 10% of the total catch at the Sofala Bank. This quantity was exceeded only by D. russellii and Rastrelliger kanagurta. At Boa-Paz the catches were somewhat lower, around 5%.

D. macrosoma is a wide-spread species found in coastal waters throughout most of the tropical Indo-Pacific region ( Tiews et al. 1970, Ronquillo 1974). In Mozambique it is commonly caught from Boa-Paz to Angoche (Saetre and Paula e Silva 1979) and it probably occurs further to the north as it is also common off Tanzania (Iversen et al. 1984).

Some aspects of the biology, mainly growth, of D. macrosoma from the Phillipines have been summarized by Tiews et al. (1970), Ronquillo (1974), Anon.(1978), Ingles and Pauly (1985) and Corpus et al. (1986). Some biological data from Mozambique have been included in papers by Borges, Gislason and Sousa (1984) and Sousa and Gjøsaeter (1986).

The present paper is based on material collected from the commercial fisheries in the Sofala Bank area (Fig. 1) and from some surveys with research vessels in the same area. The main objectives are to present information on age, growth, reproduction and other characteristics important for a rational management of this species.

## MATERIAL AND METHODS

### Collection of data

Since 1979 samples of scad and mackerel have been collected onboard the commercial vessels on a daily basis. Records of length measurements, weight, sex and maturity stages were taken and the otoliths of some fish extracted. The method used is described in Gjøsaeter and Sousa (1983) p. 86 to 88.

In addition samples were also collected during several surveys.

From March 1979 to January 1982 a total of 5 400 individuals of D. macrosoma from Sofala Bank were examined.

Ageing by growth rings in the otoliths

Otoliths were extracted in the way described by Gjøsaeter and Sousa (1983) p. 87. A total of 50 otoliths of fish of size from 14.1 to 20.5 cm were used for growth studies.

The method of preparing and reading the otoliths is described by Gjøsaeter and Sousa (1983) p. 88.

Otoliths of round scad are thin and about 4,5 mm long in medium sized fish. They have a rostrum and a smaller antirostrum and the opposite edge is rounded.

The growth curve was fitted to age length data using the least square method (Allen 1966).

Gonad development

Gonad development was studied by the observation of maturity stages and by gonadosomatic index (GSI = gonad weight/total weight x 100).

The scale of maturity stages used is indicated by Gjøsaeter and Sousa 1983. Appendix I.

RESULTS

Length weight relationship

The length-weight relationship was studied based on about 2 000 specimens with length 15.3-22.5 cm collected from the commercial fisheries between February and December 1980. The regression obtained by using $lg_{10}$-transformation was

$$lgW = 3.258\ lg\ l - 2.417 \text{ or}$$
$$W = 3.828 \times 10^{-3}.l^{3.258}$$

where W is weight in grams and l is fork-length in centimeters. The coefficient of determination $r^2 = 0.89$. Similar estimates for the individual months are given in Table 1.

Reproduction

A good correlation was found between the gonadosomatic index (GSI) and the subjectively identified maturity stages (Fig. 2). The highest values for gonadosamatic index was found in stage IV (mature). The lower index found in stage V (spawning) indicate that at least part of those fishes classified as spawning have shed eggs or sperms. Similar observations were made in the closely related D. russellii (Gjøsaeter and Sousa 1983).

The gonadosomatic index for fish caught in the commercial fisheries at the Sofala Bank during 1979, 1980 and 1981 is shown in Fig. 3. The distribution of maturity stages from the same fishery is given in Table 2. Although the distribution of maturity stages suggests some spawning and spent fishes to be present over most of the year, both maturity stages and gonadosomatic indexes show that there are two spawning peaks. One of these occurs during the first months of the year, and may even start in December (1979). The other one seems to occur between June and September. The data available do not permit an assessment of the relative importance of the two spawning periods, or of the importance of the recruitment originating from them.

Data from scientific cruises in the same area are presented in Table 3 and 4. The information is too sparse to give an independent picture of the maturation cycles, but does not contradict the conclusions drawn from the commercial samples.

The data suggest that D. macrosoma spawn slightly before, or simultaneously with D. russellii (see Gjøsaeter and Sousa 1983).

Age and growth

The otoliths of D. macrosoma are similar to those of D. russellii in size and appearance (Gjøsaeter and Sousa 1983). The rings interpreted as daily growth marks were laid down in regular groups of 2 or 3 rings in the central

part of the otolith. After about 2 months, the structure changed, and groupings, often consisting of 7 or 14 rings were found. When reaching an age of 1-1.5 years the structure changed again, this time to densely packed narrow rings without any superimposed pattern.

The number of rings were counted in otoliths from 50 specimens of D. macrosoma caught by commercial bottom trawlers at the Sofala Bank. The fish ranged in total length from 14.1 to 20.5 cm, and the number of rings counted from 412 to 990 (Fig. 4). The small fish were not caught, and from the youngest age groups probably only the largest specimens were caught. This is because of the behaviour of the fish and the selectivity of the gears used (Sousa 1986).
Because of this bias the growth curve could not be fitted directly as it would give an unrealistic high negative $t_o$ and low growth coefficient, K. To overcome the problem $t_o$ was set to 0, although this procedure will probably underestimate the $L_\infty$ and overestimate the K of the population.

The resulting equation was

$$l_t = 26 \text{ cm } (1 - e^{-0.6t})$$

DISCUSSION

The reproduction periods deduced from the present material, one in January--March and another one in June-September is in good accordance with those found by Chullasorn and Yusukswad (1977) for fish taken in the Gulf of Thailand.

The time of spawning also fits closely with the spawning of D. russellii in Mozambican waters or possibly D. macrosoma spawn slightly before D. russellii (Gjøsaeter and Sousa 1983). In Plillipine waters Ingles and Pauly (1984) and Corpuz et al. (1985) estimated recruitment patterns by projecting growth curves obtained by Elefan programs (Pauly and David 1981) backwards. The results are highly variable, sometimes giving one protracted period and sometimes two peaks.

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Table 1 - Length-weight relationship for D. macrosoma from commercial catches 1980. Parameters a and b from predictive regression log W = a + b log L and the corresponding coefficient of determination $r^2$.

| Month | n | a | b | $r^2$ | Size range (cm) |
|---|---|---|---|---|---|
| January | | | | | |
| February | 302 | -1.487 | 2.541 | 0.69 | 16.4-20.5 |
| March | 246 | -3.110 | 3.819 | 0.89 | 16.2-22.2 |
| April | 165 | -1.734 | 2.719 | 0.84 | 15.9-20.8 |
| May | | | | | |
| June | 60 | -2.076 | 2.993 | 0.93 | 15.6-20.9 |
| July | 428 | -2.254 | 3.135 | 0.86 | 15.6-21.7 |
| August | 79 | -1.228 | 2.334 | 0.81 | 16.1-21.4 |
| September | 89 | -1.594 | 2.625 | 0.82 | 16.3-21.0 |
| October | 210 | -2.221 | 3.078 | 0.97 | 13.3-22.3 |
| November | 107 | -2.386 | 3.221 | 0.92 | 15.3-21.2 |
| December | 269 | -2.358 | 3.193 | 0.91 | 15.322.5 |
| TOTAL | 1955 | -2.417 | 3.258 | 0.89 | 15.3-22.5 |

Table 2 - Monthly relative percentage of maturity stages by sex of D. Macrosoma during 1979, 1980 and 1981.

| | Females | | | | | | | Males | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | n | I | II | III | IV | V | VI | n |
| 1979 | | | | | | | | | | | | | | |
| January | | | | | | | | | | | | | | |
| February | | | | | | | | | | | | | | |
| March | 19.4 | 8.5. | 38.2 | 20.0 | 12.7 | 1.2 | 165 | 11.9 | 6.3 | 20.2 | 32.0 | 27.3 | 2.4 | 253 |
| April | 4.2 | 17.7 | 41.7 | 30.2 | 6.3 | - | 96 | 3.0 | 3.0 | 23.2 | 57.6 | 13.1 | - | 99 |
| May | | | | | | | | | | | | | | |
| June | | 14.7 | 0.9 | 6.0 | 49.1 | 29.3 | 116 | 1.7 | 3.4 | 1.7 | - | 89.8 | 3.4 | 59 |
| July | | 0.4 | 0.4 | 7.7 | 61.4 | 30.1 | 259 | | | 0.6 | 5.5 | 86.0 | 7.9 | 164 |
| August | | | 8.9 | 11.1 | 71.1 | 8.9 | 45 | | | | 6.2 | 93.8 | | 32 |
| September | | | | | | | | | | | | | | |
| October | | | | | | | | | | | | | | |
| November | | | | | | | | | | | | | | |
| December | 12.1 | 21.0 | 22.6 | 28.2 | 15.3 | 0.8 | 124 | 5.0 | 15.8 | 11.9 | 43.6 | 23.8 | - | 101 |
| 1980 | | | | | | | | | | | | | | |
| January | | | | | | | | | | | | | | |
| February | | 0.6 | 7.0 | 3.8 | 84.7 | 3.8 | 157 | | | 2.1 | 0.7 | 95.9 | 1.4 | 145 |
| March | | 8.2 | | | 43.6 | 48.2 | 110 | | | | | 77.4 | 22.6 | 106 |
| April | 48.9 | 20.7 | | | 6.5 | 23.9 | 92 | 5.1 | 1.7 | | | 11.9 | 81.4 | 59 |
| May | | | | | | | | | | | | | | |
| June | 3.7 | 14.8 | 40.7 | 29.6 | 1.1 | | 27 | | 6.2 | 50.0 | 37.5 | 6.2 | | 32 |
| July | 2.4 | 11.6 | 18.4 | 27.6 | 27.2 | 12.8 | 250 | | 2.5 | 24.1 | 34.6 | 32.5 | 6.3 | 237 |
| August | | 3.4 | 5.2 | 10.3 | 65.5 | 15.5 | 58 | | | | 9.5 | 90.5 | | 21 |
| September | 3.6 | 5.4 | | 29.1 | 56.4 | 5.5 | 55 | | | | 24.2 | 75.8 | | 33 |
| October | 25.0 | 0.7 | 2.0 | | 15.1 | 57.2 | 152 | 46.4 | 4.4 | | | 20.3 | 29.0 | 69 |
| November | 48.9 | 5.6 | 4.4 | | 8.9 | 32.2 | 90 | 40.0 | 23.6 | 3.6 | | 12.7 | 20.0 | 55 |
| December | 51.0 | 7.0 | | 1.0 | 21.0 | 20.0 | 100 | 28.7 | 5.3 | 1.1 | | 34.0 | 30.9 | 94 |
| 1981 | | | | | | | | | | | | | | |
| January | 29.4 | 9.2 | 7.6 | 0.5 | 33.7 | 19.6 | 184 | 10.8 | 5.4 | 8.1 | | 46.6 | 29.1 | 148 |
| February | 41.1 | 5.4 | 1.8 | 5.4 | 28.6 | 17.9 | 56 | 10.4 | 3.9 | | 1.3 | 59.7 | 24.7 | 77 |
| March | 10.5 | | | | 10.5 | 79.0 | 19 | 44.7 | 39.5 | 2.6 | | 2.6 | 10.5 | 38 |
| April | 29.4 | 52.9 | | | | 17.7 | 17 | 28.6 | 64.3 | 7.1 | | | | 14 |
| May | 77.2 | 18.3 | | | | 4.5 | 224 | 46.3 | 45.4 | 3.2 | | 1.4 | 3.7 | 216 |
| June | | | | | | | | | | | | | | |
| July | | | | | | | | | | | | | | |
| August | | 2.1 | | 3.2 | 59.0 | 35.8 | 190 | | | | 8.2 | 88.9 | 3.0 | 135 |
| September | | | | | | | | | | | | | | |
| October | | | | | | | | | | | | | | |
| November | | | | | | | | | | | | | | |
| December | 0.5 | 36.6 | 0.5 | 0.5 | 36.6 | 25.3 | 202 | 0.4 | 14.1 | 0.4 | 1.3 | 75.2 | 8.6 | 234 |
| 1982 | | | | | | | | | | | | | | |
| January | | 12.9 | | | 35.7 | 51.4 | 70 | | 6.1 | | | 69.7 | 24.2 | 99 |
| February | | | | | | | | | | | | | | |

Table 3 - Relative percentage of maturity stages by sex of D.macrosoma caught during some surveys.

| | Female | | | | | | | Males | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | n | I | II | III | IV | V | VI | n |
| 1981 | | | | | | | | | | | | | | |
| S. Kadanchik (21/04-17/05) | 53.3 | 34.9 | 2.2 | - | 4.4 | 5.2 | 229 | 41.5 | 42.6 | 7.7 | 1.1 | 1.6 | 5.5 | 183 |
| Pegago IV (22/05-12/06) | 36.3 | 55.8 | 0.9 | - | 6.2 | 0.9 | 113 | 21.8 | 46.8 | 11.3 | 3.2 | 13.7 | 3.2 | 124 |
| Pantikapey (7/06-23/06) | 62.5 | 33.3 | | | | 4.2 | 24 | 75.0 | 16.7 | | | | 8.3 | 24 |
| 1982 | | | | | | | | | | | | | | |
| Fr. Nansen (29/08-30/09) | | | 60.0 | 20.0 | 20.0 | | 5 | | | 100.0 | | | | 30 |
| S. Rybak (25/09-27/10) | | | 45.0 | 55.0 | | | 20 | | | 60.0 | 40.0 | | | 30 |
| S. Rybak (9/11-18/12) | | 91.7 | | | 4.2 | 4.2 | 24 | | 7.7 | | | 23.1 | 69.2 | 26 |

Table 4 - Mean gonadosomatic index and standard deviation of females of D.macrosoma caught during same survey.

| | $\overline{GSI}$ | s | n |
|---|---|---|---|
| 1981 | | | |
| S. Kadanchik (21/04-17/05) | 0.61 | 0.470 | 228 |
| Pegago IV (22/05-12/06) | 0.63 | 0.468 | 112 |
| Pantikapey (7/06-23/06) | 0.52 | 0.350 | 29 |

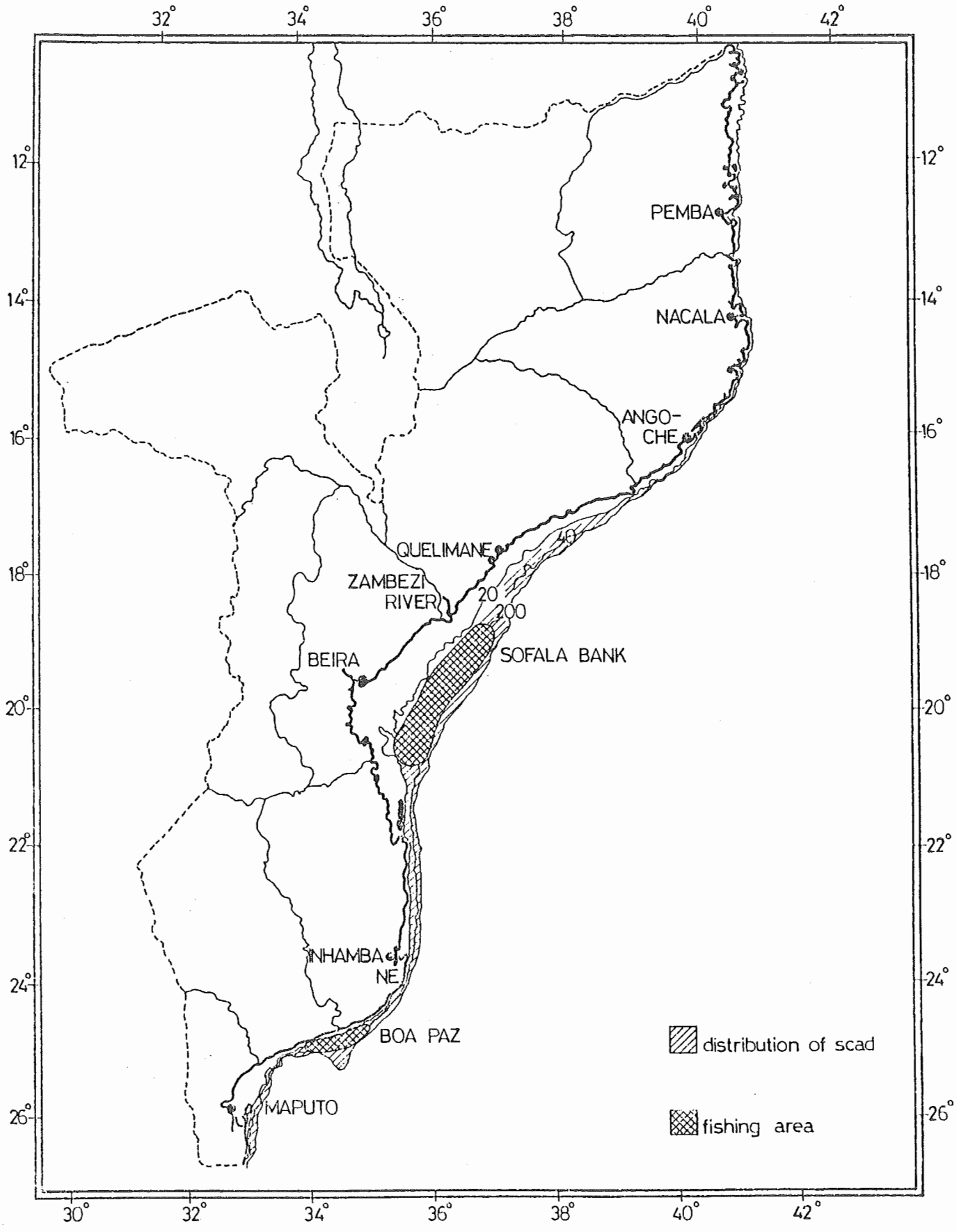


Fig. 1 Distribution and fishing areas of scad in Mozambican waters.

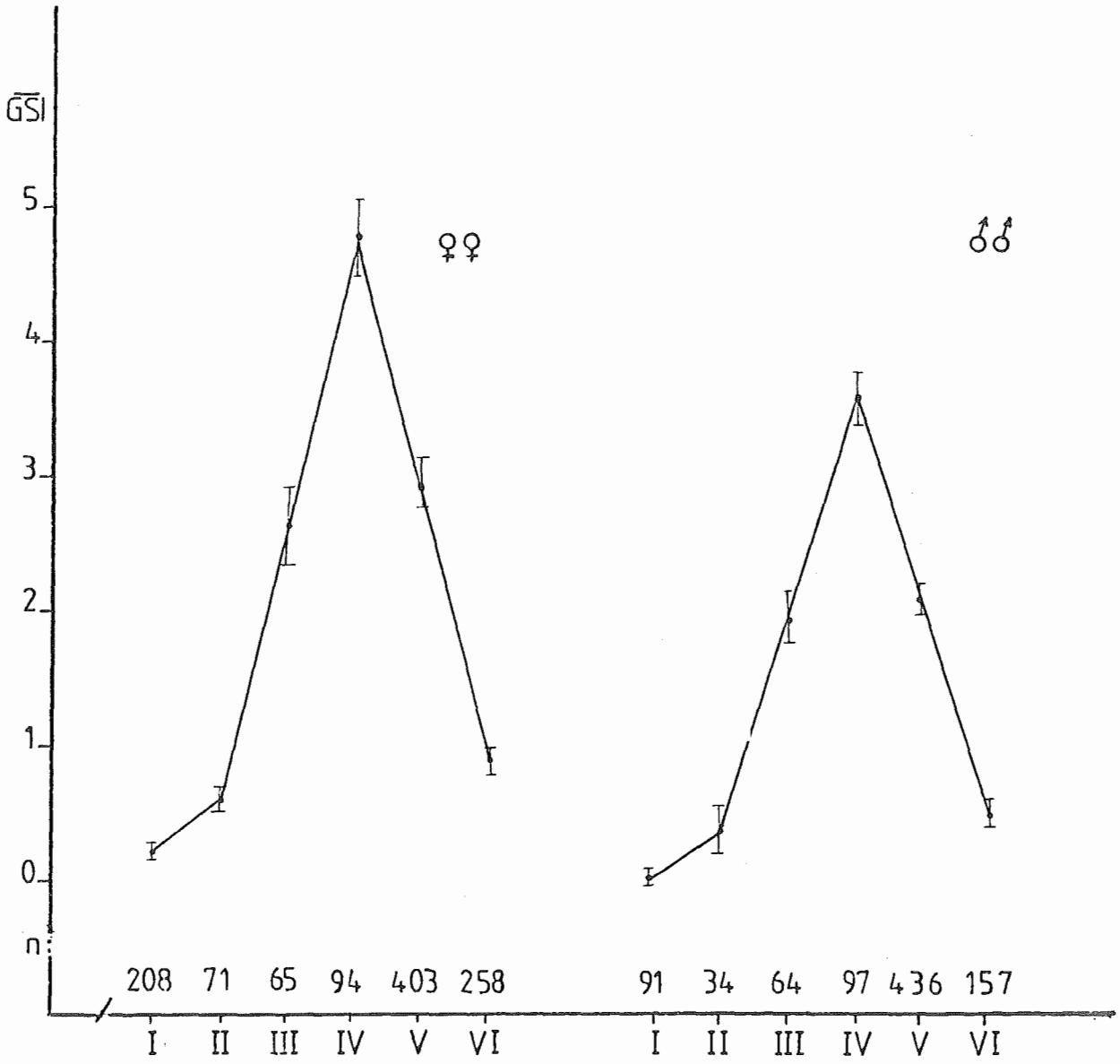


Fig. 2 Mean gonadosomatic index of D. macrosoma by maturity stages of males and females (verticals bars indicate 95% confidence limits).

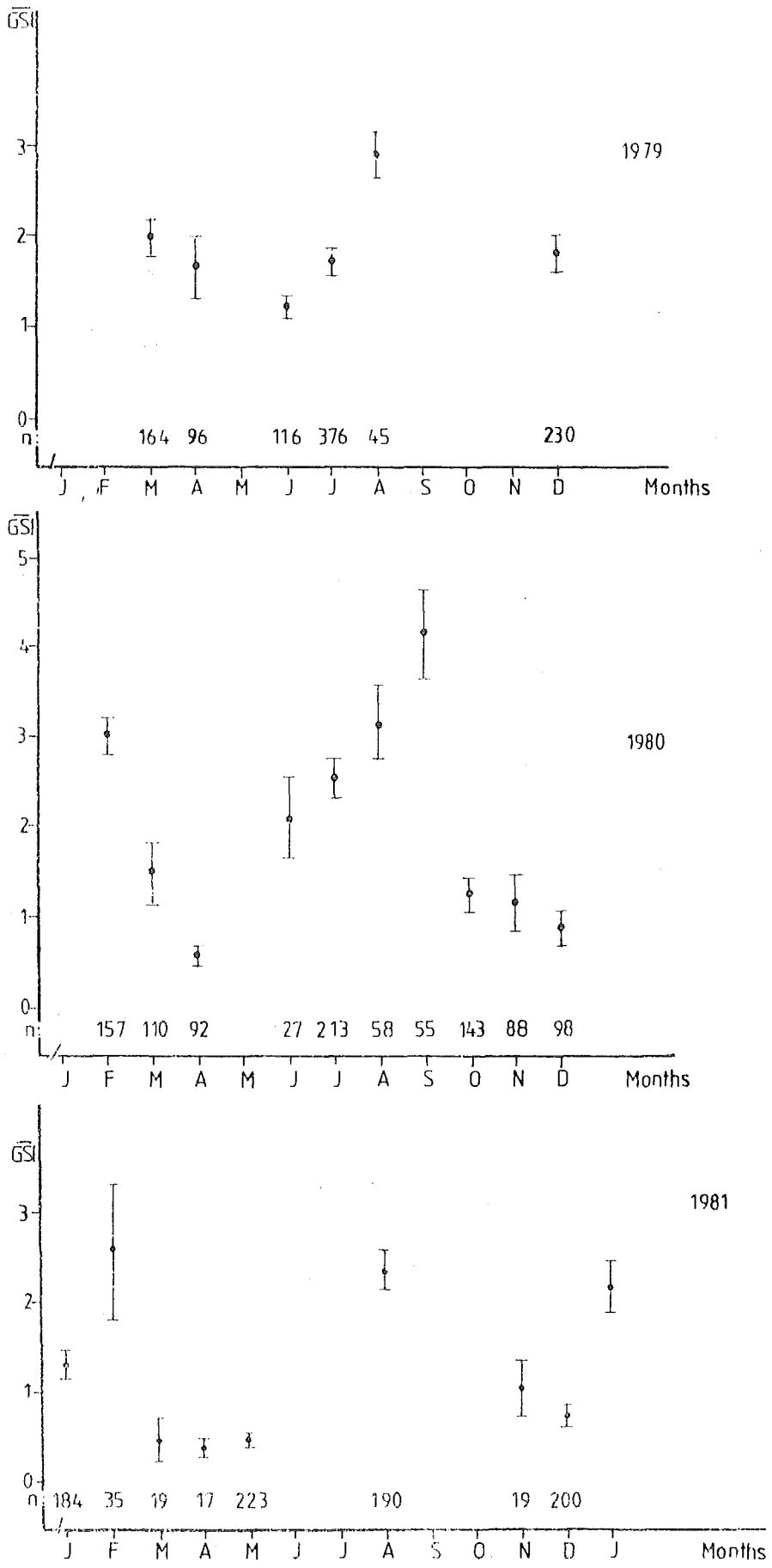


Fig. 3 Monthly mean gonadosomatic index of D. macrosoma during 1979, 1980 and 1981.

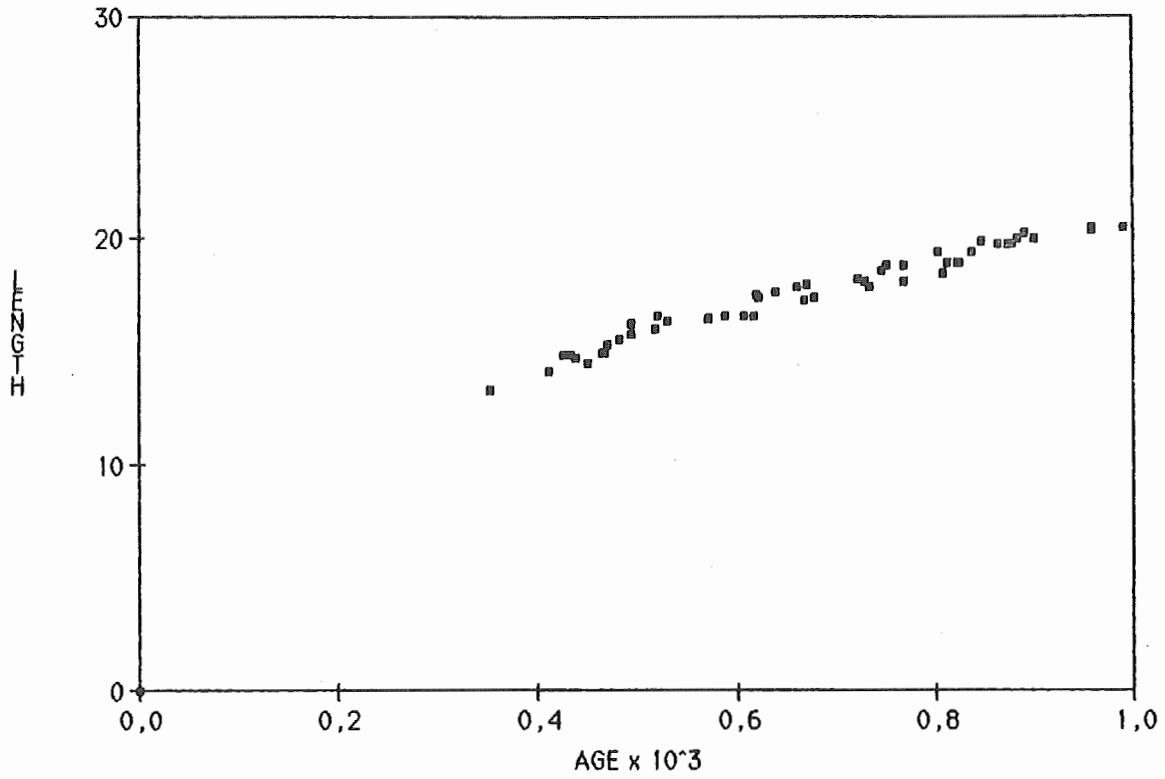


Fig. 4 Age and length of D.macrosoma