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REPRODUCTION ASPECTS OF SOME DEMERSAL FISHES CAPTURED IN AZORES ARCHIPELAGO

by

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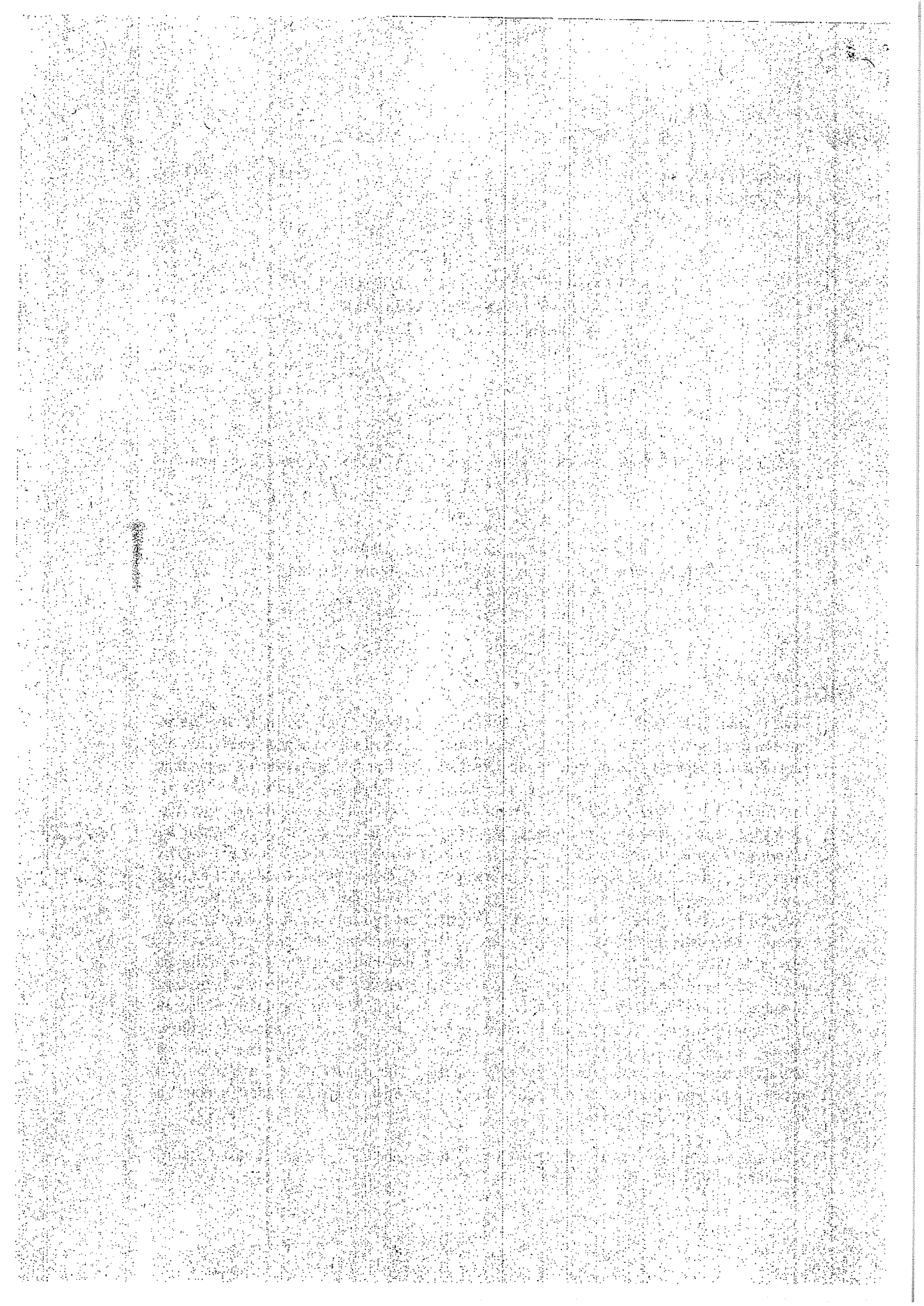
ABSTRACT

The insular resources specificity in Azores Archipelago and the little biological information available strengthens the importance of this study which concentrates on reproductive aspects of some marine demersal species. For this purpose nine important commercial species were studied: the red (blackspot) seabream (*Pagellus bogaraveo*), the forkbeard (*Phycis phycis*), the bluemouth (*Helicolenus dactylopterus*), the two alfonsinos (*Beryx splendens* and *Beryx decadactylus*), the yellow-orange scorpionfish (*Pontinus kuhlii*), the silver scabbardfish (*Lepidopus caudatus*), the red porgy (*Pagrus pagrus*) and the axillary seabream (*Pagellus acarne*) were obtained in the local market since 1985 and during the survey cruises of 1995,1996 and 1997 onboard the R/V ARQUIPÉLAGO. The sampling consisted in measure the total or fork lengths, total weight, liver weight, gonads weight, sex identification and definition of maturity stages. In order to achieved the lengths and ages of first maturity the maturation ogives were estimated using the Logistic or the Gompertz models according to the best fit obtained. These parameters were obtained for males and females separately and only for *Pagellus acarne* females. The gonadosomatic index was determined for those species which the reproductive period was unknown or less known. The sex-ratios were calculated and tested by chi-square analysis. The results were correlated with other studies and contributed to a better knowledge of the biology of these species in the Northeast Atlantic.

Keywords: age at first maturity, demersal fishes, gonosomatic index, length at first maturity, maturation ogive, reproduction, sex-ratio.



INTRODUCTION

Since 1982 a significant part of the resource developed in the Department of Oceanography and Fisheries, of the University of Azores, has been the study of the biology and ecology of demersal fishes of Azores in order to monitor the state of those stocks.

The purpose of this effort is due to the economic value involved and to an intensive exploration of this resources, associated to a reduced area of distribution, that is limited to the edge of the islands, banks and seamounts. These factors and also some biological characteristics like the hermaphroditism and the high longevity contribute for a particular sensibility of demersal species. These aspects justify the urgent necessity of understand the vulnerability of these species to the fisheries, providing an important biological information.

The aim of this work concerns with the study of several reproduction aspects of nine important commercial species from Azores: the red (blackspot) seabream (*Pagellus bogaraveo*), the forkbeard (*Phycis phycis*), the bluemouth (*Helicolenus dactylopterus*), the two alfonsinos (*Beryx splendens and Beryx decadactylus*), the yellow-orange scorpionfish (*Pontinus kuhlii*), the silver scabbardfish (*Lepidopus caudatus*), the red porgy (*Pagrus pagrus*) and the axillary seabream (*Pagellus acarne*).

MATERIALS AND METHODS

The samples of nine demersal species were collected in the local market since 1985 and during the survey cruises of 1995, 1996 and 1997 onboard the R/V ARQUIPELAGO.

The sex-ratios were calculated and tested by chi-square analysis for each species.

To access the lengths of first maturity (L_{50}) the maturation ogives were estimated applying the Gompertz or Logistic models for males and females separately. The age of first maturity was also obtained for both sexes.

The reproductive period was attained through the gonadosomatic index (GSI).

RESULTS AND DISCUSSION

Pagellus bogaraveo

Of a total of 2895 specimens examined, 1795 (62.0%) were males, 357 (16.6%) were females and 743 (25.7%) hermaphrodites. The overall ratio of males to females was 1:0.20 and X^2-test revealed significant differences from 1:1 ratio ($P<0.05$) as it was obtained for most size categories.

This species is characterised by a protandric hermaphroditism, however can appear individuals that never sexually invert and are permanent males or females during the entire life [1,2]. For males it was obtained a L_{50} (Figure 1) similar to the value observed for the period 1982-83, but smaller than the results achieved for the period of 1984-86 and 1991. For the same periods females showed always higher L_{50} (Figure 1) than the data revealed in the present work. It also seemed that the ages of L_{50} decreased in 1 year for both sexes relatively to the data of 1991 [2].

In Azores the reproductive period occur during winter, Jan.-Apr., with maximum of activity in Feb. and Mar. [1,2]. This species reveal the same period in Cantabric Sea [3].

Phycis phycis

Of a total of 826 specimens examined, 444 (53.7%) were males and 382 (46.3%) females. The overall ratio of males to females was 1:0.860 and X^2-test revealed a significant differences from 1:1 ratio ($P<0.05$). For most size classes no significant differences (X^2-test, $P>0.05$) were observed.
Comparing the present data (Figure 2) with the values obtained for the period 1983-86[4], males suffered an increase and females a slight decrease in lengths of first maturity, although the respective ages did not revealed significant changes.
Between 1983-86 [4] it was verified that spawning takes place during Dec.-Feb. with peak in January. Besides this period, the present work (Figures 3, 4) made evident two peaks taking place during summer. However these recent results need further confirmation, increasing the number of monthly samples, mainly during summer.

Helicolenus dactylopterus

Of the 2293 fish examined, 1235 (53.9%) were males and 1058 (46.1%) females. The overall ratio of males to females was 1:0.86 and X^2-test revealed significant differences from 1:1 ratio ($P<0.05$) as it was obtained for half of length classes.
During 1985-88 [5] a similar length of first maturity was achieved for females, however for males it was observed a great distance from the present value (Figure 5). Some conformity seems to exist between the ages of L_{50} achieved for both sexes and the ages obtained for the same period.
This species is a partial spawner, with internal fertilization occurring at Jun.-Oct. and spawning at Jan.-Apr./May. A notable feature of the females is the retention of sperm inside for a long period, reaching 6-7 months, until start spawning [5]. This reproductive behaviour seems well correlate with the results obtained, although being represented only for 8 months (Figures 6, 7).

Beryx splendens

Of the 806 individuals examined 359 (45%) were males and 447 (55%) females. The overall ratio of males to females was 1:1.25. The X^2-test revealed a significant departure from 1:1 ratio. Females predominated in almost all length classes. Sex-ratios for males and females had no significant departure from 1:1 ratio (X^2-test $P>0.05$) for most size classes.
The L_{50} obtained for females and males were similar (Figure 8). This results are very similar to those published for Azores [6]. However the age at L_{50} is higher in both sexes (3.4 years for males and 4.3 years for females) [6] due to the difference in the growth curves of the two studies. The results are concordant with Masuzawa *in* [7] in Japanese waters (4 years). However in the Atlantic, Pacific and Indian Oceans, most alfonsino attain sexual maturity at 5-6 years though a few are mature at 2 years [8].
In Azores sea the females GSI indicates a tendency to be higher from the late Summer, through Autumn and Winter (Jan./Feb.). For males, this index suggested a protracted spawning season from Sep. to Mar./Apr. [6]. A deeper study on the reproductive behaviour of this alfonsino is necessary to reconfirm this results.

Beryx decadactylus

Of a total of 355 individuals, 149 (42%) were males and 206 (58%) females. The overall ratio of males to females was 1:1.38 and X^2-test revealed a significant departure from 1:1 ratio ($P<0.05$). Sex-ratios for males and females had no significant differences from 1:1 ratio (X^2-test, $P>0.05$) for most size categories.
The L_{50} obtained for females is higher than the results from the period 1991-93 although L_{50} achieved for males was similar [6] (Figure 9). The age at L_{50} found for both sexes is similar in the two studies.
The GSI for males showed some tendency for a maximum between May and Jul. and a minimum between Aug. and Dec. Females GSI is of low amplitude and does not suggest any particular restricted period of spawning activity [6]. To have a better understanding of the reproductive behaviour of this species is important a reconfirmation of this results in future studies.

Pontinus kuhlii

Of a total of 456 specimens collected 166 (36%) were males and 290 (64%) females. The overall ratio of males to females was 1:1.75 and X^2-test revealed a significant departure from 1:1 ratio (X^2-test, $P>0.05$). In this study females are smaller than males so a sexual dimorphism seems to exist. This results are consistent with those observed during 1990-92 [6].
The L_{50} value obtained for males is greater than that achieved for females (Figure 10). This is expected due to the more frequency of males observed in larger lengths. The L_{50} found during 1990-92 [6] are much lower than the results attained in this study. The sexual dimorphism is also revealed by the differences between the males and females L_{50}.
In Azores this species spawns between Jun. and Nov. with a peak population level spawning between Jul. and Oct. [6].

Lepidopus caudatus

Of the 909 fish examined, 332 (36.5%) were males and 577 (63.5%) females. The overall ratio of males to females was 1:1.74 and X^2-test showed significant differences from 1:1 ratio ($P<0.05$) as it was verified for most size categories. Females predominated in the greatest size intervals.
This species is described for the Mediterranean Sea as a partial spawner with evidence of sexual dimorphism [9, 10]. In the present study the difference between the values of L_{50} revealed by females and males (Figure 11) also confirm a sexual dimorphism for Azores sea. The L_{50} and the ages obtained were very similar to those achieved for a monthly samples examined during 1994 [11]. The ages of L_{50} of specimens from Catalan Sea [10] are also not very distant from the present data.
The most important period for reproduction activity is from the mid-summer through the entire autumn (Figures 12, 13). A spawning peak is evident at Sep.-Nov. for males and Nov.-Dec. for females. A similar activity occurs in the Mediterranean and Adriatic Sea [9, 10, 12, 13].

Pagrus pagrus

Of a total of 1016 specimens examined, 451 (44.4%) were males, 339 (33.4%) were females and 226 (22.2%) hermaphrodites. The overall ratio of males to females was 1:0.75 and X^2-test revealed significant differences from 1:1 ratio ($P<0.05$). For most size categories no significant differences were evident (X^2-test, $p>0.05$).
To confirm the protogynous hermaphroditism of the species [14, 15, 16] the results indicate that females mature at smaller sizes than males (Figure 14). The values of L_{50} obtained were distinct from data observed in North Carolina [14] and from the southeastern USA[15]. Perhaps a value more approximately was attained for individuals from Canarias[17].
The most important spawning period occurs at Mar-May (Figures 15, 16), very similar to the spawning season of North Carolina [14].

Pagellus acarne

Of the 1176 individuals analysed, 813 (69%) were females, 327 (28%) were males and 36 (3%) hermaphrodites. The overall ratio of males to females was 1:2.49. The chi-square analysis revealed significant differences from 1:1 ratio (X^2-test, $P>0.05$). The global proportion between males and females is clearly favourable to females, mainly in the great length classes, while males predominated in the smallest. Several authors observed a protandric hemaphroditism for the species [18, 19, 20].
The L_{50} for males was not possible to determine. Probably they attain the maturity earlier than females so at inferior length classes. The estimated L_{50} of females (Figure 17) is similar to that revealed for Atlantic Northeast African waters [19], Mauritania (Kompowski *in* [19]) and South Morocco (Lamrini *in* [19]). However the estimated values for Canary Islands [18], Libyan (Mouneimné *in* [19]) and Mediterranean Sea [20] are lower.
The age at which 50% of females were mature is similar to the results obtained for Atlantic Northeast African waters [19], Canary Islands [18] and Mediterranean Sea [20].
This species seems to present a spawning season between Spring/early Summer months, however is important to confirm the tendency of IGS during the Summer months (Figures 18, 19). The same pattern seems to occur in Atlantic Northeast African waters [19], but not in Canary Islands (Oct.-Mar.) [18] and Mediterranean Sea (Jul.-Sep.) [20].

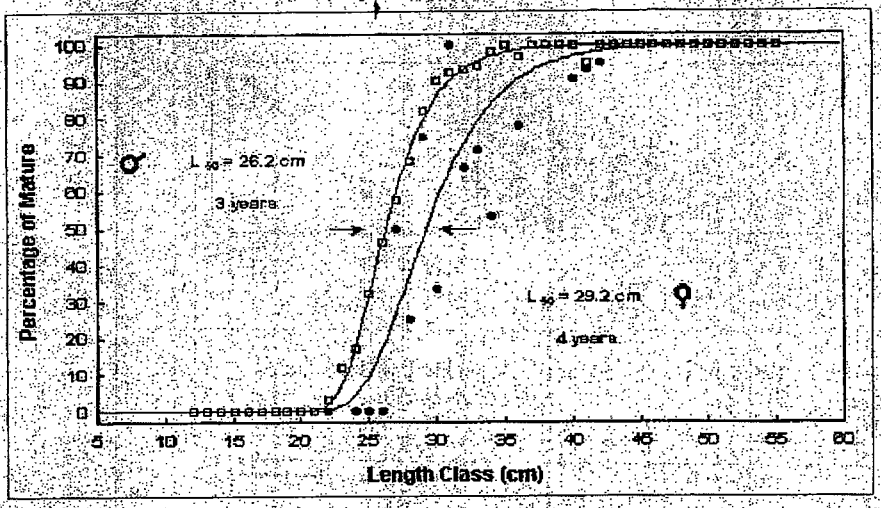


Figure 1 - Maturation ogive of males and females *Pagellus bogaraveo*.

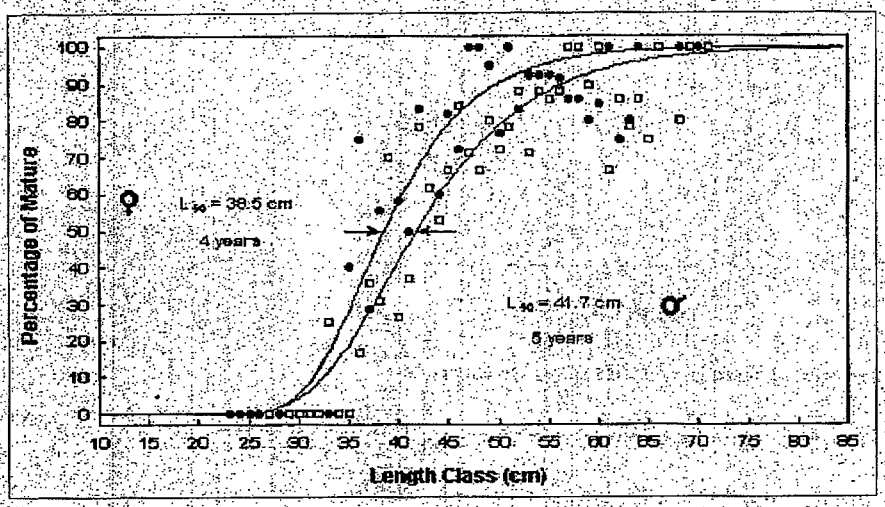


Figure 2 - Maturation ogive of males and females *Phycis phycis*.

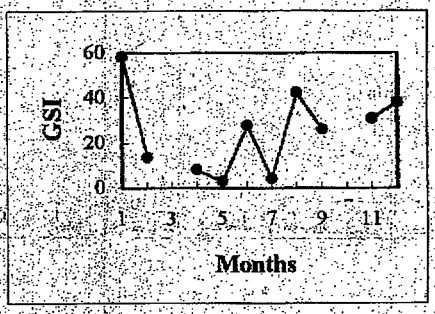


Figure 3 - Mean Monthly GSI of females *Phycis phycis*.

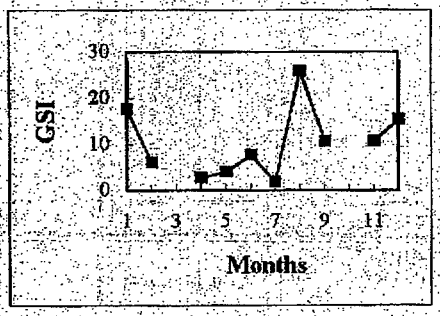


Figure 4 - Mean Monthly GSI of males *Phycis phycis*.

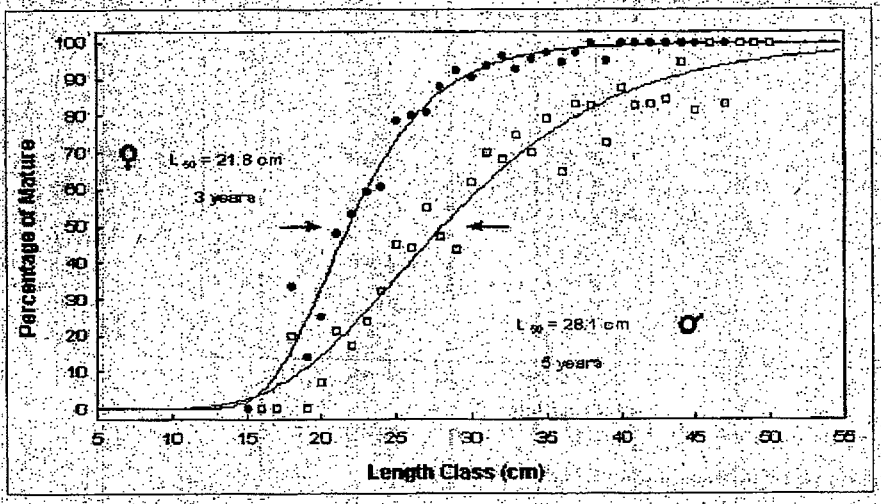


Figure 5 - Maturation ogive of males and females *Helicolenus dactylopterus*.

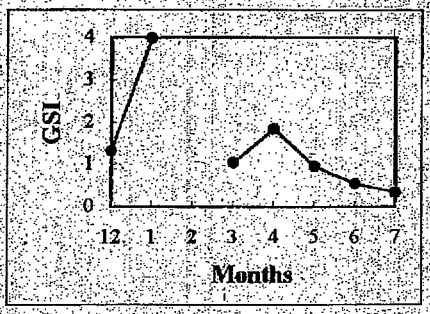


Figure 6 - Mean Monthly GSI of females *Helicolenus dactylopterus*.

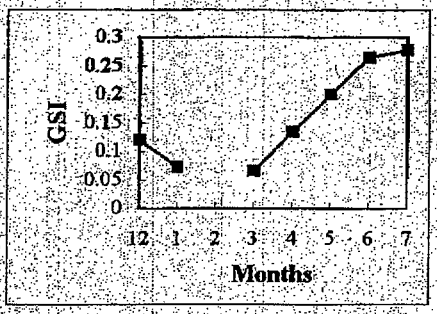


Figure 7 - Mean Monthly GSI of males *Helicolenus dactylopterus*.

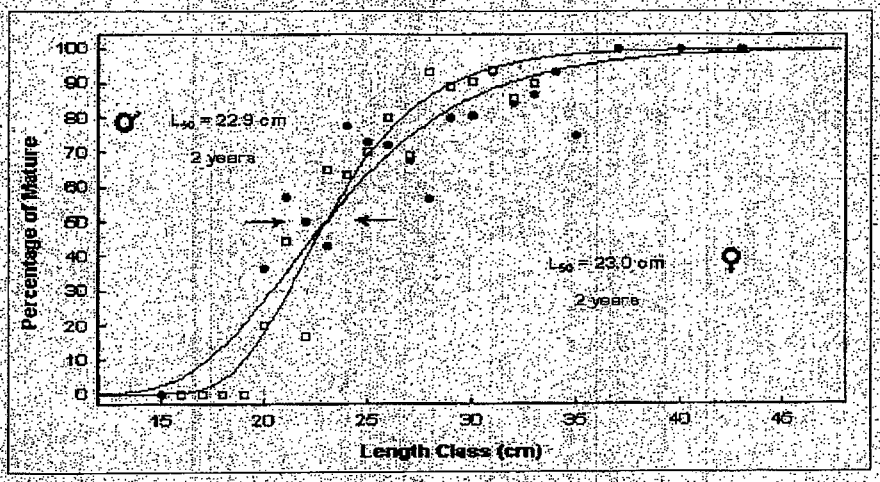


Figure 8 - Maturation ogive of males and females *Beryx splendens*.

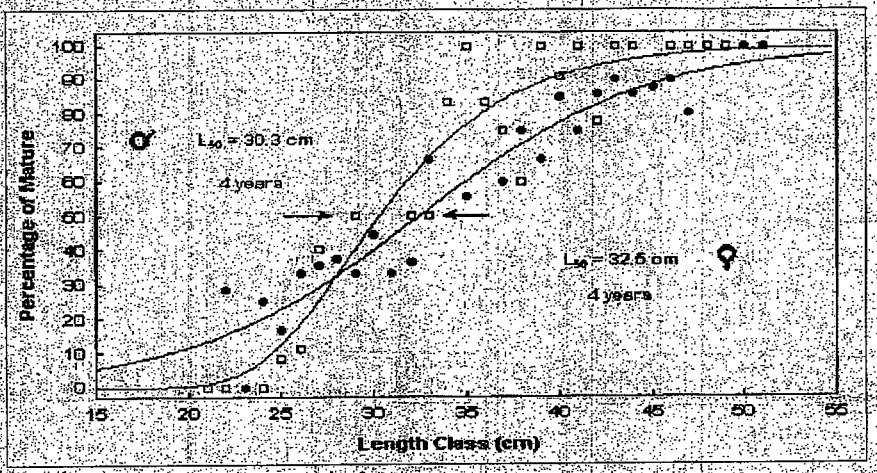


Figure 9 - Maturation ogive of males and females *Beryx decadactylus*.

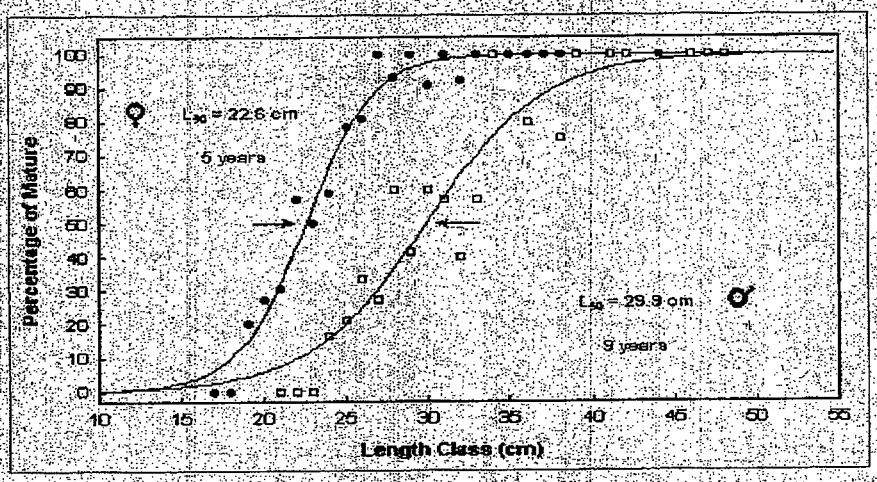


Figure 10 - Maturation ogive of males and females *Pontinus kuhlii*.

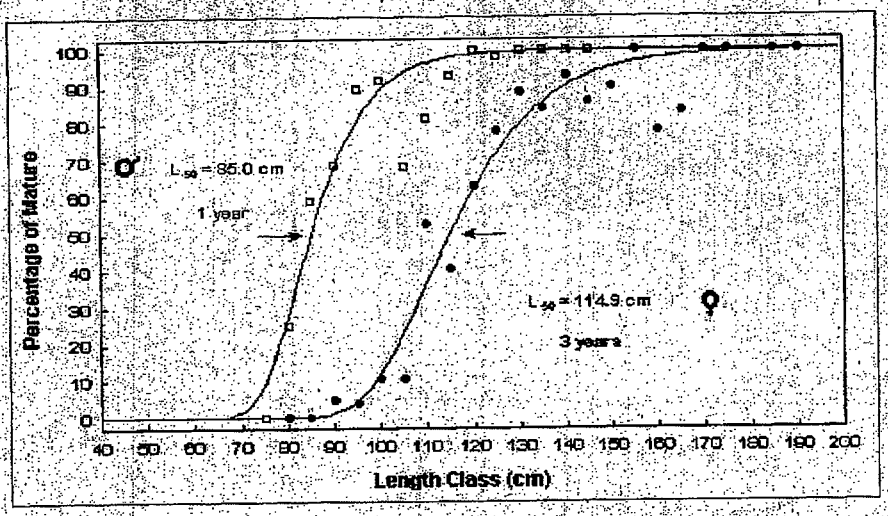


Figure 11 - Maturation ogive of males and females *Lepidopus caudatus*.

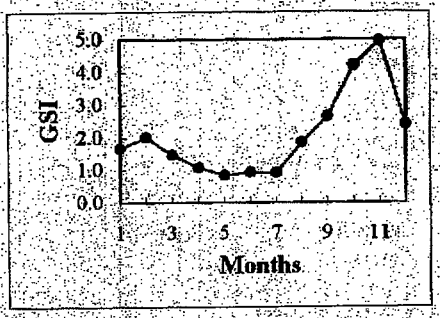


Figure 12 - Mean Monthly GSI of females *Lepidopus caudatus*.

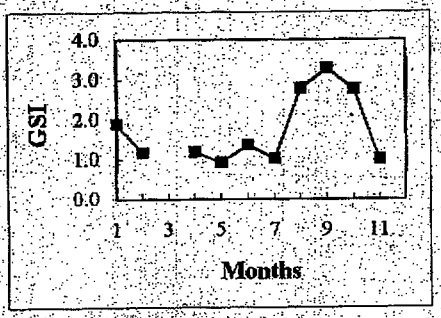


Figure 13 - Mean Monthly GSI of males *Lepidopus caudatus*.

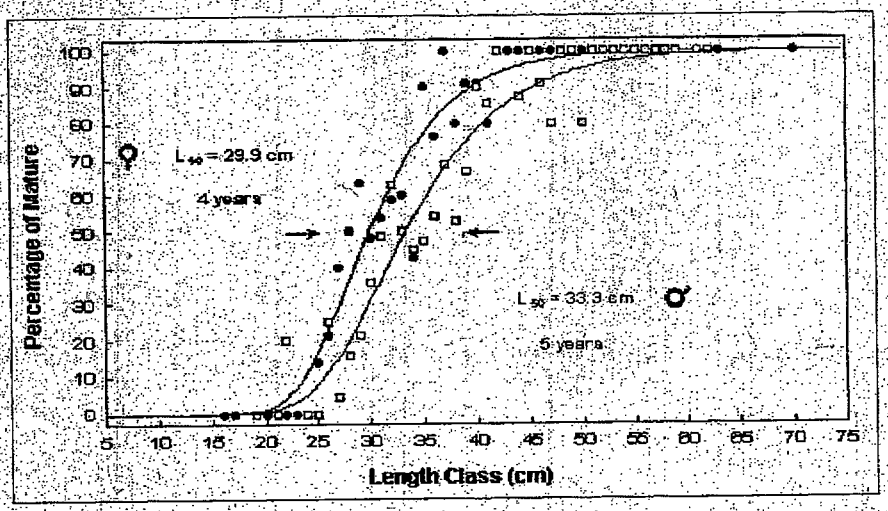


Figure 14 - Maturation ogive of males and females *Pagrus pagrus*.

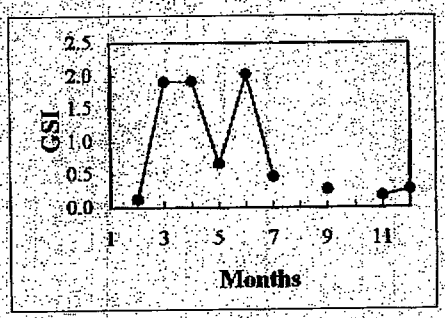


Figure 15 - Mean Monthly GSI of females *Pagrus pagrus*.

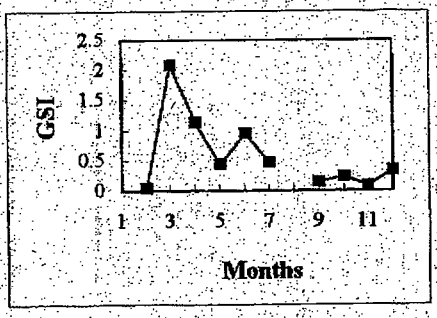


Figure 16 - Mean Monthly GSI of males *Pagrus pagrus*.

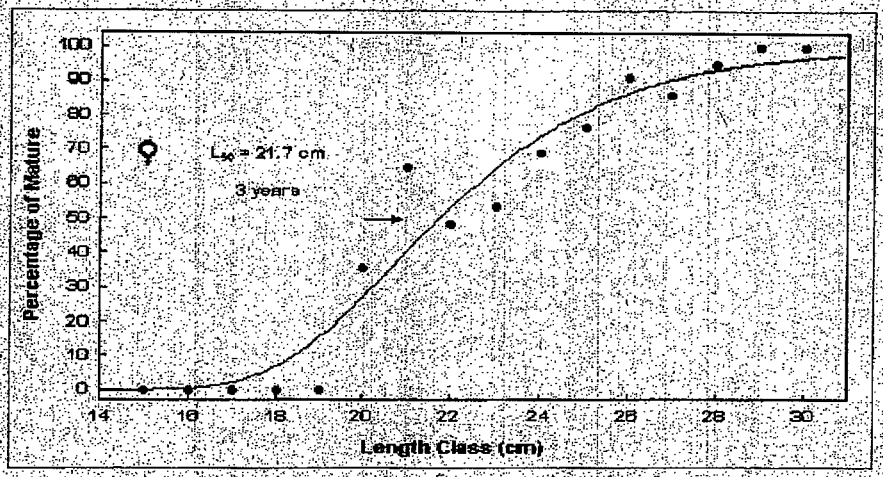


Figure 17 - Maturation ogive of females *Pagellus acarne*.

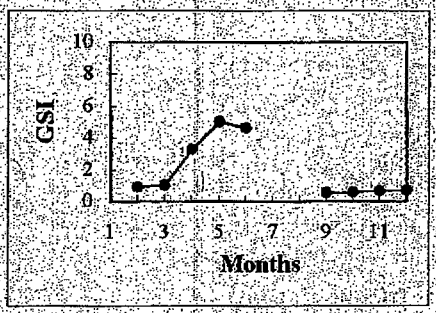


Figure 18 - Mean Monthly GSI of females *Pagellus acarne*.

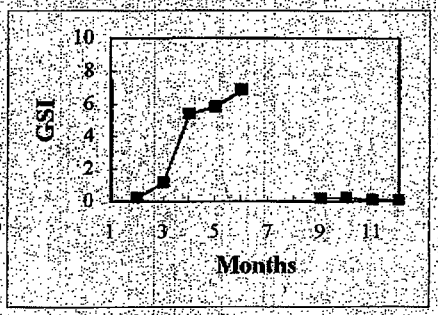


Figure 19 - Mean Monthly GSI of males *Pagellus acarne*.

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