Age and growth of some demersal species of the Azores

by

Helena Krug, Domitilia Rosa, Gui Menezes and Mário Pinho

Departamento e Oceanografia e Pescas
Universidade dos Açores
9900 Horta – Açores PORTUGAL
tel: 092 292988, fax: 092 292659, e-mail: hkrug@dop.uac.pt

ABSTRACT
Otoliths were used for age determination of nine demersal species of the 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*); data was from the 1995, 1996 and 1997 cruises. Analysis of length frequency for the same species were also done by the MULTIFAN method (data from 1993 to 1997 cruises) to reconfirm otolith reading results. Von Bertalanffy growth parameters were estimated from otolith and length frequency analysis. In all species studied the growth model derived from otolith increment counts is close to the MULTIFAN model except for those were significant differences were detected between males and females growth (*L. caudatus* and *P. kuhlii*).

Keywords: age and growth, demersal fishes, length frequency analysis, otoliths.

1. INTRODUCTION

Part of the work of the fisheries resources group of the Department of Oceanography and Fisheries of the University of the Azores is to monitor the state of exploitation of those stocks of marine fish that are important to the azorean fishery. For this purpose, it is necessary to obtain the age structure of the fish populations whenever deterministic models are to be applied. The present study was undertaken to determine the age and growth parameters of nine demersal species of the 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*). Age and growth estimates obtained from otolith-based techniques were compared with estimates based on length-frequency analyse.

2. OBJECTIVES

The main objectives of this contribution were: (1) to study growth by direct reading of the otoliths ; (2) to use length-based methods to check the validity of the growth studies done by direct reading;

3. MATERIAL AND METHODS

Otoliths were used for age determination, data was from the 1995, 1996 and 1997 cruise surveys. Analysis of length frequency for the same species were also done by the MULTIFAN method (data from 1993 to

1997 surveys). Von Bertalanffy growth parameters were estimated from otolith and length frequency analysis.

4. RESULTS AND DISCUSSION

Red (blackspot) seabream (*Pagellus bogaraveo*)

Table 1 - Parameters of the von Bertalanffy growth equations calculated for both sexes, by direct method and by MULTIFAN from this study, and published by other authors.

| AUTHOR	AREA		METHOD	Loo	K	to	N	PERIOD
*	Azores	Both sexes	Direct (otolith)	54,9	0,127	-1,83	597	1997
*	Azores	Both sexes	MULTIFAN	72,1	0,067	-3,43	4806	95-97
Castro 1989	VIII ICES	Both sexes	Direct (otolith)	54,2	0,174	-0,66	-	-
Alcaraz 1987	Asturias	Both sexes	Direct (otolith)	48,1	0,196	-0,47	-	-
Sanchez 1983	Cantabric	Both sexes	Direct (otolith)	51,6	0,209	-0,53	-	1982
Gueguen 1969	VII - VIII ICES	Both sexes	Direct (scales)	56,8	0,092	-2,92	-	66-68
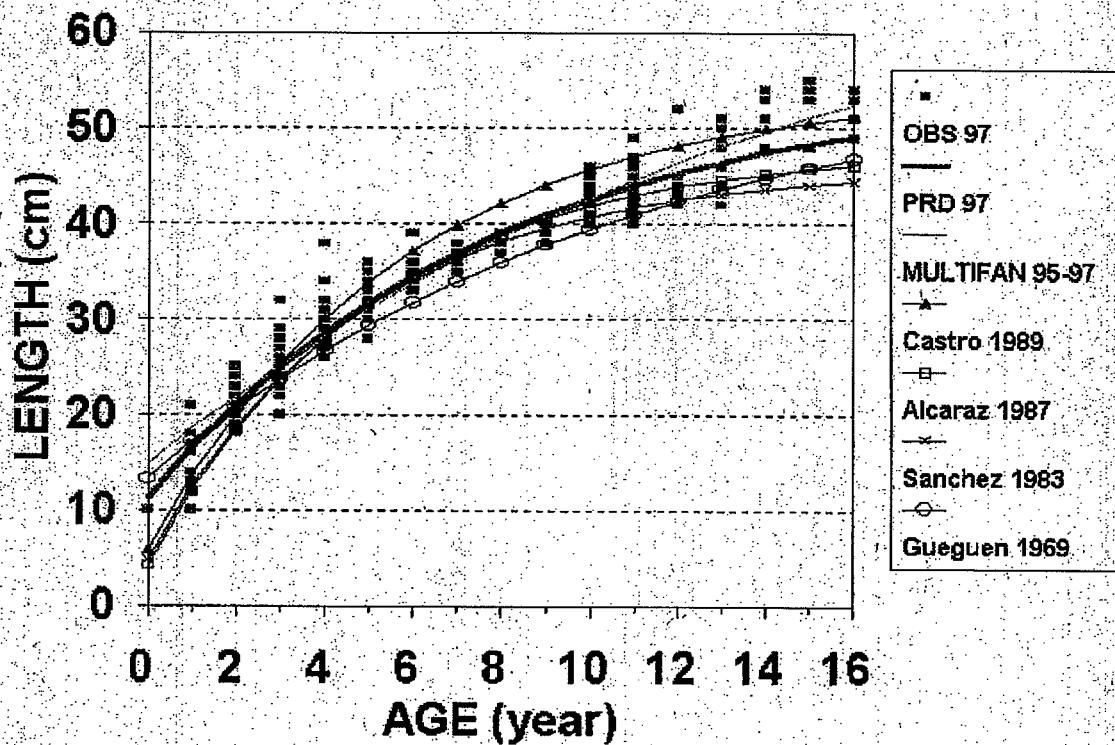
Figure 1. von Bertalanffy growth curves for blackspot seabream, from the Azores. Also included are vB growth curves published by other authors.

The growth curve obtained from otolith analysis is similar to the one which resulted from the application of MULTIFAN (they were similar statistically, ANCOVA, p>0.05, p=0.142).

The estimates of k and L∞ are similar to those of previous age studies.
The growth curves obtained in different areas seems similar but they differ statistically
(ANCOVA, p<0.05). Such variation reflects some differences in the patterns of growth of this species in
Azores and the others areas.

Forkbeard (*Phycis phycis*)

Table II- Parameters of the von Bertalanffy growth equations calculated for both sexes, by direct method and by MULTIFAN from this study, and published by Silva (1985).

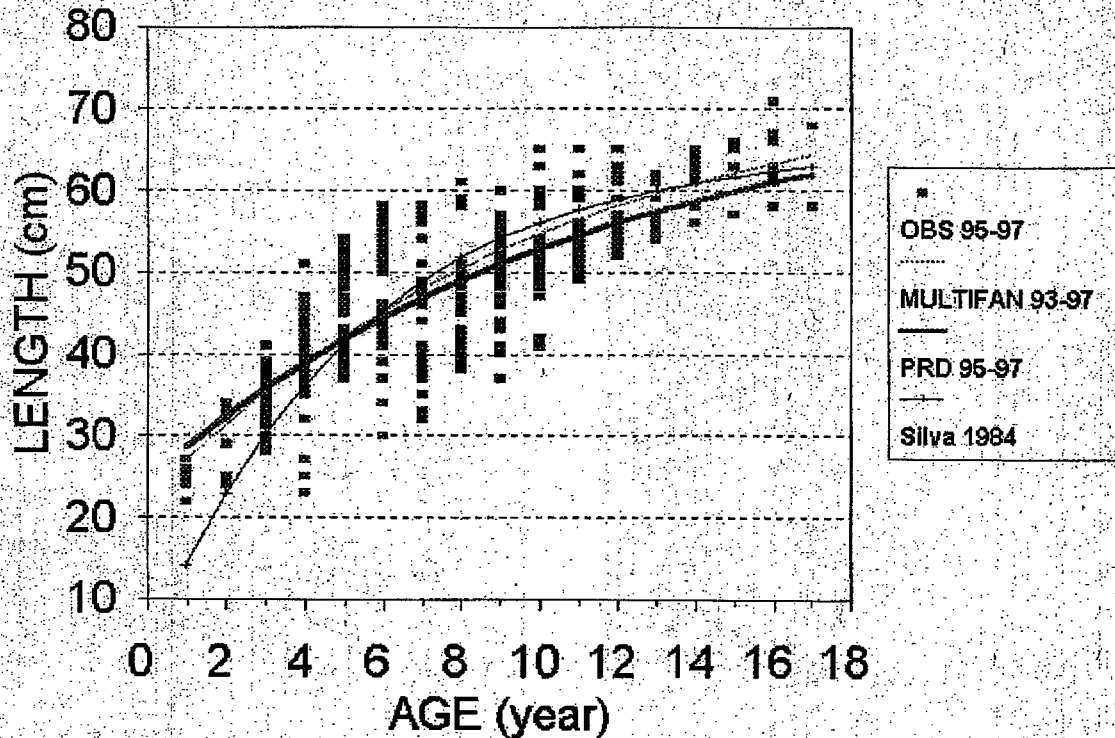| AUTHOR	AREA		METHOD	L∞	k	to	N	PERIOD
*	Azores	Both sexes	Direct (otolith)	72,4	0,092	-4,56	531	95-97
*	Azores	Both sexes	MULTIFAN	74	0,099	-3,56	701	93-97
Silva(1985)	Azores	Both sexes	Direct (otolith)	65,3	0,19	-0,28	350	1984

Figure 2. von Bertalanffy growth curves for forkbeard, from the Azores. Also included is vB growth curve published by Silva (1985).

The growth curve obtained from otolith analysis is close to the one which resulted from the application of MULTIFAN (they were similar statistically, ANCOVA, p>0.05, p=0.153).
The Total-Lengths predicted by the von Bertalanffy equations are very similar with those published by Silva (1985), between the ages 5-17, but higher on the ages 1-4 (they were similar statistically, ANCOVA, p>0.05, p=0.689). This is certainly due to the pour number of observations on these ages from the first study.

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Bluemouth (*Helicolenus dactylopterus*)

Table III- Parameters of the von Bertalanffy growth equations calculated for both sexes, by direct method and by MULTIFAN from this study, and published by other authors.

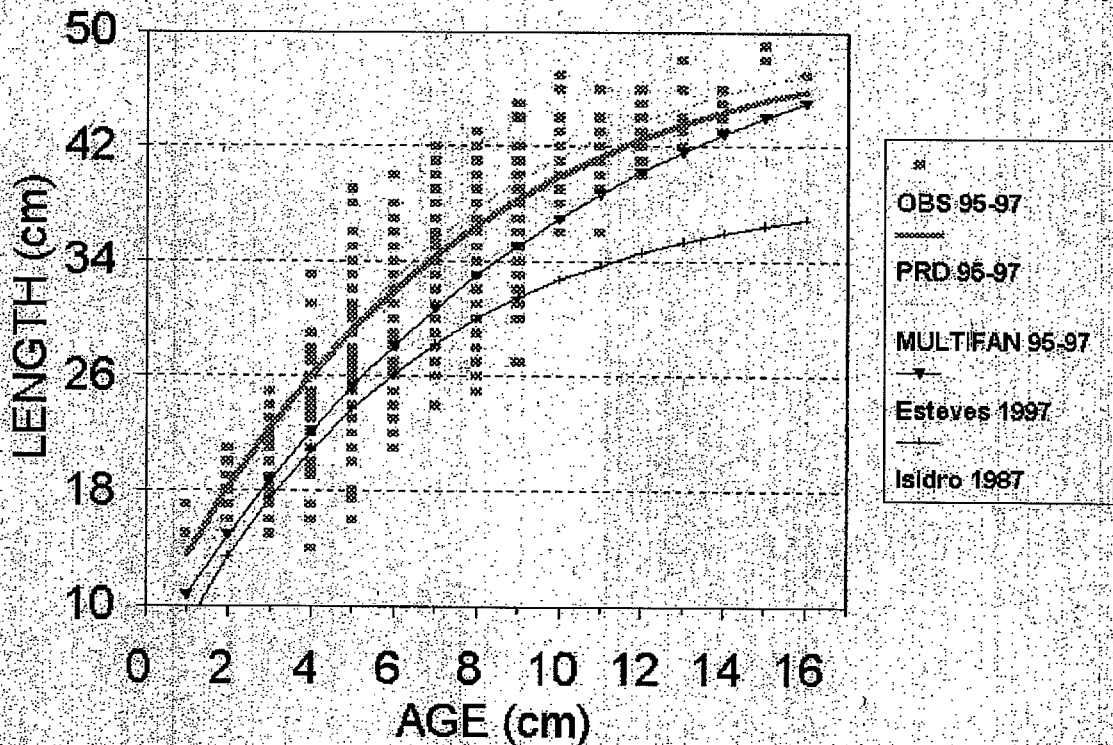| AUTHOR	AREA		METHOD	Loo	k	to	N	PERIOD
*	Azores	Both sexes	Direct (otolith)	50,5	0,139	-1,23	1745	95-97
*	Azores	Both sexes	MULTIFAN	50,5	0,162	-0,46	6630	95-97
Esteves (1997)	Azores Females		Direct (otolith)	54,7	0,101	-1,16	401	1995
Isidro (1987)	Azores Females		Direct (otolith)	39,4	0,17	-0,46	910	85-87

Figure 3. von Bertalanffy growth curves for bluemouth, from the Azores. Also included are vB growth curves published by Esteves (1997) and Isidro (1987).

The growth curve obtained from otolith analysis is similar to the one which resulted from the application of MULTIFAN (similar statistically, ANCOVA, $p > 0.05$, $p = 0.425$).

The estimates of k are close to those given by Isidro (1987) also in the Azores, but the estimates of Loo given by that author is much lower. The much smaller sample sizes of larger lengths could have biased his parameter estimates. The Total-Lengths predicted by the von Bertalanffy equations are higher than those published by Esteves (1997) maybe due to the same problem. They differ statistically (ANCOVA, $p < 0.05$, $p = 0.0001$).

Alfonsino (*Beryx splendens*)

Table IV- Parameters of the von Bertalanffy growth equations calculated for both sexes, by direct method and by MULTIFAN from this study, and published by other authors.

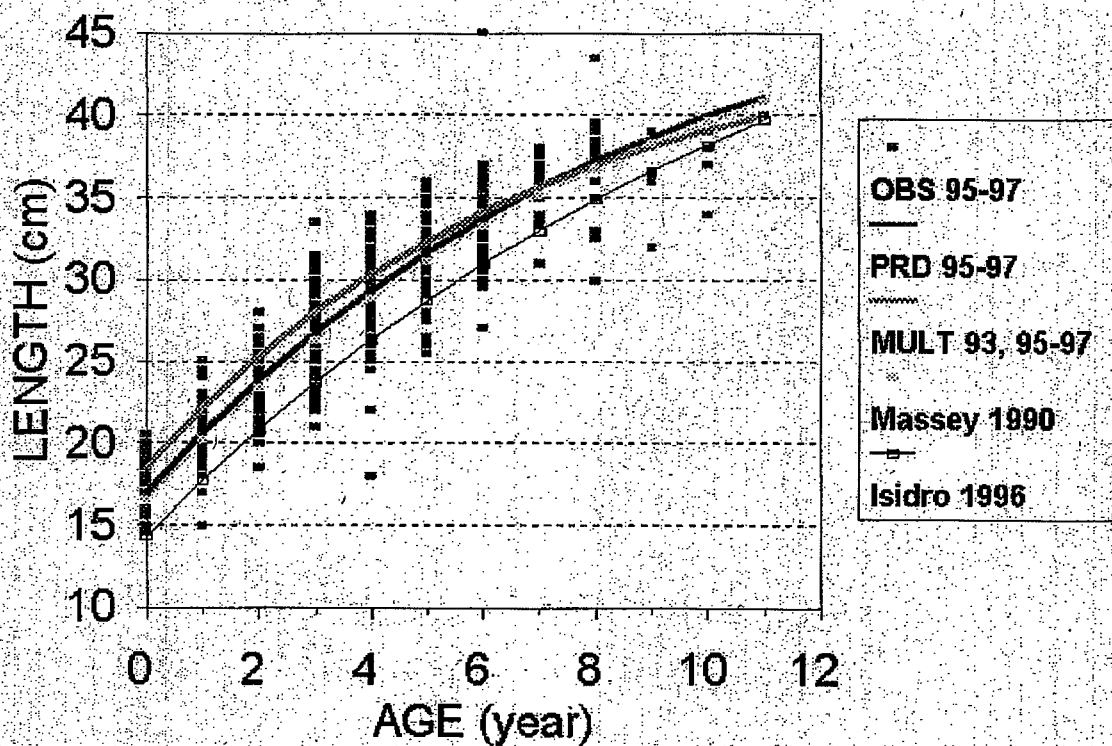| AUTHOR	AREA		METHOD	Loo	k	to	N	PERIOD
*	Azores	Both sexes	Direct (otolith)	50,8	0,114	-3,58	1245	95-97
*	Azores	Both sexes	MULTIFAN	45,3	0,146	-3,61	1599	93,95-97
Isidro (1996)	Azores	Both sexes	Direct (otolith)	56,7	0,083	-3,51	905	91-92
Massey (1990)	New Zealand	Males	Direct (otolith)	51,1	0,11	-3,56	-	86-87

Figure 4. von Bertalanffy growth curves for *Beryx splendens*, from the Azores. Also included are vB growth curves published by Isidro (1996) and Massey (1990).

The growth curve obtained from otolith analysis is similar to the one which resulted from the application of MULTIFAN (similar statistically, ANCOVA, p>0.05, p=0.606).

Length-at-age relationships derived from otolith readings in this study were consistent with those given by Massey (1990) (similar statistically, ANCOVA, p>0.05, p=0.395). The estimates of k and Loo are very similar in the 3 studies. But the FL values predicted by vB equations are generally higher than those published by Isidro (1996) for the Azores (statistically significant difference (p<<0.05). Due to the increase catches in this fishery, with a likely decreasing effect of the population over this 5-year period, it is possible that the population is responding in a "compensatory" density-dependent way through growth.

Alfonsino (*Beryx decadactylus*)

Table V- Parameters of the von Bertalanffy growth equations calculated for both sexes, by direct method and by MULTIFAN from this study, and published by Isidro (1996).

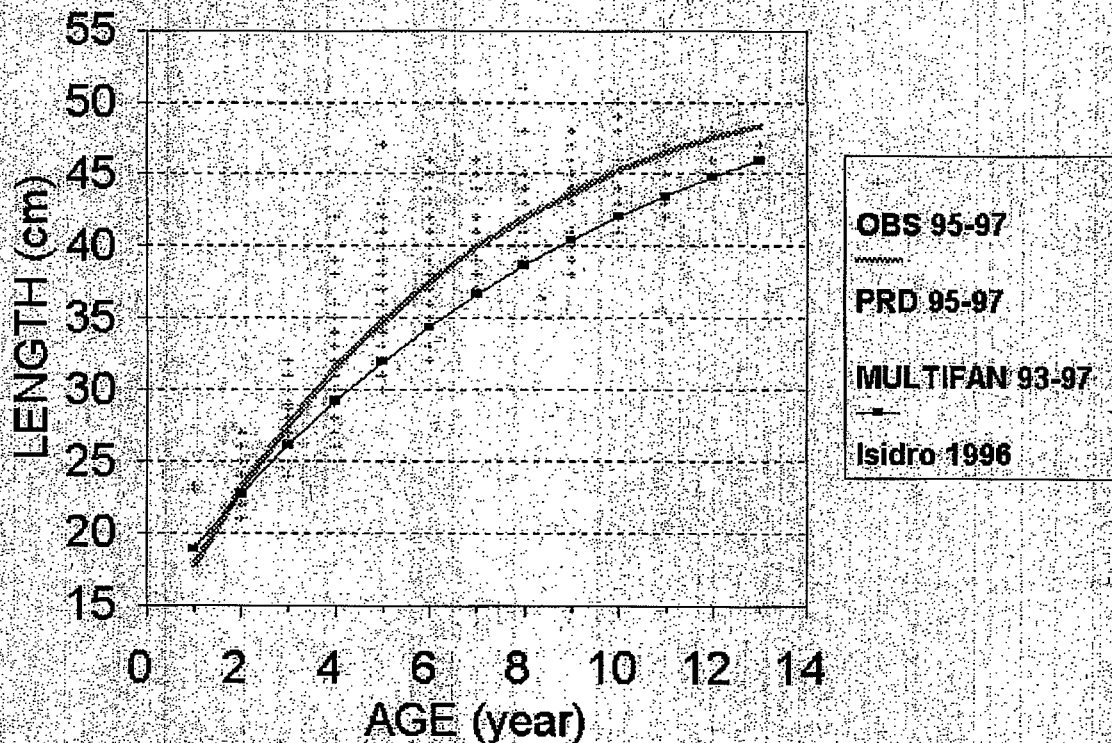| AUTHOR	AREA		METHOD	Loo	k	to	N	PERIOD
*	Azores	Both sexes	Direct (otolith)	53,7	0,163	-1,52	523	95-97
*	Azores	Both sexes	MULTIFAN	59,4	0,121	-2,22	694	93-94, 96-97
Isidro (1996)	Azores	Both sexes	Direct (otolith)	56,3	0,107	-2,83	833	91-93

Figure 5. von Bertalanffy growth curves for *Beryx decadactylus*, from the Azores. Also included is vB growth curve published by Isidro (1996).

The growth curve obtained from otolith analyse is close to the results of application of MULTIFAN (similar statistically, p=0.95). The estimates of k and L∞ are similar in these studies.
The Total-Lengths predicted from this study are very similar to those published by Isidro (1996), between ages 1-4, but higher on ages 5-13 (similar statistically, p=0.481).

Yellow-orange scorpionfish (*Pontinus kuhlii*)

Table VI- Parameters of the von Bertalanffy growth equations calculated for both sexes, by direct method and by MULTIFAN from this study, and published by Isidro (1996).

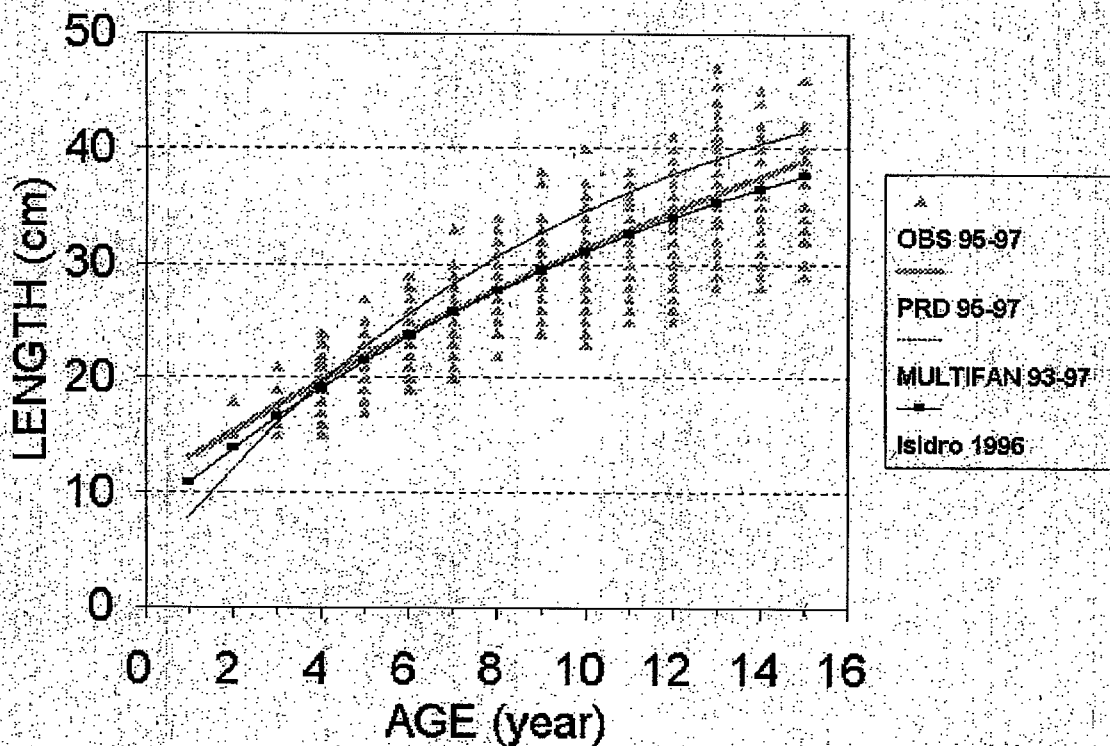| AUTHOR	AREA		METHOD	Loo	k	to	N	PERIOD
*	Azores	Males	Direct (otolith)	80,2	0,037	-3,82	402	95-97
*	Azores	Females	Direct (otolith)	43,3	0,098	-1,98	396	95-97
*	Azores	Both sexes	Direct (otolith)	73,6	0,039	-3,87	824	95-97
*	Azores	Both sexes	MULTIFAN	51,4	0,106	-0,55	1171	93-97
Isidro (1996)	Azores	Both sexes	Direct (otolith)	51,7	0,076	-2,1	1034	90-92

Figure 6. von Bertalanffy growth curves for yellow-orange scorpionfish, from the Azores. Also included is vB growth curve published by Isidro (1996).

Significant differences were detected between the two growth curves for males and females of this scorpionfish (ANCOVA, $p < 0.05$, $p = 0.001$). The growth curve obtained for both sexes combined derived from otolith analysis is different from the curve obtained by the MULTIFAN (ANCOVA, $p < 0.05$, $p = 0.029$). The Total-Lengths predicted by the von Bertalanffy equation obtained by otolith reading in this study, are very similar with those published by Isidro (1996). The two growth curves appeared similar (ANCOVA, $p > 0.05$, $p = 0.34$).

Silver scabbardfish (*Lepidopus caudatus*)

Table VII- Parameters of the von Bertalanffy growth equations calculated for both sexes, by direct method and by MULTIFAN from this study, and published by Demestre (1993).

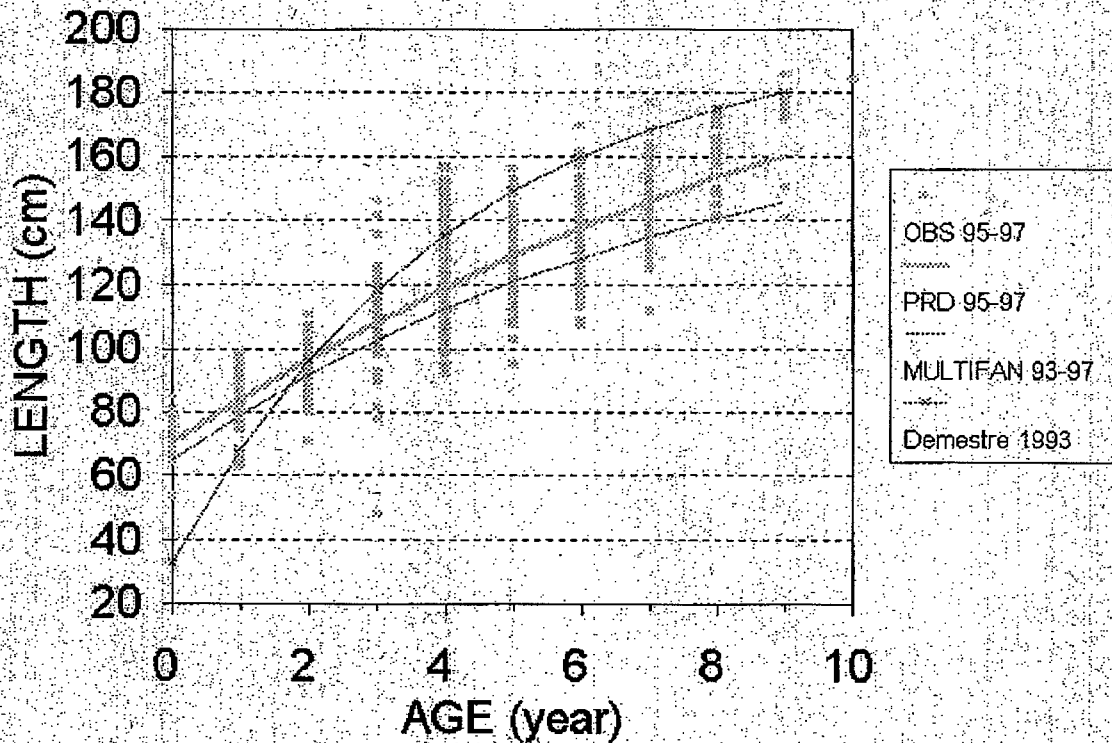| AUTHOR	AREA		METHOD	Loo	k	to	N	PERIOD
*	Azores	Males	Direct (otolith)	148,9	0,178	-3,66	378	95-97
*	Azores	Females	Direct (otolith)	203,6	0,13	-3,04	840	95-97
*	Azores	Both sexes	Direct (otolith)	238,9	0,085	-4,12	1217	95-97
*	Azores	Both sexes	MULTIFAN	184	0,126	-3,47	1580	93-97
Demestre (1993)	Mediterranean	Both sexes	Direct (otolith)	200	0,238	-0,76	580	88-89

Figure 7. von Bertalanffy growth curves for silver scabbardfish, from the Azores. Also included is vB growth curve published by Demestre (1993).

Significant differences were detected between the two growth curves for males and females of this scabbardfish (ANCOVA, $p < 0.05$, $p = 0.0002$). The growth curve for both sexes derived from otolith analysis is close to the curve obtained by MULTIFAN for the smaller lengths but tend to increase the difference for larger ages (statistically significant difference, ANCOVA, $p = 0.0024$).

The two parameters (k and L∞) differ markedly with those given by Demestre (1993) for the Mediterranean Sea. Also FL values predicted by the vB equations are different. Such variation reflects differences in the patterns of growth (slower growth in Azores) of this species in the two areas.

Red porgy (*Pagrus pagrus*)

Table VIII- Parameters of the von Bertalanffy growth equations calculated for both sexes, by direct method and by MULTIFAN from this study, and published by other authors.

| AUTHOR	AREA		METHOD	Loo	k	to	N	PERIOD
*	Azores	Both sexes	Direct (otolith)	101	0,049	-3,29	484	95-97
*	Azores	Both sexes	MULTIFAN	132,2	0,035	-3,05	529	94-97
Serafim (1995)	Azores	Both sexes	Direct (otolith)	104,6	0,061	-1,7	356	1993
Vassilopoulou (92)	Mediterranean	Both sexes	Indirect (otolith)	55,7	0,078	-3,56	138	85-86
Manooch (1977)	North Carolina	Both sexes	Indirect (scales)	76,3	0,096	-1,88	1770	72-74
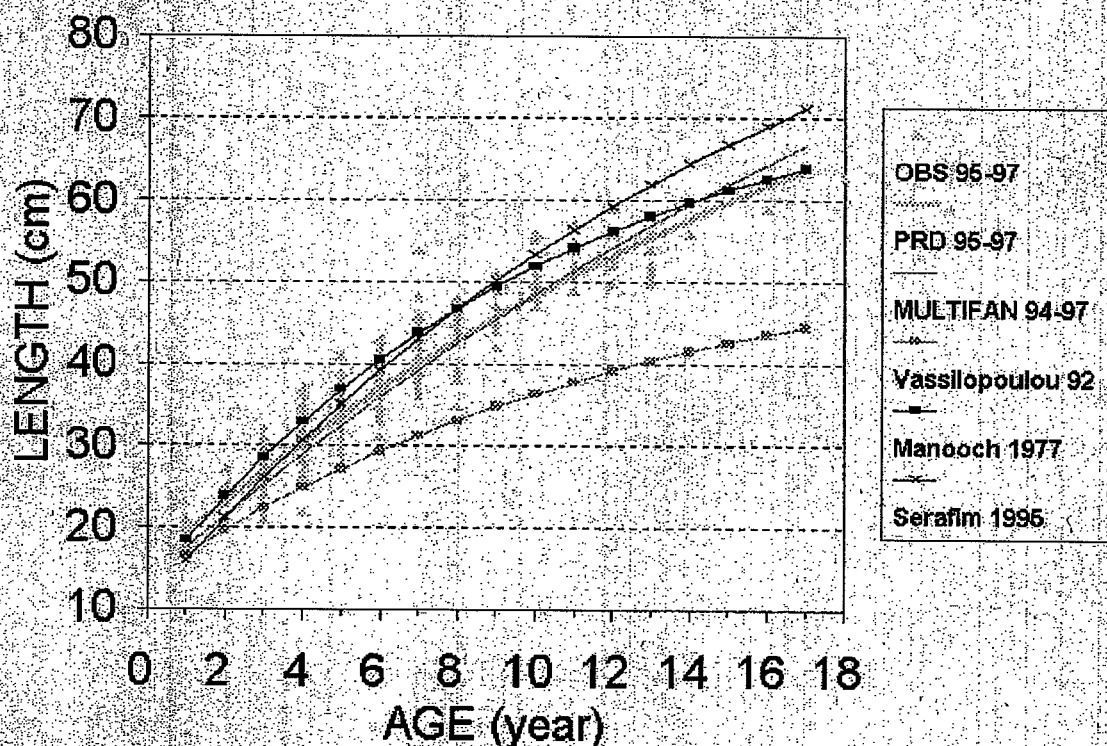
Figure 8. von Bertalanffy growth curves for red porgy, from the Azores. Also included are vB growth curves published by other authors.

The growth curve obtained from otolith analyse is similar to the results of the application of MULTIFAN (ANCOVA, p>0.05, p=0.934).

The estimates of k and Loo are similar in the studies of the same area (Azores), but differ to those given by Vassilopoulou (1992) for the Mediterranean Sea and Manooch (1977) for the North Carolina. But FL values predicted by the vB equations are very similar with those published by Manooch (p=0.135) and the differences persist when compared to those of Vassilopoulou (p=0.0001). Such variation reflects differences in the patterns of growth - faster growth and bigger lengths in red porgy of Azores and North Carolina.

Axillary seabream (*Pagellus acarne*)

Table IX- Parameters of the von Bertalanffy growth equations calculated for both sexes, by direct method and by MULTIFAN from this study, and published by Pajuelo (1994).

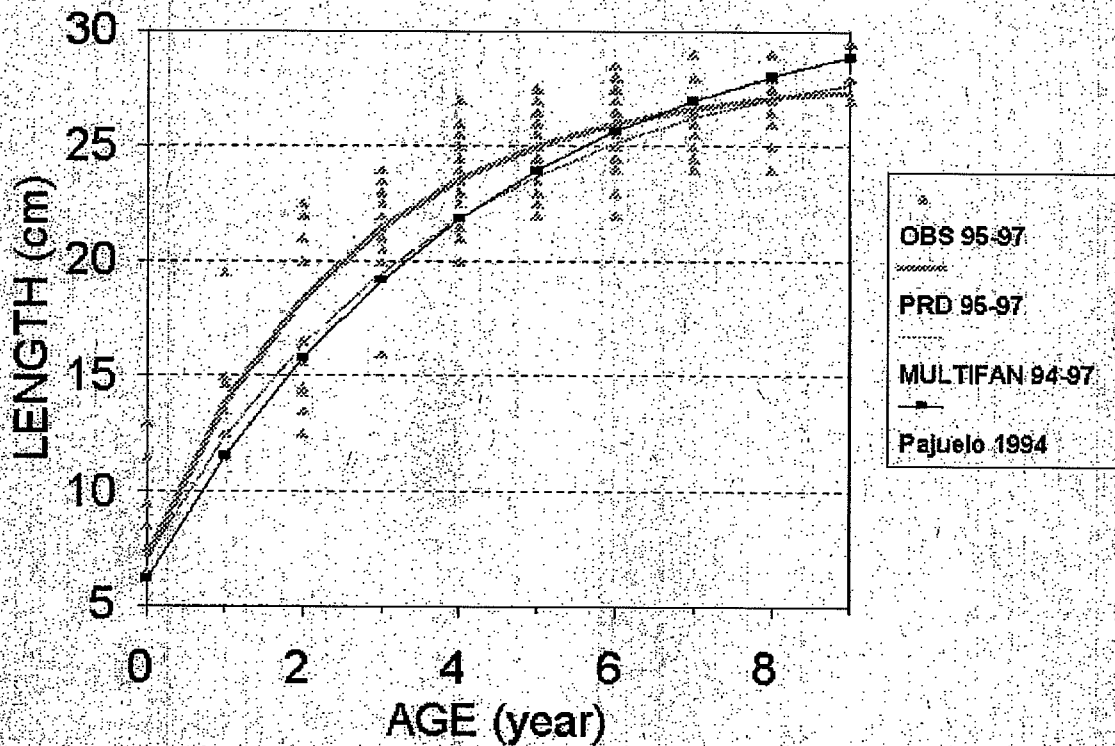| AUTHOR	AREA		METHOD	Loo	k	to	N	PERIOD
*	Azores	Both sexes	Direct (otolith)	28	0,385	-0,78	556	95-97
*	Azores	Both sexes	MULTIFAN	29,9	0,261	-1,04	741	94-97
Pajuelo (1994)	Canary Islands	Both sexes	Direct (otolith)	32,1	0,232	-0,92	437	91-93

Figure 9. von Bertalanffy growth curves for axillary seabream, from the Azores. Also included is vB growth curve published by Pajuelo (1994).

The age and growth estimates in this study afford good comparison with results of Pajuelo (1994). Length-at-age relationships derived from otolith readings were consistent with those given by the other author (similar statistically p=0.192). The small differences observed in FL at ages, even from the obtained by the MULTIFAN (p<0.05, p=0.006), is certainly a result of the lack of individuals in those smaller lengths.

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