7.3 Survey results

7.3.1 Bluespotted seabream *Pagrus caeruleostictus*

(1) Introduction

The bluespotted seabream *Pagrus caeruleostictus* (Figure 7.2) is distributed in the Atlantic Ocean along the coast of Europe and off southwestern Africa, at depths between 10 and 200 m. Juveniles are found in shallow waters, those over 30 cm TL migrate to areas over 50 m deep (Bauchot & Hureau, 1990). The species is caught mainly by Mauritanian-registered trawlers and is exported to Europe and North Africa.

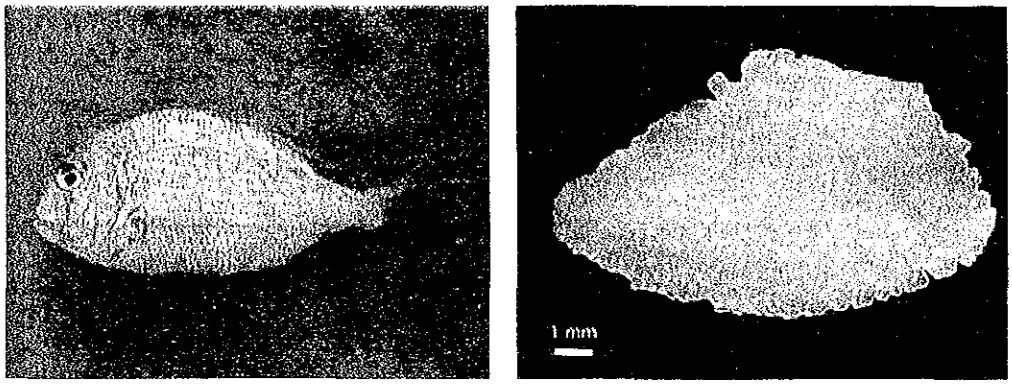

Figure 7.2 Bluespotted seabream *Pagrus caeruleostictus* and its otolith.

Some biological information has been published on this species: length-weight relationship (Showers, 1993); maturation, spawning period and feeding (Bauchot & Hureau, 1990) and reproductive biology (Maigret & Ly, 1986). However, studies on age determination by studying age structures are presumably lacking. In 1984, CNROP attempted to estimate the age of *Pagrus caeruleostictus* using scales of 215 specimens, but age validation remained was not determined (Boukatine *et al.*, 1985).

The objective of this survey was to investigate the possibility of age determination in the bluespotted seabream *Pagrus caeruleostictus* using otoliths and the results of age ring observation.

(2) Materials and Methods

For age determination, otoliths from 461 specimens of *Pagrus caeruleostictus* collected between March 2000 and October 2001 were utilized. Collecting was done in the cold season (March to May) and warm season (September and October) in the survey area (16-20°N, 3-80m in depth) with a trawl net. In the transitional seasons (June to August and November to January), material was collected from the landings at the artisanal fisheries port in NDB (Table 7.3). All specimens were subjected to a multi-item biological measurement process in which they were sexed and had their fork length measured.

Otoliths were extracted from the fish, and sealed in and preserved in age character bags. Except for the material related to the transitional seasons, all the preceding work was done by the Sea-borne Survey team. In the laboratory, the otoliths were embedded in acrylic resin (PLASTIC KIT) and sliced into thin sections (0.4-0.7 mm) with a linear precision saw (ISOMET 5000). Sections were then mounted on glass slides and coated with transparent nail polish for examination.

Table 7.3 Number of bluespotted seabream *Pagrus caeruleostictus* specimens examined. Numerals in parentheses indicate the number of specimens used in otolith analysis.

Month	Sex			Total
	Male	Female	Unknown	
January[A]	15 (7)	14 (6)	2 (1)	31 (14)
February	-	-	-	-
March[B]	12 (7)	5 (3)	-	17 (10)
April[B]	22 (16)	32 (29)	6 (4)	60 (49)
May[B]	13 (3)	25 (12)	12 (5)	50 (20)
June[A]	17 (13)	29 (20)	10 (5)	56 (38)
July[A]	20 (15)	38 (26)	2 (1)	60 (42)
August[A]	28 (15)	28 (15)	2 (2)	58 (32)
September[B]	25 (16)	26 (19)	4 (3)	55 (38)
October[B]	14 (11)	15 (11)	-	29 (22)
November[A]	12 (5)	15 (7)	-	27 (12)
December[A]	13 (7)	5 (3)	-	18 (10)
Total	191 (115)	232 (151)	38 (21)	461 (287)

[A] : Specimens collected at the artisanal fisheries port in NDB.
[B] : Specimen collected by the Sea-borne Survey.

Of the total sample of 461 individuals, age rings could be observed in 287 (62%). They were not clearly visible in thick otolith sections (0.6-0.7 mm).

Distance from the focus to outer margin of otolith (radius of otolith: R) and from the focus to each opaque ring (r1, r2,...rn) were measured using micrometer or color measure unit. As size increased, ring formation become more evident near the edge of the otolith. The average number of rings counted between readers and the mean radius of otoliths were calculated for data analyses (Figure 7.3).

Two methods were used to determine the periodicity of ring formation – that is, whether a ring is formed once a year or otherwise. The first method relates the transition between seasons to a situation where rings are formed at the edge of the otolith. Three types of otolith edge were categorized – opaque band, narrow translucent band and broad translucent band – and their rate of appearance investigated. The second method utilizes the marginal increment ratio (MIR), which measures the amount of growth observed in the edge of the otolith. The MIR is calculated according to the equation

$$MIR = (OR - Rn) / (Rn - Rn\text{-}1)$$

where OR is the otolith radius, Rn is the radius of the last complete ring, and Rn-1 is the radius of the penultimate complete ring.

Ring readings were made by three readers through a binocular microscope (40X magnification), one reading per reader, and the mean value of the three readings were registered for each sample. Of the two methods, MIR analysis is more widely used, and its results are reported here. From those data, otolith radius/ fork length relationship, sample count by age group and mean and standard deviation of the distance of each ring from the focus, and age/fork it length relationship were all calculated.

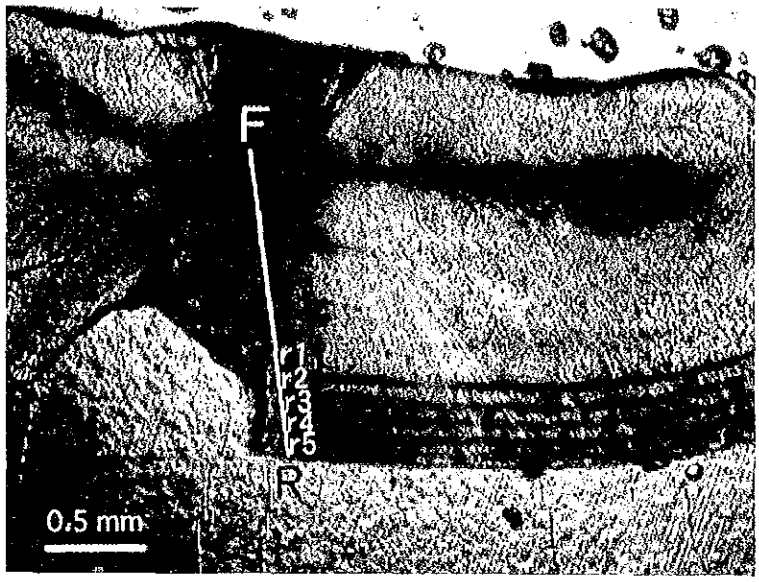

Figure 7.3 Otolith of *Pagrus caeruleostictus*.
Male, 326 mm in fork length, collected in April 2001.
F, focus; R, otolith radius; r1-r5, ring radii.

(3) Results and discussion

The relationship between otolith radius and fork length in *Pagrus caeruleostictus* is shown in Figure 7.4. The relationship is a linear regression within the sample limits. It was thus possible to estimate the fork length from the otolith radius.

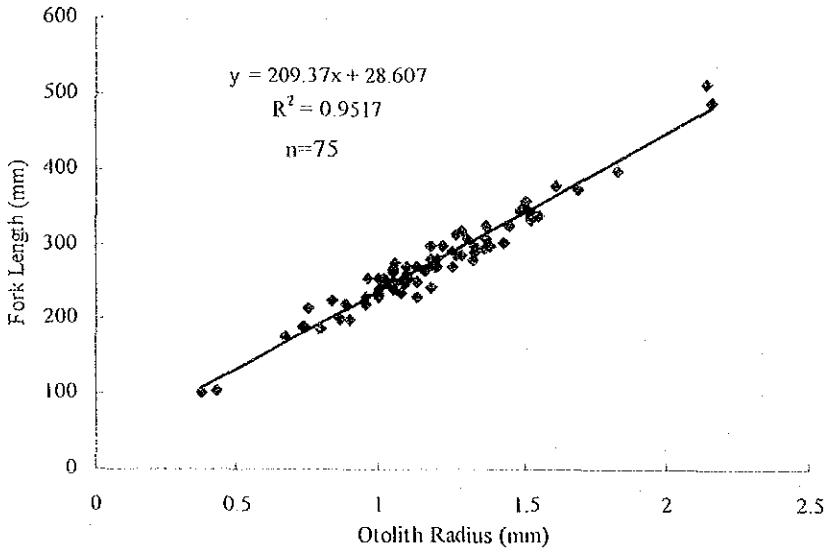

Figure 7.4 Relationship between otolith radius and fork length in *Pagrus caeruleostictus*.

Monthly variation of the marginal increment ratio (MIR) is shown in Figure 7.5.

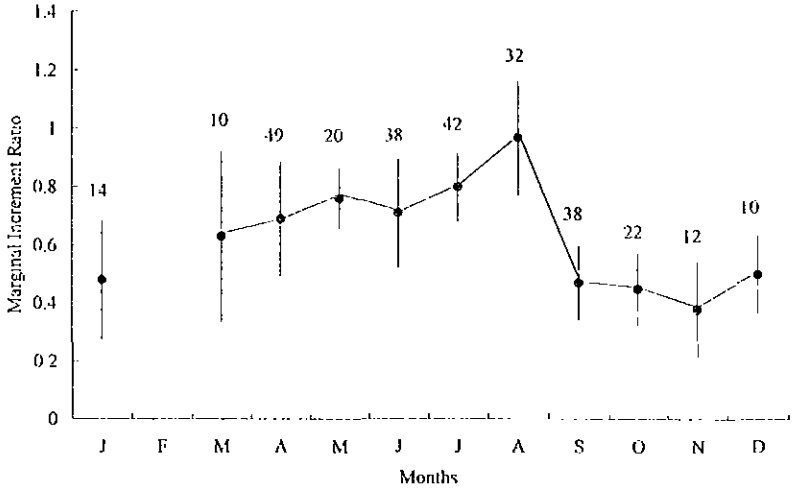

Figure 7.5 Marginal increment ratio for the otolith of *Pagrus caeruleostictus*. Plots and bars show mean and standard deviation respectively.

MIR was small in the warm season (September to November), with the lowest mean value (0.38) in November, and increased gradually thereafter, with high values between March and August. These data suggest that rings are formed once a year from September to November. Water temperature measured in the Sea-borne Survey at the 3-80 m layer was 13.6–22.4°C in the cold season and 16.0–29.1°C in the warm season, being obviously higher in the warm season (Chapter 2). Light and temperature are supposedly the major environmental factors that most affect the physiology of energy, and possibly changes in temperature could influence the formation of otolith rings in *P. caeruleostictus*. Murakami and Okada (1967) reported that ring formation might be closely related to the spawning season in a related species from the East China Sea and the Yellow Sea, the red sea bream snapper *Chrysophrys major*, which suggests ring formation could be related to a reproductive activity. As for *Pagrus caeruleostictus* inhabiting Mauritanian waters, ring formation season coincided with the warm season, when the rate of maturation is high (Chapter 3).

Table 7.4 shows sample count by age group and mean and standard deviation of the distance of each ring from the focus for *Pagrus caeruleostictus*.

Neither Lee's Phenomenon nor Reversed Lee's Phenomenon was found for those calculations.

Age/length relationship of the species was expressed as a quadratic equation (Figure 7.6).

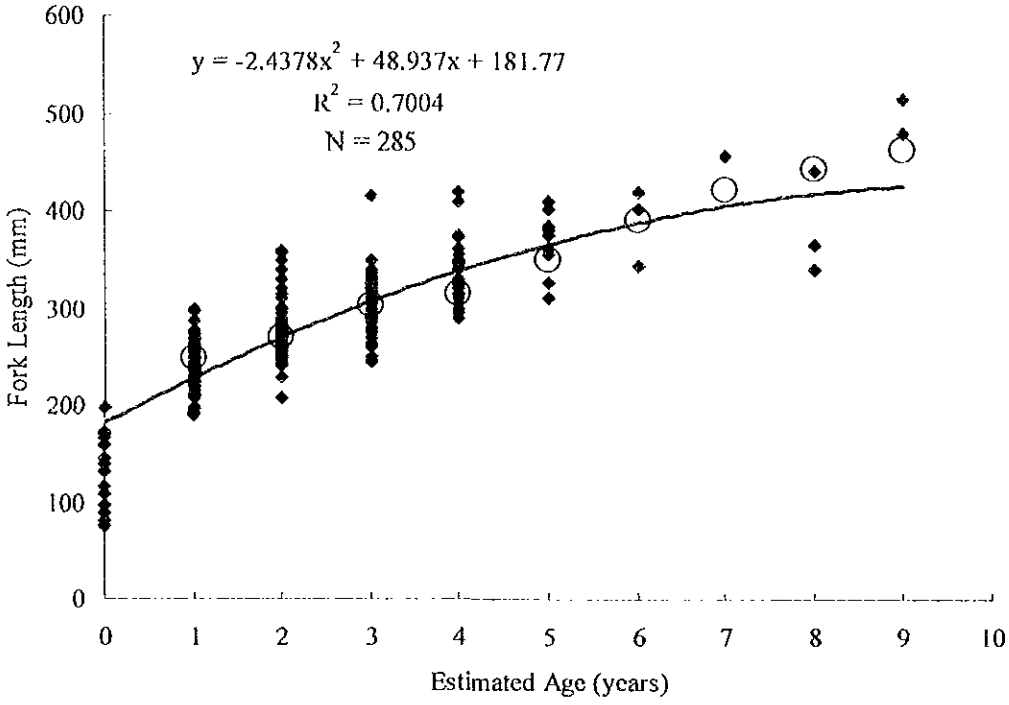

Figure 7.6 Age/length relationship in bluespotted seabream *Pagrus caeruleostictus*. Circles show calculated length at each age.

Maximum age was 9 years for males and 8 years for females. The smallest one-year specimen (male) measured 190 mm FL. Comparing observed and calculated lengths, the latter was larger at age 8-9, but for ages 1-7 calculated lenghts were more or less distributed over the growth curve. This seems to indicate the 8-9 year class sample was small.

Table 7.4 Sample count by age group and mean and standard deviation of the distance of each ring from the focus for bluespotted seabream *Pagrus caeruleostictus.*

Age groups	N	Ring radius (mm)								
		r1	r2	r3	r4	r5	r6	r7	r8	r9
1	58	1.02±0.10								
2	75	1.01±0.07	1.14±0.07							
3	66	1.13±0.14	1.16±0.11	1.35±0.14						
4	47	1.00±0.10	1.11±0.09	1.24±0.11	1.34±0.12					
5	13	1.05±0.12	1.16±0.12	1.27±0.13	1.39±0.13	1.48±0.13				
6	3	1.18±0.07	1.22±0.15	1.34±0.07	1.43±0.07	1.52±0.08	1.62±0.11			
7	1	1.19	1.30	1.41	1.46	1.56	1.69	1.79		
8	3	1.28±0.08	1.37±0.05	1.40±0.07	1.54±0.06	1.64±0.11	1.79±0.10	1.89±0.07	1.95±0.06	
9	2	1.23±0.07	1.39±0.06	1.50±0.11	1.65±0.04	1.66±0.04	1.81±0.09	1.91±0.04	2.02±0.06	2.07±0.06
Mean±SD		1.05±0.10	1.15±0.09	1.31±0.12	1.37±0.11	1.53±0.11	1.73±0.10	1.88±0.06	1.98±0.06	2.07±0.06
N		268	210	135	69	22	9	6	5	2
Back-calculated length (mm)		248	269	303	315	349	391	422	443	462

Comparing the above growth curve to the results of a previous study on the same species (Boukatine *et al.*, 1985), for the same age class (as determined by the number of rings), the specimens examined in the present survey are larger (Table 7.5). Differences in results might be attributed to the fact age validation was considered or not.

Table 7.5 Comparison with a previous age determination study on bluespotted seabream *Pagrus caeruleostictus*.

Estimated age										Information
0	1	2	3	4	5	6	7	8	9	based on
73.9	99.9	150.2	202.2	226.8	257.7	285.4	330.4			Boukatine *et al.* (1985)
181.8	228.3	269.9	306.6	338.5	365.5	387.6	404.9	417.2	424.7	This survey

An age-length key for *Pagrus caeruleostictus* is presented in Table 7.6. From these results, it is possible to estimate age composition for the species.

Table 7.6 Age-length key for bluespotted seabream *Pagrus caeruleostictus*.

Fork length (mm)	Age									Total
	1	2	3	4	5	6	7	8	9	
180-200	4									4
201-220	11	1								12
221-240	12	2								14
241-260	17	19	9							45
261-280	11	27	6							44
281-300	3	12	22	6						43
301-320		7	14	20	2					43
321-340		4	12	10	1			1		28
341-360		3	2	6	1	1				13
361-380				3	5			1		9
381-400					2					2
401-420			1	2	2	2				7
421-440								1		1
441-460							1			1
461-480									1	1
481-500										
501-520									1	1
Total	58	75	66	47	13	3	1	3	2	268

7.3.2 Senegalese hake *Merluccius senegalensis*

(1) Introduction

The Senegalese hake *Merluccius senegalensis* (Figure 7.7) is distributed along Northwest African coasts in depths from 18 to 500 m. The maximum recorded total length and common size for this species are 81 cm and 42 cm respectively (Cohen *et al.* 1990). At present, Spanish trawlers and a few longliners are targeting this species in Mauritanian waters.

Studies on the fisheries biology of *Merluccius senegalensis* include: Doutre (1960); FAO (1979, 1990, 1995); Inada (1981); Wysokinski (1986); Ramos & Fernandez (1995); Ramos *et al.*,(1998). In IRM waters, the only information made available on the species is its geographical distribution (Overko *et al.*, 1985).

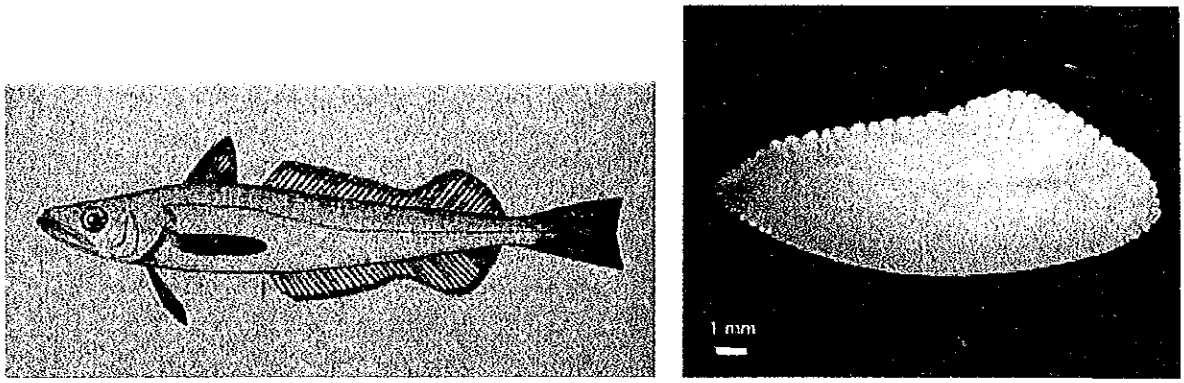

Figure 7.7 Senegalese hake *Merluccius senegalensis* (from Cohen *et al.*, 1990) and otolith.

Papers focusing on the age and growth include those based upon otolith observation (Doutre, 1960) and body length composition (Wysokinski, 1986).

The objective of this survey was to investigate the possibility of age determination in the Senegalese hake *Merluccius senegalensis*, with the ultimate goal of estimating the resources of this species in IRM waters.

(2) Material and methods

Specimens of *Merluccius senegalensis* for age determination studies were trawled in Mauritanian territorial waters (16-21 °N, 60-400m in depth) in the cold season (March–April) and warm season (September–October) of 2000 (Table 7.7).

Table 7.7 **Number of Senegalese hake *Merluccius senegalensis* specimens examined.**
Numerals in parentheses indicate the number of specimens actually used in otolith analysis.

Month	Sex			Total
	Male	Female	Unknown	
March	4 (4)	6 (6)	3 (3)	13 (13)
April	3 (3)	3 (3)	1 (1)	7 (7)
September	7 (7)	11 (11)	36 (36)	54 (54)
October	7 (7)	17 (17)	-	24 (24)
Total	191 (115)	232 (151)	38 (21)	98 (98)

Of the above total, 98 individuals were selected for age determination purposes. The otoliths of 20 winter season (March–April) samples were polished with whetstone (250-grade for rough polishing, 1000-grade for medium finish), and those of 78 warm season (September-October) individuals were embedded in acrylic resin and sliced into 0.4-0.5 mm thick sections. These were then attached to slide glasses with bonder glue and covered with either liquid paraffin or clear enamel nail polish.

The otoliths of the Senegalese hake show rings of two kinds, translucent and opaque. Being narrower and more visible, the translucent rings were considered here as age indicators (Figure 7.8). Otolith ring radius was measured with a micrometer under a biological microscope at 40X magnification, as was the distance from the focus to each ring. Measurements were taken three times per piece and the mean value registered.

Methods for investigating age validations were the same utilized for the bluespotted seabream *Pagrus caeruleostictus*. But such methods require year-round data, and ring formation period cannot be determined only with those taken in March–April and September–October.

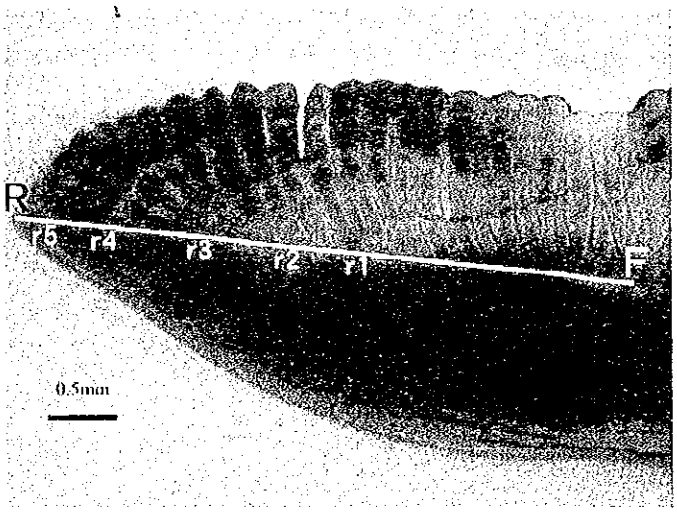

Figure 7.8 Otolith of *Merluccius senegalensis*.
Female, 576 mm in total length, collected in April 2000.
F, focus; R, otolith radius; r1-r5, ring radii.

(3) Results and discussion

The relationship between otolith radius and total length in *Merluccius senegalensis* is shown in Figure 7.9. It was found to be linear within the sample interval.

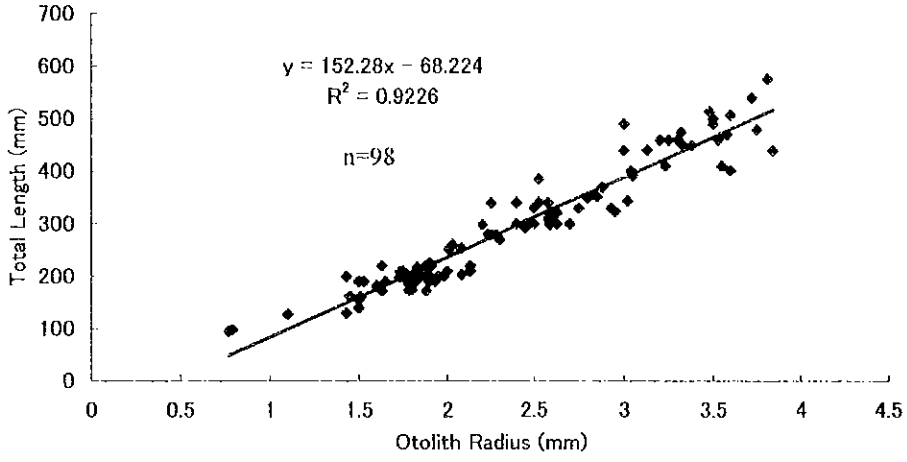

Figure 7.9 Relationship between otolith radius and total length in Senegalese hake *Merluccius senegalensis*.

Marginal increment ratio (MIR) *Merluccius senegalensis* is shown in Figure 7.10.

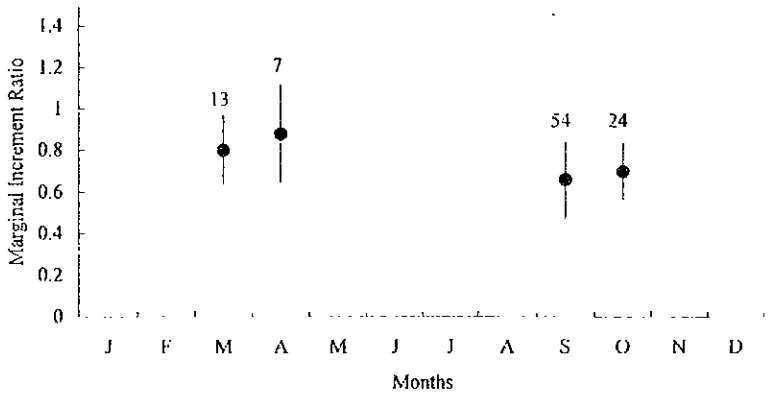

Figure 7.10 Marginal increment ratio for the otolith of Senegalese hake *Merluccius senegalensis*.

In the samples examined, there was a slight decline in the mean MIR from the cold season (March-April) to the warm season (September–October), although there was no much seasonal

discrepancy. Future studies should investigate the MIR in the inter-seasonal period not covered by the present survey, in order to clarify the periodicity of ring formation – which happens at the smallest MIR value.

Table 7.8 shows sample count by age group and mean and standard deviation of the distance of each ring from the focus, and Figure 7.11 presents the relationship between otolith radius and group 2 ring radius in *Merluccius senegalensis*. Standard deviation for ring radii per ring group was small, and the ring radii in group 2 are generally distributed along their regression lines. It can be said that, for these samples, there was a correspondence between individuals in ring formation. However, there is a need to increase the sampling of this species and actively investigate possible correspondences in ring formation.

Table 7.8 Sample count by age group and mean and standard deviation of the distance of each ring from the focus for Senegalese hake *Merluccius senegalensis*.

Ring groups	N	Ring radius (mm)					
		r1	r2	r3	r4	r5	r6
1	23	1.09±0.11					
2	25	1.52±0.18	1.74±0.18				
3	21	1.85±0.32	2.19±0.28	2.52±0.20			
4	11	2.35±0.11	2.93±0.16	3.24±0.33	3.49±0.28		
5	3	2.36±0.64	2.66±0.54	2.89±0.53	3.17±0.51	3.44±0.47	
6	1	2.19	2.86	3.14	3.30	3.47	3.64
Mean±SD		1.63±0.20	2.17±0.23	2.79±0.27	3.41±0.33	3.45±0.47	3.64
N		84	61	36	15	4	1

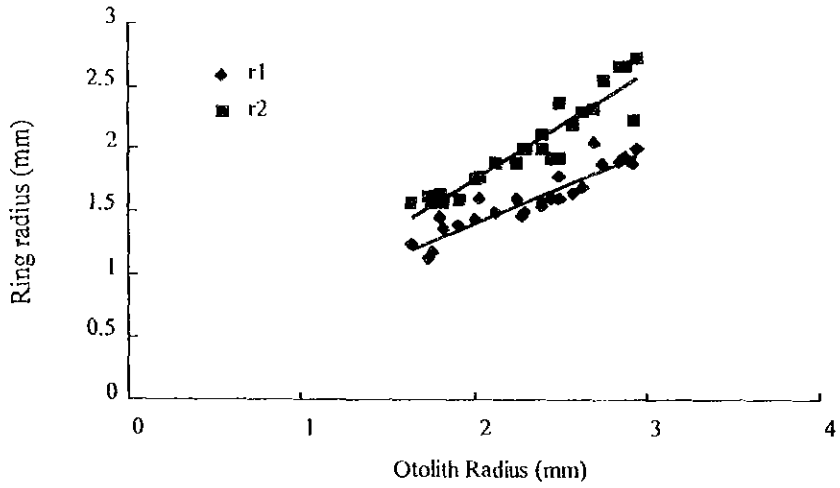

Figure 7.11 Relationship between otolith and ring radius of ring group 2 in Senegalese hake *Merluccius senegalensis*.

The relationship between the number of rings counted in the otoliths and total length is shown in Figure 7.12.

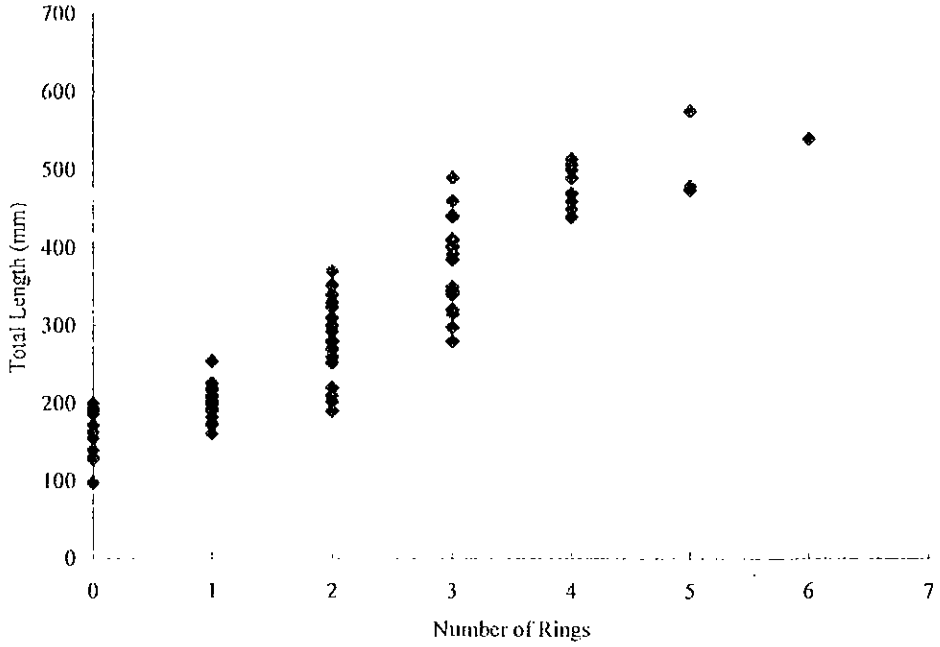

Figure 7.12 Relationship between the number of rings counted in the otoliths and total length in Senegalese hake *Merluccius senegalensis*.

It is clearly seen from the above that the number of rings were positively related with total length in *Merluccius senegalensis*. A specimen with six-ring otoliths was a 540 mm female; the largest female (576 mm) had five rings. Rings were detected in all individuals with a body longer than 161 mm. The present results are quite consistent with the relationships between age and total length determined from the otolith observation in Senegal by Doutre (1960), but body length per age group was higher than the values reported by Wysokinski (1986) calculated from length composition findings (Table 7.9).

Table 7.9 Comparison with previous age determination studies on Senegalese hake *Merluccius senegalensis*.

Estimated age or ring count												Information based on
0	1	2	3	4	5	6	7	8	9	10	11	
130.0	199.0	268.5	334.8	449.5	529.0	584.7	700.5					Doutre (1960)
	167.0	232.0	293.0	350.0	403.0	453.0	499.0	542.0	583.0	621.0	656.0	Wysokinski (1986)
166.7	198.6	279.6	371.5	472.8	510.3	540.0						This study

7.3.3 Smooth-hound *Mustelus mustelus*

(1) Introduction

The smooth-hound *Mustelus mustelus* (Figure 7.13) is the most common shark in IRM. They occur in the Eastern the Atlantic Ocean, as well as in Mediterranean inshore waters at 5–100 m depths, and a maximum size of 165 cm has been recorded (Smale & Compagno, 1997). Although demersal trawl fisheries have had a considerable by-catch of this shark in Mauritanian waters, most catches were discarded in the past because of their low commercial value.

But in the recent years, they have been considered a promising resource for human consumption and medicinal purposes. This trend has prompted the CNROP to gather biological information of this species, for resource evaluation and management purposes.

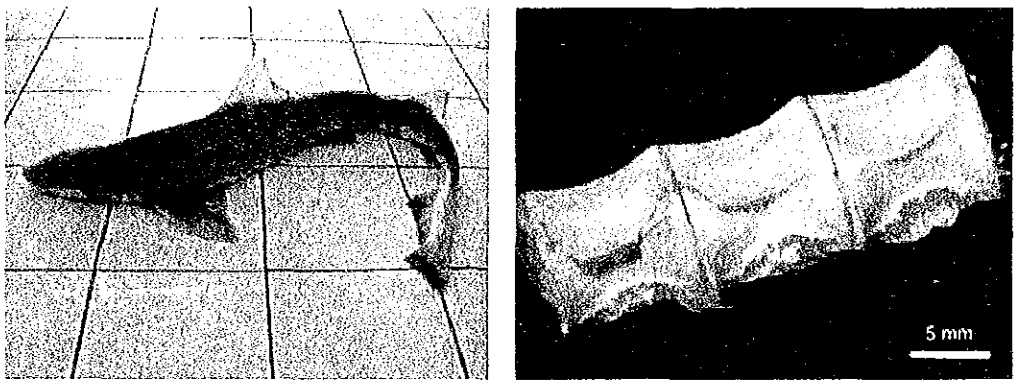

Figure 7.13 Smooth-hound *Mustelus mustelus* and its vertebra.

So far, the only study published on the age and growth of this species is that by Goosen & Smale (1997) in South Africa, utilizing vertebral centra for age determination. On the other hand, various age determination studies on other species of the genus *Mustelus* (dogfishes) have been reported in Australia, North America and Japan (Table 7.10).

In order to study age determination of the smooth-hound *Mustelus mustelus* in IRM waters utilizing vertebral samples, the first step was to develop a technique to collect them, followed by an investigation on the peculiar features of the rings formed in vertebrae and the relationship between the number of these rings and age.

Table 7.10 Previous studies on age and growth of the genus *Mustelus*.

Species	Country	Age determination methods			Estimated life-span (years)	Information based on
		Age character analysis	Size frequency analysis	Tagging experiment		
Mustelus antarcticus	Australia	+		+	16	Moulton *et al.* (1992)
Mustelus californicus	United States	+			6 (male), 9 (female)	Yudin and Cailliet (1990)
Mustelus henlei	United States	+			7 (male), 13 (female)	Yudin and Cailliet (1990)
Mustelus lenticulatus	New Zealand		+	+	12	Francis and Francis (1992)
Mustelus manazo	Japan	+			8 (male), 10 (female)	Yamaguchi *et al.* (1996)
Mustelus mustelus	South Africa	+			17 (male), 24 (female)	Goosen and Smale (1997)

(2) Material and methods

Material for age determination was collected in the Mauritanian coast (16-21 °N), at the 20-80 m depth range, in two periods: September to October 2000 and April to May 2001 (Table 7.11).

Table 7.11 Number of *Mustelus mustelus* specimens examined.
Numerals in parentheses indicate the number of specimens used in centrum analysis.

Month	Male	Female	Total
September 2000	5 (4)	1 (1)	6 (5)
October	8 (2)	31 (19)	39 (21)
April 2001	13 (12)	8 (8)	21 (20)
May	28 (14)	16 (10)	44 (24)
Total	54 (32)	56 (48)	110 (70)

Sharks were sexed, their total length and body weight were measured and evaluated on board, after measurement and evaluation their vertebral centra were removed. The criterion for chosing which vertebrae to pull out was size: the largest ones are the 30th to the 35th (under the first dorsal fin). The selected vertebrae were kept in age character bags, frozen and preserved on board. Upon reaching port, in the laboratory, they were boiled to remove the connective tissues and dried for one week before processing. The centra, embedded in acrylic resin for 24 h, were sliced into 0.2-0.3 mm thick sections with a linear precision saw.

For staining, in the September–November 2000 Survey, samples were decalcified for about 24 hours in 5% formic acid (Tanaka & Mizue, 1979) and stained in alizarin red S. However, many samples had unreadable rings. Now, in the May-June 2001 Survey, three sections were made for each centrum and subjected to three different techniques. In the first method, samples were decalcified for about 24 hours in 5% formic acid and stained in alizarin red S. The alizarin solution comprised 0.1 g alizarin red S, 10 ml 90% ethanol and 90 ml distilled water. In the second method, the samples were imbibed for one minute with the above solution, then washed in water and finally soaked in 3% hydrogen peroxide for one hour. For the third procedure, an alizarin stock solution was prepared, comprising 2 g alizarin red S, 33 ml distilled water and 33 ml concentrated acetic acid. Next, a staining solution was made with potassium hydroxide (15% in distilled water), glycerin (16% in distilled water) and alizarin stock solution, in the ratio 35:14:1. Specimens were soaked for about 1-2 hours in the staining solution, then rinsed in water followed by 97% ethanol (Seki *et al.*, 1998). A comparison between the three methods revealed that the third procedure was the most suitable for smooth-hound studies in IRM, because of the clarity of the rings stained by it.

Centrum sections were observed in a biological microscope under proper transmitted light and a 40x magnification. There were clear and opaque bands, and in this case, the clearer and narrower opaque bands were chosen as growth rings. Since in dogfishes a birth ring can be identifed (Taniuchi *et al.*, 1983) the ring count was defined as the number of rings recognized minus one. Ring radii were calculated as the distance between the focus and each ring, and were measured either by a micrometer or a Color Measure Unit. Rings were counted once by two readers and the mean value of these counts was recorded.

Age validation calculations basically followed the same procedure as in the bluespotted seabream *Pagrus caeruleostictus*.

(3) Results and discussion

Centrum diameter measurements of *Mustelus mustelus* are shown in Figure 7.14. Measurements were possible throughout the 128th vertebral centrum counting from head to tail. The largest diameters were found in the 30th and 31th centra. Since other researchers have used the vertebrae under the first dorsal fin, for this survey the 30th to the 35th centra, located under the first dorsal fin, were also chosen.

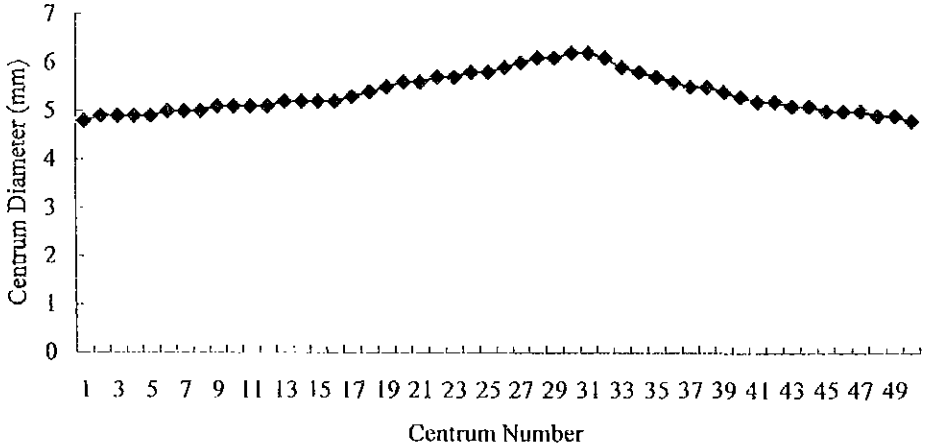

Figure 7.14 Centrum diameter of smooth-hound *Mustelus mustelus*.
Male, 486 mm in total length, collected in May 2001.

The relationship between centrum radius and total length for *Mustelus mustelus* is shown in Figure 7.15. Centrum radii and total lengths were respectively in the range of 3.43–7.63 mm and 590–1080 mm. Centrum radius in specimens over 700 mm in total length was broadly distributed and the coefficient of correlation was not high. This may be due to the possibility of some centra not having been removed on board exactly from under the first dorsal fin.

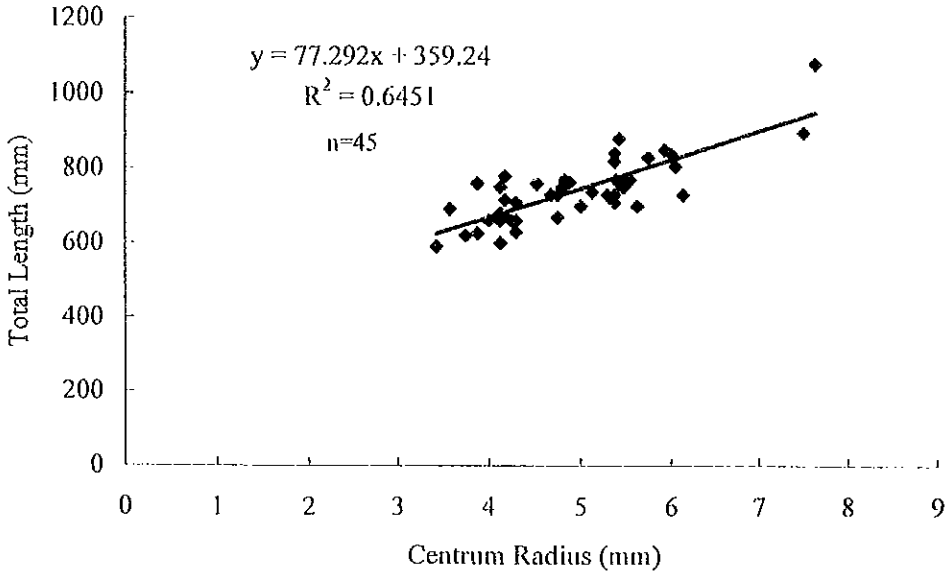

Figure 7.15 Relationship between total length and centrum radius of smooth-hound *Mustelus mustelus*.

Of 110 centra examined, rings were readable only in 70 (64 %), the remaining 40 having obscure rings. Causes for this might reside in: (1) centrum preservation methods; (2) etching methods; (3) staining methods; (4) living environment; (5) effects of diet or breeding condition, etc.

A sectioned centrum is shown in Figure 7.16. Rings were observed in the outer layer region A (corpus calcareum) and the center layer region B (intermedialia). Centra of smaller specimens had comparatively better defined rings, but in large ones the rings were more often obscured.

Marginal increment ratio (MIR) in centra is shown in Figure 7.17. MIR was relatively high in April and May and decreased in September and October. But the sampling was small, corresponding to only four months, and a study for the year round is not feasible. To understand the periodicity of ring formation, seasonal sampling cannot be incomplete.

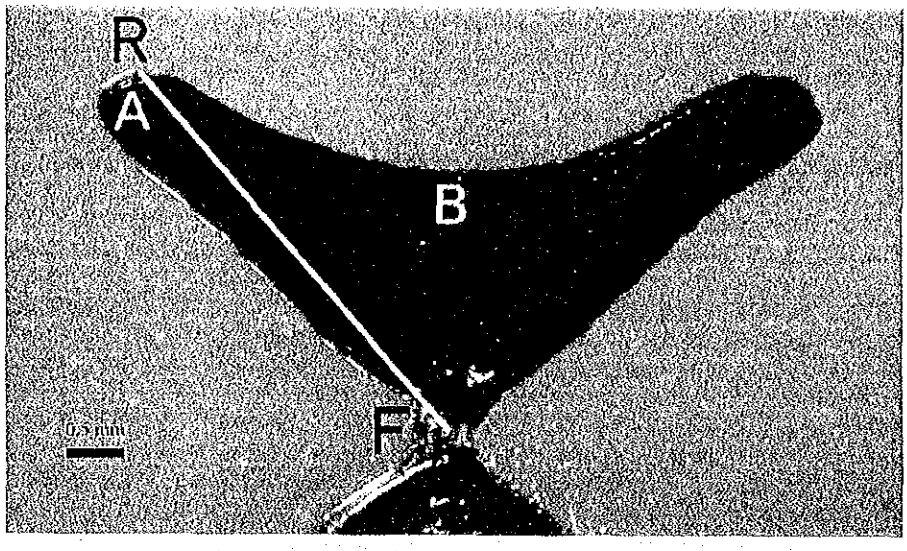

Figure 7.16 Centrum of smooth-hound *Mustelus mustelus*.
Female, 710 mm in total length, collected in May 2001.
F, focus; R, centrum radius; r1-r5, ring radii.

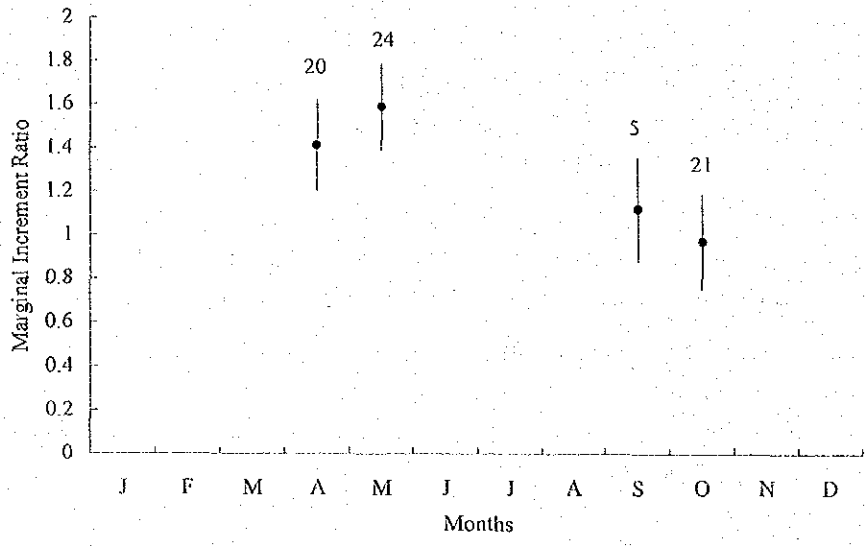

Figure 7.17 Marginal increment ratio in centrum of smooth-hound *Mustelus mustelus*.
Plots and bars show the mean and the standard deviation respectively.
Numbers above each month indicate sample sizes.

Table 7.12 shows sample count by age group and mean and standard deviation of the distance of each ring from the focus for smooth-hound *Mustelus mustelus*. Figure 7.18 shows the relationship between centrum radius and ring radius of ring group 3. Standard deviation of ring radius per ring group is small, and the ring radii in group 3 are generally distributed along their regression lines. It can be said that, for these samples, there was a correspondence between individuals in ring formation. However, there is a

need to increase the sampling and actively investigate possible correspondences in ring formation.

Table 7.12 Sample count by age group and mean and standard deviation of the distance of each ring from the focus for smooth-hound *Mustelus mustelus*.

Ring groups	N	Ring radius (mm)					
		r1	r2	r3	r4	r5	r6
1	2	1.47±0.48	2.07±0.64				
2	22	1.64±0.25	2.37±0.37	2.92±0.41			
3	30	1.67±0.34	2.38±0.42	2.88±0.46	3.25±0.47		
4	10	1.83±0.65	2.48±0.71	2.80±0.67	3.11±0.63	3.40±0.63	
5	6	1.51±0.25	2.23±0.41	2.75±0.49	3.17±0.46	3.48±0.47	3.70±0.47
Mean±SD		1.66±0.35	2.37±0.45	2.87±0.48	3.21±0.50	3.43±0.57	3.70±0.47
N		70	70	68	46	16	6

The relationship between the number of rings and total length (Figure 7.19) shows that, as the number of rings grows, body length also increases. The smallest (455 mm TL) and largest (850 mm TL) sharks in the sample had 2 and 5 rings respectively. Ring number range was 2–5 in males and 2–6 in females. The body length of an individual with 3 rings is compatible with that of a 3-year old specimen in South Africa, as reported by Goosen and Smale (1997). However, specimens with more than 4 rings in IRM waters were small in size. An increase in collection by season and by month is needed to understand the age/length relationship.

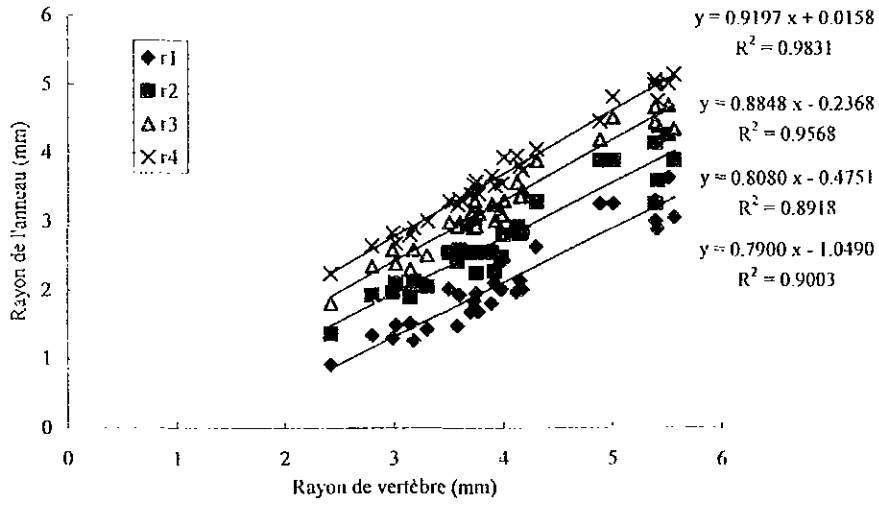

Figure 7.18 Relationship between centrum radius and ring radius of ring group 3 in smooth-hound *Mustelus mustelus*.

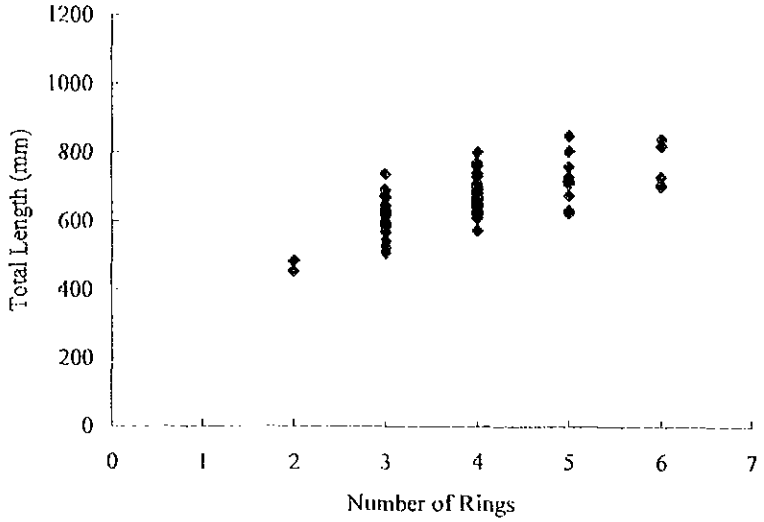

Figure 7.19 Relationship between the number of rings in centrum and total length in smooth-hound *Mustelus mustelus*.

7.3.4 Common octopus *Octopus vulgaris*

(1) Introduction

The common octopus *Octopus vulgaris* (Figure 7.20) is commercially the most important fisheries resource in IRM. It lives on a soft sandy or muddy bottom in coastal waters (Mangold, 1983), and attains a maximum size of about 10 kg (Roper *et al.*, 1984). In IRM, *Octopus vulgaris* is being harvested by trawlers, and most of the catch is exported to Europe and Asia. In recent years, the "octopus pot" fishing method has flourished among artisanal fishermen. Because of its importance, and aiming at resource management, the CNROP has been conducting resource analysis and evaluation based on information on biological characteristics like distribution, migration or reproduction, and catch data (see, for example, Mohamed Fall, 1999; Inejih, 2001). However, studies on age determination based on age characters are still limited.

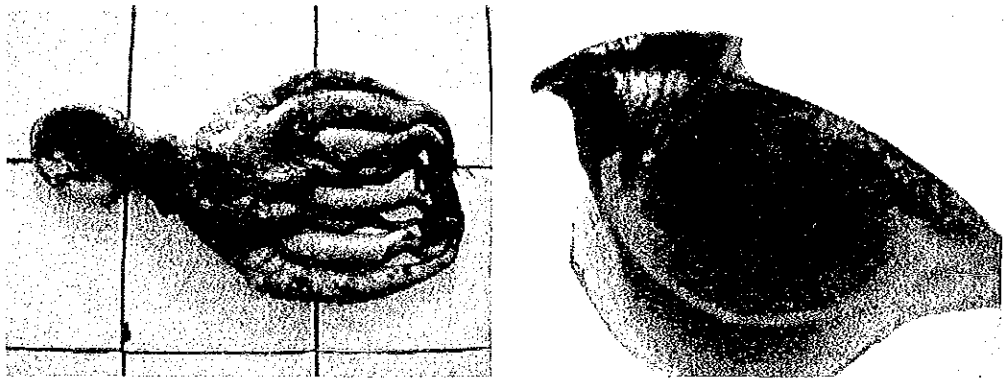

Figure 7.20 Common octopus *Octopus vulgaris* and its upper beak.

Age and growth studies for *Octopus vulgaris* have been conducted by various overseas researchers, with much research done based on size and weight frequency analysis for age estimation, laboratory rearing or tagging experiment for age verification (Table 7.13). However, the only study of age determination based on age characters is that of Raya & Hernández-González (1998), utilizing 25 specimens obtained from the Northwest African coast (21-26 °N), and observing and counting growth rings in the upper and lower sections of the beak.

Here, the methods for the utilization of beaks to determine the age of the common octopus *Octopus vulgaris* in IRM are presented, along with the results of ring observation.

Table 7.13 Previous studies on age and growth of common octopus *Octopus vulgaris*.

Country	Age determination methods					Estimated life-span(months)	Information based on
	Size frequency analysis	Weight analysis	Laboratory rearing	Tagging experiment	Beak microstructure		
North-West Africa	+					48 (male), 24 (female)	Hatanaka (1979)
-ditto-		+				> 24	Guerra (1979)
-ditto-					+	9 >	Raya and Hernandez-Gonzalez (1998)
Senegal				+		12-14	Domain *et al.* (2000)
South Africa		+				15 (male), 12 (female)	Smale and Buchan (1981)
France			+			12-18	Mangold and Boletzky (1973)

(2) Material and methods

Specimens of *Octopus vulgaris* were obtained on 3 April 2000 and 7 September 2001 from a research trawler operating in coastal waters of IRM (17°08' 77" - 17°52' 30" N) at the depth of 30-80 m. After capture, samples were frozen and taken to the laboratory, where they were defrosted, sexed and measured (dorsal mantle length [DML], total weight). Later, the upper and lower beaks were removed and preserved in 70% alcohol. The following measurement were taken: hood length (HL), rostral length (RL), shoulder-tip length (STL) and weight (Figure 7.21, Table 7.14).

Beaks were taken from a sample of 80 individuals and submitted to the following routine procedure. After being embedded in acrylic resin, they were sliced carefully into centro-sagittal sections (0.5-0.6 mm) with a linear precision saw so as not to drop the focus. These sections were mounted on glass slides with clear nail polish and left still for more than one night. Next they were grounded and polished with abrasive paper (JIS 2000 grade), Trident Cloth (commercial buffing cloth containing one-micron ground diamond paste), Mastertex (same, with liquid aluminium abrasive). Polished surfaces were etched with 30% HCl (exposure time, 10 minutes) or 8.5% disodium ethlenediaminetetraacetate (EDTA) solution (exposure time, 6-24 hours) and were observed with a binocular microscope under fiber scope reflected light. Viewing magnifications were 100–400x. Rings were counted by two readers and the mean value of those counts was recorded.

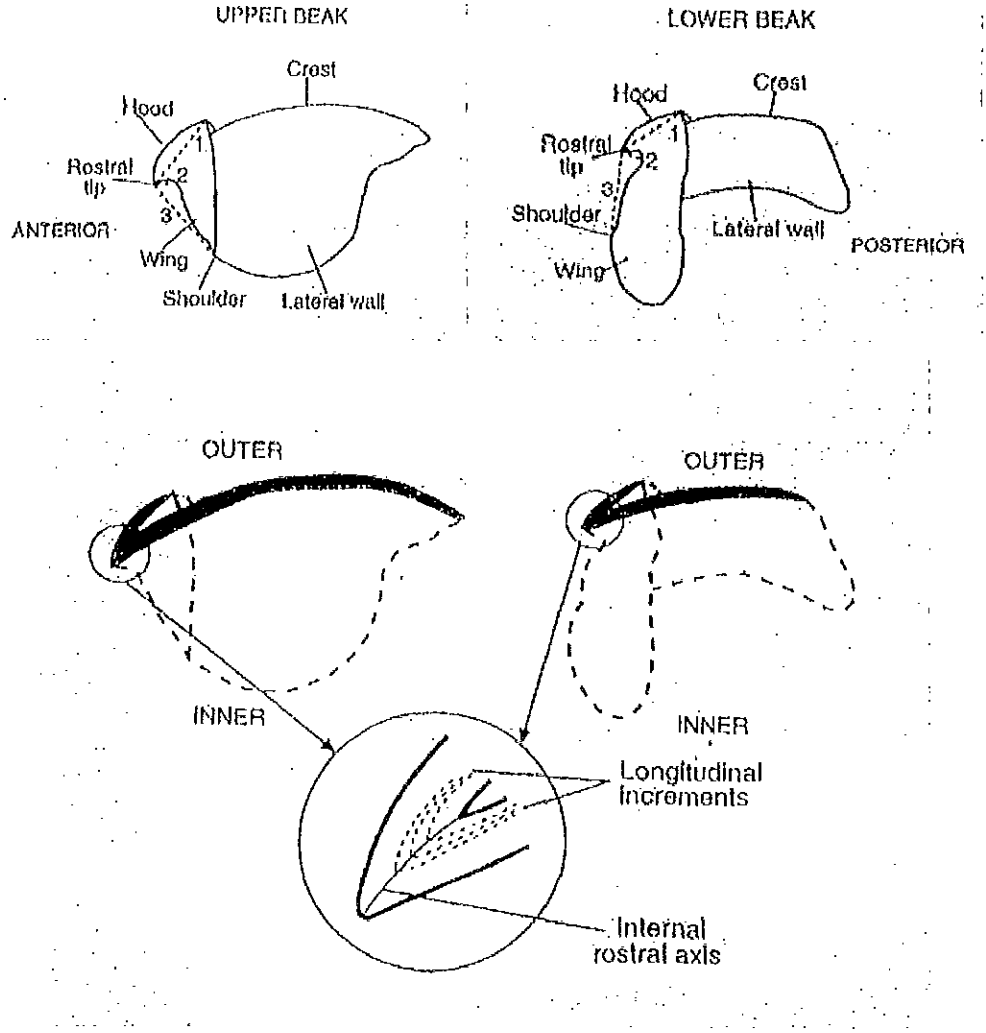

Figure 7.21 Diagrams of the upper and lower beaks of common octopus *Octopus vulgaris* (from Raya & Hernandez-Gonzalez, 1998).

Table 7.14 Data collected for 15 samples of *Octopus vulgaris*. Dorsal mantle length (DML), sex, hood length (HL), rostral length (RL), shoulder-tip length (STL) and weight of upper and lower beaks.

Sample	DML	Sex	Upper beak				Lower beak			
			HL(mm)	RL(mm)	STL(mm)	Weight(g)	HL(mm)	RL(mm)	STL(mm)	Weight(g)
1	78	F	5.1	2.1	4.2	0.04	3.2	1.8	4.5	0.02
2	67	F	5.1	1.9	4.2	0.03	3.6	2.1	4.8	0.03
3	75	M	5.5	1.8	4.2	0.04	3.8	1.8	5.1	0.03
4	68	M	4.8	2.2	4.5	0.04	3.2	1.5	4.2	0.03
5	93	F	5.8	2.2	4.8	0.05	3.8	2.0	4.5	0.04
6	145	F	7.8	3.2	6.8	0.11	5.1	2.8	5.5	0.08
7	88	M	5.2	2.1	4.2	0.03	3.6	1.7	4.3	0.03
8	101	F	5.9	2.9	5.2	0.05	3.8	1.9	4.5	0.04
9	77	M	5.1	1.5	4.1	0.03	3.2	2.2	4.1	0.02
10	85	F	5.8	2.1	4.8	0.05	3.8	2.2	4.5	0.04
11	68	M	4.2	1.9	3.8	0.02	2.9	1.9	3.2	0.02
12	102	F	6.1	2.2	5.8	0.05	4.2	2.2	4.3	0.05
13	132	M	7.0	3.0	5.8	0.08	4.8	2.2	4.8	0.06
14	89	F	5.8	2.2	4.3	0.04	4.1	2.2	3.8	0.03
15	78	M	5.0	2.1	4.2	0.04	3.2	1.6	3.5	0.03

(3) Results and discussion

The relationship between hood length (HL) and dorsal mantle length (DML) is presented for upper and lower beaks in Figure 7.22. The coefficient of correlation is larger in upper beak than in their lower counterparts. This relationship points out to the possible use of the upper beak and DML.

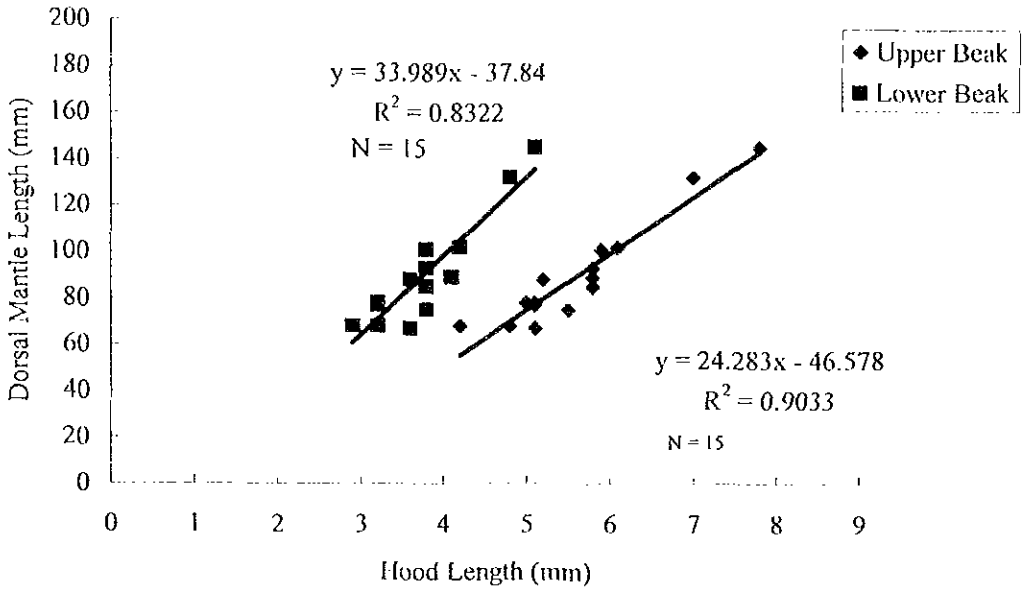

Figure 7.22 Relationship between dorsal mantle length and hood length of common octopus *Octopus vulgaris*.

The relationship between the length of the internal rostral axis (IRA) and dorsal mantle length (DML) is shown in Figure 7.23. No obvious change is discernible in the IRA in relation to the DML, or between upper and lower beaks. In the future, a larger sample should be studied.

Rings in the upper and lower beaks were observed along the IRA (Figure 7.24). However, by the time of the 2000 Survey, rings were not clear, and when they were seen, their identification was questionable and their total count was unfeasible. Also, rings were better identifiable on the posterior side than on the anterior one, and the former numbered from 5 to 20. Poor ring visibility was probably due to any of the following two reasons: (1) the possibility of the grinding process having been too fast and intense, scraping off a portion of the IRA; or (2) the possibility of HCl not being suitable for etching beaks of *Octopus vulgaris*.

In the 2001 Survey, beak samples were cautiously ground and at the same time etched with EDTA. The results of 35 beak specimens allowed for the reading of rings (Figure 7.25).

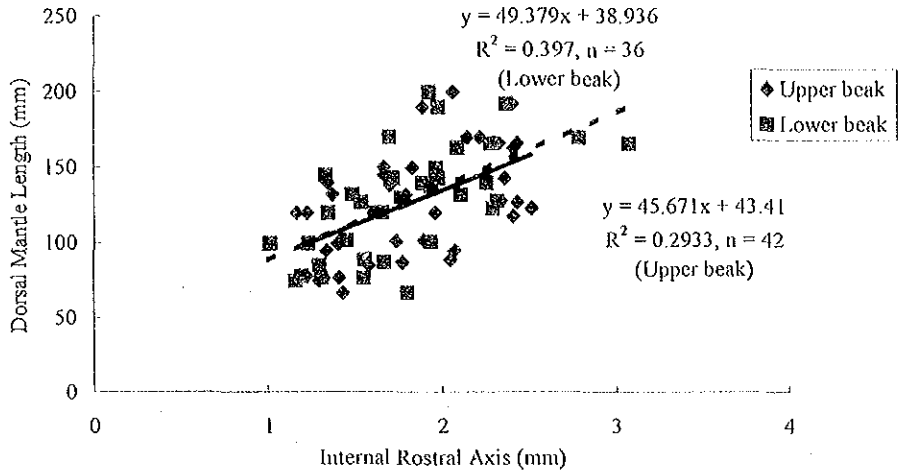

Figure 7.23 **Relationship between the length of internal rostral axis and dorsal mantle length of common octopus *Octopus vulgaris*.**

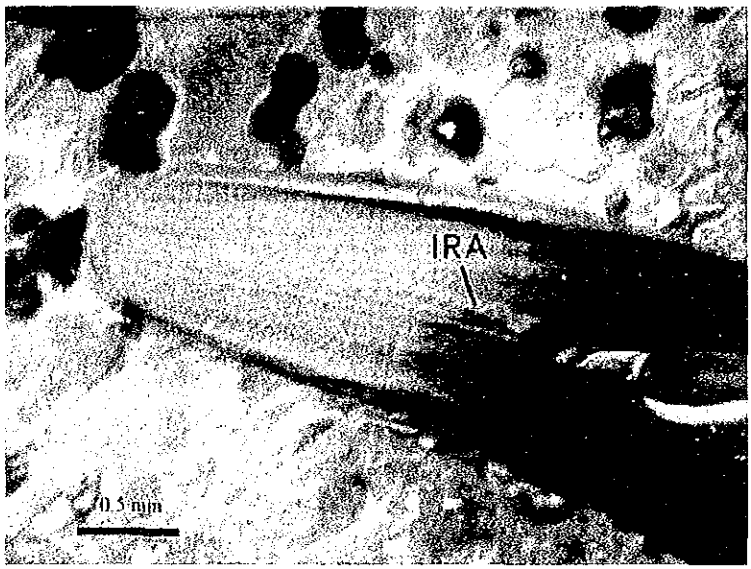

Figure 7.24 **Centro-sagittal section of common octopus *Octopus vulgaris* upper beak, showing rings along the internal rostral axis (IRA).**

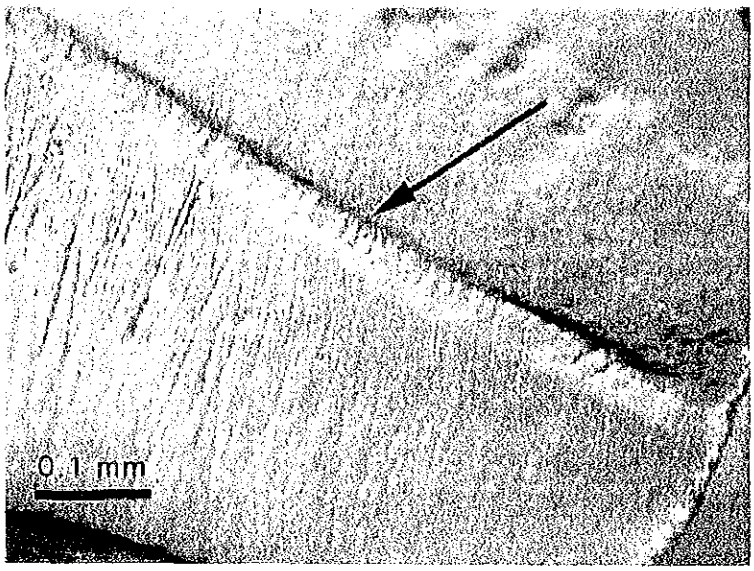

Figure 7.25 **Rings (black arrow) in upper beak section of common octopus *Octopus vulgaris*.**
Female, 101 mm in dorsal mantle length, collected in April 2000.

Ring count range was 45–199, the respective extremes being the upper beak of two females, one 77 mm and the other 200 mm (Table 7.15)

Table 7.15 Internal rostral axis (IRA) and ring count in upper and lower beaks of common octopus *Octopus vulgaris*.

Specimen No.	DML	Sex	IRA		Increment count	
			Upper beak	Lower beak	Upper beak	Lower beak
1	101	F	1.73	1.93	102	99
2	140	F	1.34		122	
3	145	F	1.66	1.33	108	
4	75	M	1.29	1.16	78	
5	170	F	2.21	2.78	110	134
6	120	F	1.60	1.65		110
7	170	M	2.14	1.70	150	165
8	143	F	1.95	1.98	51	64
9	87	F	1.77	1.67	76	
10	128	F	2.33	2.31	93	95
11	163	M	2.41	2.09		76
12	192	M	2.40	2.37	180	
13	143	F	2.36	1.72	178	166
14	89	F	2.05	1.55	74	
15	130	M	1.76	1.76		90
16	166	F	2.43	3.07		146
17	140	M	1.70	1.89		88
18	127	F	2.43	1.54		81
19	120	F	1.22	1.35	120	125
20	100	M	1.40	1.01	84	61
21	132	M	1.37	1.48	150	160
22	200	F	2.06	1.93	199	
23	166	F	2.32	2.27	189	189
24	140	M	1.71	2.25	90	100
25	132	F	1.79	2.11	89	110
26	120	F	1.16	1.61	57	
27	100	F	1.41	1.23	67	
28	77	F	1.32	1.31	45	
29	67	F	1.39	1.70	55	65
30	75	F	1.30	1.28	80	71
31	145	M	1.79	1.46	120	130
32	101	F	1.55	1.64	90	82
33	77	F	1.12	1.01	80	
34	102	M	1.89	1.45	60	
35	115	M	1.55	1.68	90	78

The relationship between the number of rings and DML of common octopus *Octopus vulgaris* is shown in Figure 7.26.

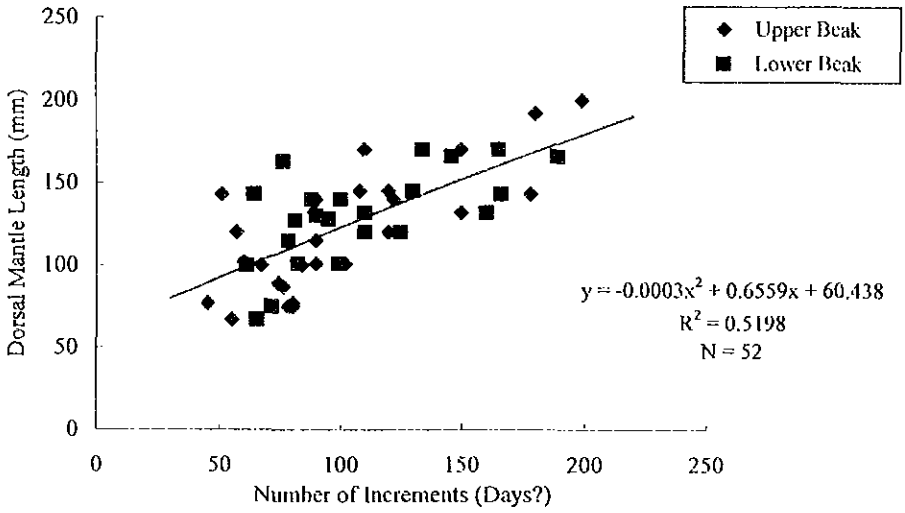

Figure 7.26 Relationship between the number of rings and dorsal mantle length of common octopus *Octopus vulgaris*.

The sample size (29 upper beak, 23 lower beak) was small, but a positive correlation was found between ring count and DML. To date, beak age validation has not been studied in the common octopus. However, based on ring width, ring count/DML relationship and experimental rearing, Raya & Hernandez-Gonzalez (1998) indicated the rings are possibly deposited on a daily basis. Assuming those are indeed daily rings, the age (in days) / DML relationship can be illustrated in Figure 7.26.

A recent study of *Octopus vulgaris* in IRM using beaks of spent females caught in the spawning season, revealed a ring count of 140–175. This suggests a short lifespan of around 5-6 months for the common octopus (Raya, pers. comm.). In the present survey, individuals of *Octopus vulgaris* also collected during the spawning season had a maximum ring count of 199. Further studies, including on age validations, are necessary in order to explain the relationship between age and DML.

7.3.5 European squid *Loligo vulgaris*

(1) Introduction

The European squid *Loligo vulgaris* (Figure 7.27) is one of the most important species caught by trawlers operating in the coast of IRM. They live at depths between 10 and 150 m (Worms, 1983) and believed to spawn in winter on the Saharan Bank (Raya *et al.*, 1999).

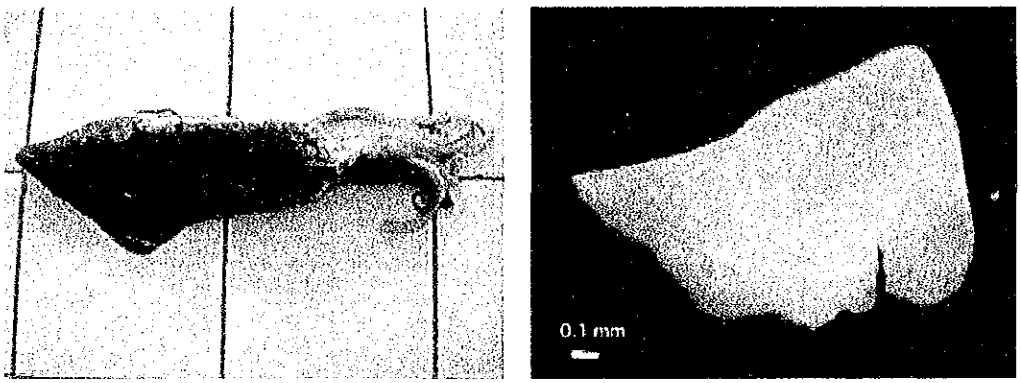

Figure 7.27 European squid *Loligo vulgaris* and its statolith.

Previous studies on age determination of this species have either resorted to size frequency analysis or to reading age characters (statoliths). Many papers in the former category have estimated the life span of the European squid in 2–4 years (for instance, Mangold, 1963). However, in general, size frequency analysis requires that for each year the spawning period should be well defined and short-term, otherwise the estimation of age is unfeasible. Therefore, catch data are of little value by themselves, and should be compared with the results of the alternative method of examining statolith rings (Arkhipkin, 1991).

In the 1990s, studies on the age determination of *Loligo vulgaris* utilizing statoliths were flourished (Natsukari & Komine, 1992; Arkhipkin, 1995; Raya *et al.*, 1999; Rocha & Guerra, 1999; see Table 7.16). These studies have shown that the life span of *Loligo vulgaris* is of about one year.

Although age determination techniques for squids using statoliths is a matter of great concern for the CNROP, so far there has not been an opportunity to learn techniques relating age (in days) determination with sample structure or ring measurements. Here, techniques are introduced on how to prepare *Loligo vulgaris* statolith, at the same time as the results of age determination on this species are presented.

Table 7.16 Previous age determination studies for European squid *Loligo vulgaris*, using statoliths.

Study area	Maximum number of increments	Information based on
French Mediterranean coast	236(male,277mmDML),179(female,174mmDML)	Natsukari and Komine(1992)
North-WestAfrica(21-23° N)	396(male,498mmDML),335(female,290mmDML)	Arkhipkin(1995)
North-WestAfrica(21-26° N)	308(male,534mmDML),294(female,285mmDML)	Raya *et al.*,(1999)
North-westSpain	382(male,383mmDML),361(female,255mmDML)	Rocha and Guerra(1999)

(2) Material and methods

Statoliths were extracted from 97 specimens (Figure 7.28) ranging from 68 to 365 mm in dorsal mantle length (DML), which were collected by R/V Al-Awam (bottom-trawls) on September 2000 and October 2001 from Mauritanian waters (16°30'68"-17 °51'32"N) at depth of 30-200 m. Extracted statoliths were washed in water and preserved in 90% alcohol in separate vials.

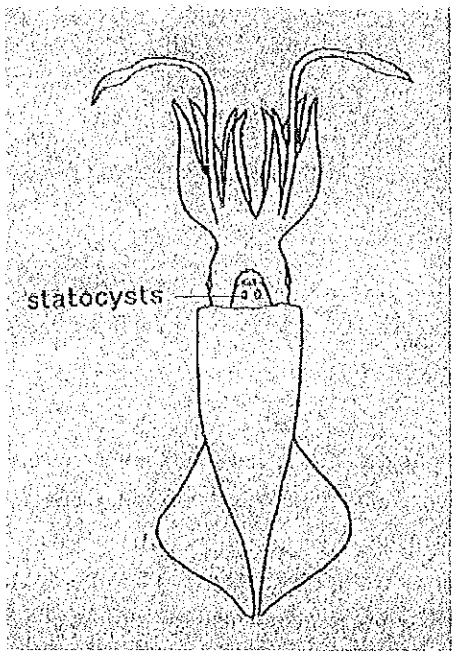

Figure 7.28 Location of statoliths.

Statolith preparation closely followed the methods of Natsukari & Komine (1992) for *Loligo vulgaris* in the Mediterranean. First, a small quantity of Unifast II powder (superfast ordinary temperature layered resin) was slowly placed with a earspoon on the center of a glass slide. Next, liquid Unifast II was brushed on the powder again in a small amount. After ten seconds the Unifast piled up and adhered, and the statolith was placed on top of the resin with the convex side up. At this point, a poor positioning of the statolith could have resulted in the rings being unreadable. The statolith was then covered with Unifast II powder (half an earspoon) and then with its liquid form: the entire set became sticky. Then a medicine capsule (of about 1 g) was sliced into a ring with scissors. The capsule was placed on top of the slide, the ring over the center of the statolith. A brush imbibed in liquid resin and dusted with powder sealed the gap between the capsule and the slide from the inner side. Then the liquid was dropped into the center of the capsule attached to the slide, and Bioresin powder (dental acrylic resin) sprinkled over the liquid. The whole set was left aside for half a day to a full day to harden.

The grinding procedure was as follows. The capsule was stripped off the resin block embedding the

statolith, and the useless portions of the block cut away with a knife. Then the remaining block was ground flat with waterproof sandpaper (JIS 800 grade). The side where the statolith was embedded was ground with finer sandpaper (JIS 1000 grade). As the grounding went on, the set was placed on the slide with the portion containing the statolith facing up. A drop of water was placed on the polished face, followed by a slide cover. Observations were made in a biological microscope, with a 150–300x magnification. The whole grinding and polishing process should have been done with care so as not to lose the focus or leave opaque portions. The final thickness of the properly prepared resin block was about 0.1 mm. Finally, Canada balsam was dropped onto the slide for the portions in the block not occupied by the statolith. The statolith side was then enclosed and fixed with Canada balsam and a slide cover.

Rings were counted from the focus to the termination of the rostrum (Figure 7.29). Measurements were taken over a TV monitor by two observers, and the mean value of their readings was recorded. Statoliths with over 10% of opaque areas where rings could not be read were not measured.

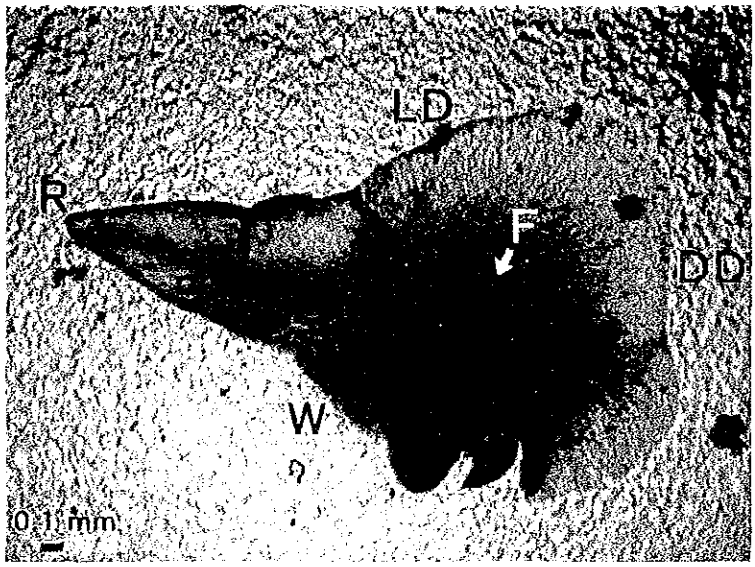

Figure 7.29 Full view of a prepared statolith of European squid *Loligo vulgaris*.
Male, 245 mm in dorsal mantle length, collected in September 2000.
F, focus; R, rostrum; LD; lateral dome; DD, dorsal dome; W, wing.

(3) Results and Discussion

Figure 7.30 shows the relationship between statolith radius (distance between the focus and the rostrum extremity) and dorsal mantle length (DML). Small squids had statolith radius values distributed approximately along their regression lines, but in large individuals they are widespread. The maximum difference between radii was as small as 0.6 mm. This suggests that statolith rings should be closely spaced and difficult to measure in large individuals.

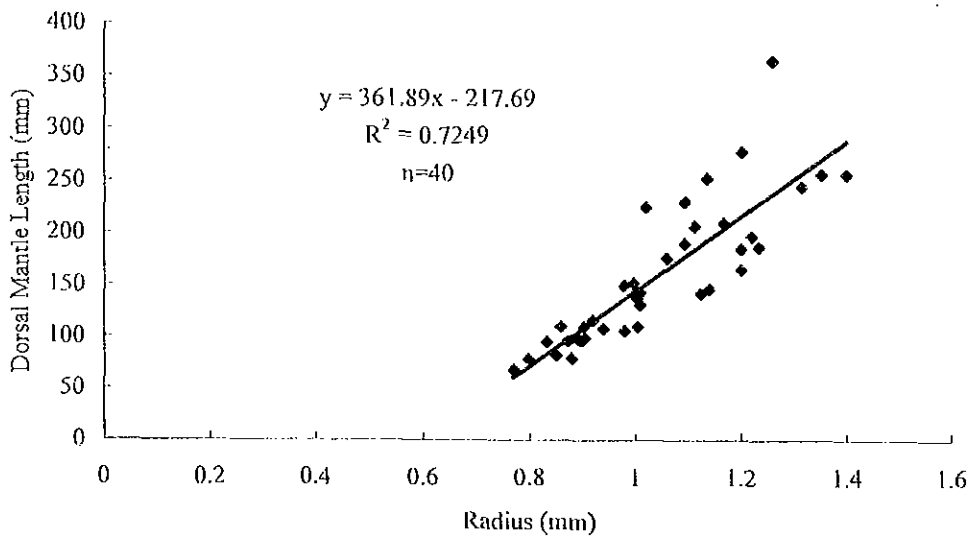

Figure 7.30 Relationship between statolith radius and dorsal mantle length of European squid *Loligo vulgaris*.

The method of statolith sampling and preparation was laborious and time-consuming. Grinding a statolith of one squid typically required 45-60 minutes. Among 60 prepared statoliths, 36 would successfully allow to observe and count rings (Table 7.17). Ring width varied from thin near the focus to thick closer to the rostrum (Figure 7.31). The space between rings varied from a narrow 0.005 mm to a wide 0.02 mm. Ring count range was 100–275. This number was about 10% less than that reported for individuals of the same size and species by Natsukari & Komine (1992) and Raya *et al.* (1999).

Table 7.17 Radius and ring count in statoliths of European squid *Loligo vulgaris*.

Specimen No.	DML (mm)	Sex	Radius (mm)	Ring count
1	98	M	0.89	120
2	142	M	1.00	150
3	187	F	1.23	162
4	230	M	1.09	202
5	278	M	1.20	232
6	365	M	1.25	275
7	79	F	0.87	101
8	210	M	1.16	200
9	197	M	1.22	198
10	245	M	1.31	202
11	165	F	1.19	182
12	207	F	1.11	190
13	137	M	1.00	105
14	142	M	1.12	170
15	257	M	1.35	180
16	185	F	1.20	160
17	68	F	0.77	102
18	152	F	0.99	150
19	146	F	1.13	160
20	82	?	0.85	120
21	190	M	1.09	180
22	150	F	0.97	148
23	97	?	0.89	115
24	116	M	0.92	120
25	131	F	1.01	155
26	96	?	0.87	101
27	78	?	0.79	104
28	176	F	1.06	188
29	143	M	1.01	120
30	110	M	0.90	120
31	95	?	0.83	104
32	110	?	0.86	100
33	99	M	0.90	120
34	97	?	0.90	105
35	106	F	0.98	120
36	110	M	1.00	110

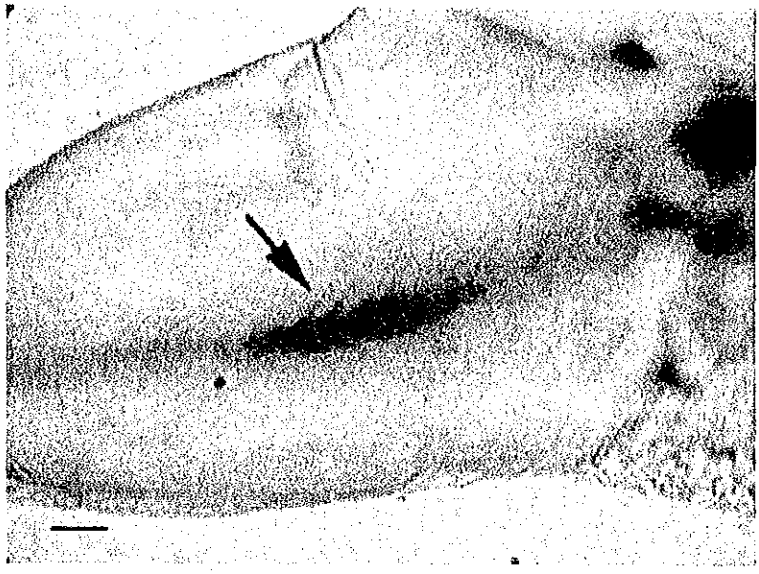

Figure 7.31 Statolith of European squid *Loligo vulgaris*.
Male, 278 mm in dorsal mantle length, collected in September 2000.
Rings (black arrow) are observed between focus and rostrum.

The relationship between the number of rings and DML is shown in Figure 7.32. Distribution for both has little spread and a quadratic equation was established. No significant difference in growth between male and female was found, although other authors found males were larger than females (Raya *et al.*, 1999; Rocha and Guerra, 1999). A larger sample and active research are in need.

In the European squid *Loligo vulgaris*, there is evidence that growth rings are deposited daily (Lipinski, 1986). Furthermore, growth rings were also shown to be daily in laboratory reared (direct method) Eastern Atlantic squid *Loligo forbesi* (Hanlon *et al.*, 1989). Assuming that rings are indeed deposited daily in *Loligo vulgaris*, results from this survey suggest a minimum age of three months for a female of 68 mm DML, and a maximum age of 9 months for a male of 365 mm DML in the sampled material. These findings are consistent with a one-year life cycle for the species in Western Sahara (Raya *et al.*, 1999).

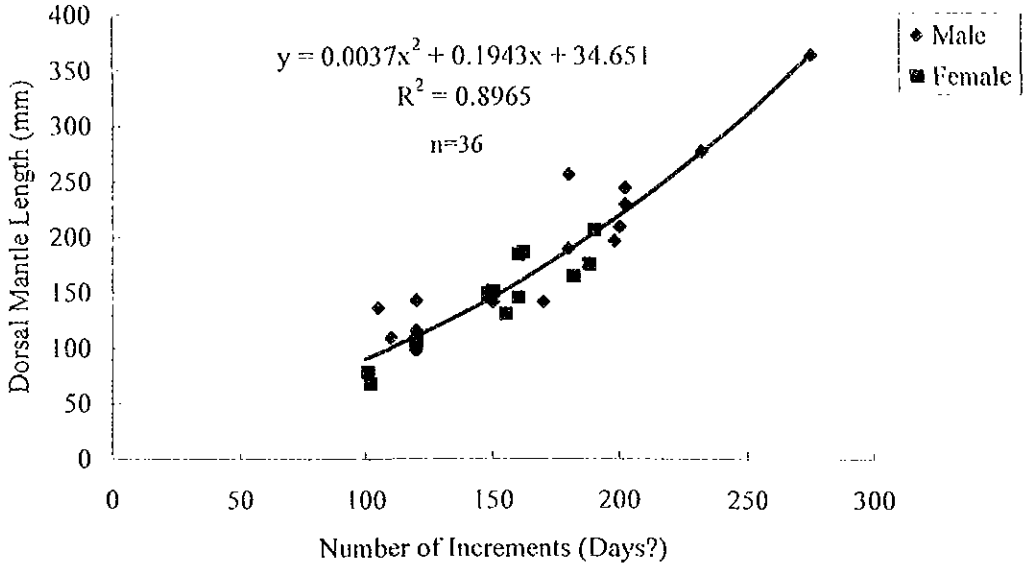

Figure 7.32 Relationship between the number of rings and dorsal mantle length of European squid *Loligo vulgaris*.

7.4 Recommendations

To sustain and upgrade research in the CNROP, the following recommendations are set forth:

1. The Joint Study Team conducted age and growth research and surveys for two years. Following the stated objectives, it developed age determination techniques for important fish and cephalopod species, and data analysis methods were actively relayed to IRM counterpart as transfer of technology. However, except for the case of the bluespotted seabream *Pagrus caeruleostictus*, of which monthly samples could be obtained, many questions remain unsolved on the age of target species. Exactly how old are the small and large individuals? In other words, are rings indeed formed once a year (or once a day in cephalopods)? Such questions could not be correctly answered. The CNROP should continuously conduct age determination with a size differential, by collecting a larger sample by month and by season.

2. It is strongly recommended for researchers and technicians to write scientific papers for publication in the CNROP periodicals *(Bulletin Scientifique, Documents Techniques)* and/or in international journals. Much of the work conducted by the Joint Study Team on age determination was done for the first time in IRM, or even in Africa, and therefore its results should be made public. Papers and reports would facilitate information exchange between the CNROP and fisheries research institutes abroad – e.g. in Senegal, Guinea, Morocco, Tunisia, Spain, etc. – countries where fisheries investigation is expanding. Much research information and aid could be obtained, and the level of research at the CNROP would also increase.

3. Fishery resources are subject to changes, and resource assessment demands continuous implementation. As the sole fisheries research institute in the country, the CNROP must positively engage in fisheries investigation that involves age determination. Determining target species and collecting samples would not only allow for age and growth studies, but also for investigating distribution, migration, maturation, spawning, feeding habits, early life history and much other research. A multilateral approach for the realization of survey and research of target species would be indispensable for the assessment and management of resources.

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8. LANDING SITE SURVEY

8.I. SOCIOECONOMIC ASPECTS

8.I.1 Introduction

(1) Context and objectives

This chapter reports on the results of the socioeconomic part of the Project "Study for the Management Plan of the Fishery Resources in the Islamic Republic of Mauritania". The socioeconomic study was part of the Landing Site Survey and had as its terms of reference the collection and analysis of socio-political and economic data. Based on this general mandate, the socio-economist consultant in charge of this work first surveyed the general features of the fisheries sector in Mauritania and identified a number of pertinent studies to conduct within the framework of the Project. Among the many important themes considered, the following studies were selected and carried out:

- *Description of the marketing and distribution system and of the export industry, and its role in financing the primary production subsector.*
- *Analysis of the labor structure and the importance of the employment generated by the fisheries sector.*
- *Review of the management measures hitherto applied, and their advantages and shortcomings from a sociopolitical perspective.*

In addition to these main studies, a number of other related subjects were also included in the work, i.e., the need to establish a *socioeconomic database, the participatory approach, and the analysis of some profit and loss accounts of a number of fishing methods employed by artisanal fisheries.*

(2) Study periods

The work related to the socio-economic study was carried out during the following periods:

1. 29 April – 5 June 2000
2. 22 September – 23 October 2000
3. 27 February – 6 April 2001
4. 9 October – 26 October 2001

(3) Study team

Japanese side: Ms. Lena Westlund (OAFIC / JICA)

Mauritanian side: Dr. Thiam Ismaïla, head of the Laboratory of Socioeconomic Analysis (LASE) / CNROP
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(4) Outline of the chapter

Following this introductory paragraph, the sections below give an overview of the general structure and the economic importance of the fisheries sector in Mauritania. Then the role of socioeconomics in resource management is discussed, both in general terms and more particularly within the context of Mauritania and the current Project. Section 8.I.2 presents the results of the above-mentioned studies conducted, and their conclusions are further developed and summarized into recommendations in Section 8.I.3. References are found in Section 8.I.4. The Appendices include details on the methodology utilized and on some of the results.

(5) General structure of the fisheries sector in Mauritania

Fisheries in Mauritania represent an activity that has been only recently developed; traditionally, foreigners have mostly exploited the territorial marine waters of the country. Dutch fishermen were the first to be attracted to the Mauritanian coast in the 18th Century, followed by the Portuguese and the Spanish. The French were at first discouraged by the lack of fresh water and the natural hostility of the environment, but in 1906 they created a permanent mission for fisheries research. This initiative was followed by the arrival of lobster fishers from Bretagne, as well as by the creation of SIGP in 1919, the largest fish drying facility in West Africa, and it was around this company that the town of NDB evolved, having become today the only center for industrial fisheries in the country. The traditional fishermen of Mauritania are mainly the Wolofs from the village of N'Diago in the south, near the Senegalese border, as well as the Imraguen communities along the coast between NDB and NKC.

It was only towards the end of the 1970s that Mauritania really began to become aware of the importance of the fisheries sector for the economic and social development of the country. Despite the youngness of the sector, there is a relatively large variety of fisheries, still with a significant participation of foreign exploiters both in the artisanal and industrial sectors. Overall, one notices the almost complete absence of coastal fisheries – like the ones that exist in Senegal, for instance – and resources are exploited mainly by industrial units or by artisanal craft, all motorized except for the Imraguen canoes within the National Park of Banc d'Arguin (PNBA) where all motorization is prohibited. The artisanal fishery sub-sector grew rapidly in the south in the 1990s with Senegalese migrant fishermen taking part along with the Mauritanians. It is estimated that there are between 2,000 and 3,000 canoes of different types. Certain artisanal fishing methods are seasonal, and a given boat or fisherman can take part in different activities according to the season, the opportunities offered and the fisherman's know-how. Table 8.I.1 shows schematically the different fishing methods by geographical zone.

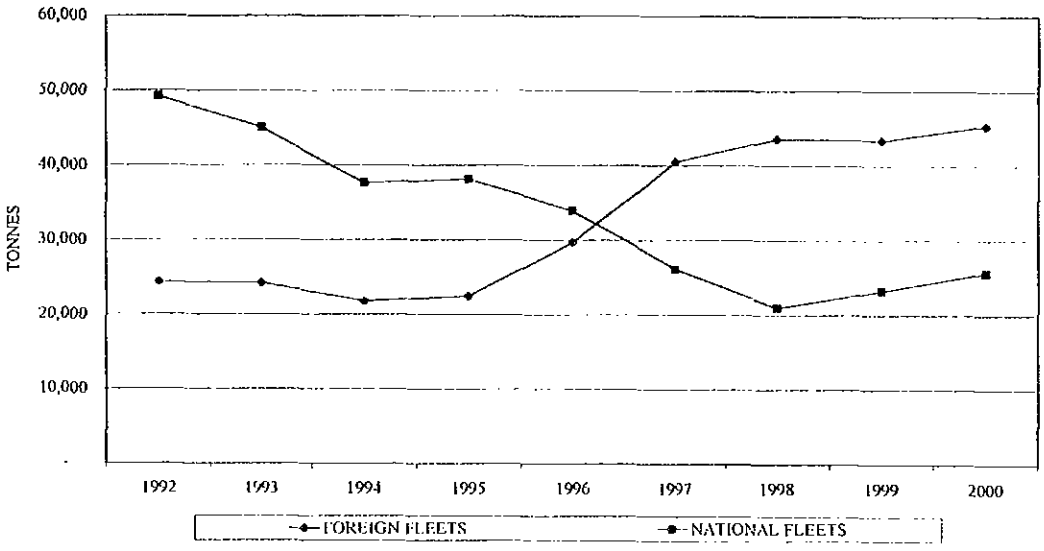
Table 8.I.1 Main fishing methods employed by Mauritanian marine fisheries according to their geographical zone.

Zone	*Main fishing methods*	*Commercial actors*
North – NDB	IF trawlers, foreign (and national) / pelagics; IF trawlers (ice/freezer vessels), foreign and national / demersals, shrimp, cephalopods, hakes, lobsters, tunas; AF pots / octopus *(Octopus)*; AF flatfish gillnets / soles (Soleidae); AF hand lines/ demersal (high-value species); AF longlines / demersal (high-value species); AF gillnets / dogfish (*Mustelus mustelus*); AF gillnets / meagre (*Argyrosomus regius*); AF gillnets / lobsters	Export companies / processing plants; Mauritanian and subregional wholesalers; Processors and wholesalers for local markets.
Imraguen fishing communities / PNBA Zone	AF castnets (traditional Imraguen fishing technology) / mullets *(Mugil spp, Liza aurita)*; AF sailboat & gillnets / rays & sharks; AF sailboat & fixed gillnets / mullets, pelagics; AF sailboat & gillnets / jewfish; AF sailboat & hand lines/ demersals.	Traditional processors; Mauritanian and subregional wholesalers / processors; Representatives of export companies / processing plants.
Imraguen south of PNBA / Mamghar/Jreif - NKC Zone	AF castnets (traditional Imraguen fishing technology) / mullets; AF ringnets / mullets ; AF fixed gillnets / mullets, pelagics; AF flatfish gillnets / soles; AF gillnets / cephalopods; AF cages / cuttlefish (*Sepia*); AF pots / octopus; AF jig hooks / octopus; AF gillnets / demersals; AF hand lines/ demersals AF longlines / demersals.	Seasonal camps (Senegalese and Southern Mauritanian fishermen); Mauritanian and subregional wholesalers / processors; Representatives of export companies / processing plants.
NKC	AF hand lines/ demersals; AF longlines / demersals; AF flatfish gillnets / soles; AF gillnets / demersals; AF ringnets / mullets, pelagics; AF fixed gillnets / mullets, pelagics; AF encircling nets / mullets, pelagics; AF gillnets / cephalopods; AF cages / cuttlefish; AF trammel nets / cuttlefish; AF pots / octopus; AF jig hooks / octopus.	Export companies / processing plants; Mauritanian and subregional wholesalers; Processors and wholesalers for local markets.
South of NKC	AF hand lines/ demersals; AF longlines / demersals; AF flatfish gillnets / soles; AF gillnets / demersals; AF ringnets / mullets, pelagics; AF fixed gillnets / mullets, pelagics; AF encircling nets / mullets, pelagics; AF gillnets / cephalopods; AF cages / cuttlefish; AF trammel nets / cuttlefish; AF trammel nets / lobsters; AF jig hooks / octopus.	Seasonal camps (Senegalese and Southern Mauritanian fishermen; Mauritanian and subregional wholesalers / processors; Representatives of export companies / processing plants.

IF = industrial fisheries; AF = artisanal fisheries.
Source : First Survey Report, June2000.

The industrial fisheries in Mauritania are essentially a demersal fishing activity with octopus as the main species, even if there are small boats targeting finfish. Other fisheries are

exploited by foreign fishing boats chartered by Mauritanian operators or operating under fishing licenses within the framework of fishery treaties between Mauritania and the foreign countries in question, or under agreements made directly between the foreign boat owner and the Mauritanian Government. The European Union (EU) fishing fleet is particularly noteworthy, operating an important number of vessels targeting demersal species. Figure 8.I.1 shows the evolution of the division of demersal fish catches between domestic and foreign industrial fleets, and one notices the importance of the latter after 1996, when the fishing protocol with the EU was signed.



Source : DSPCM, 2001.

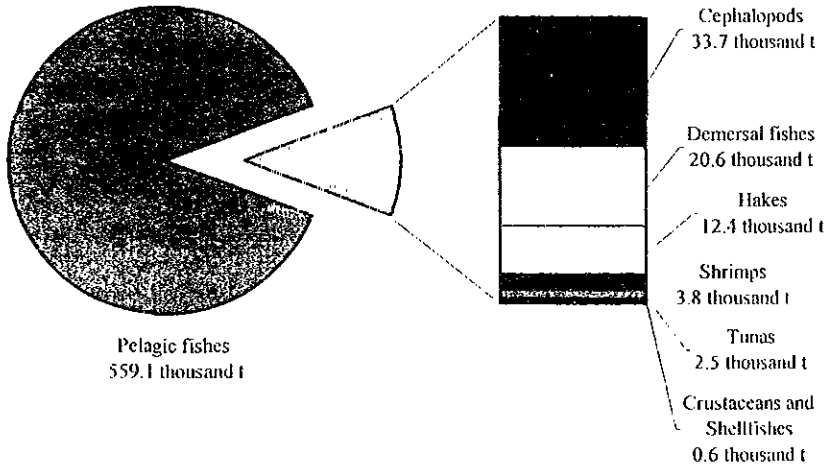
Figure 8.I.1 *Evolution of demersal fish catches by domestic and foreign fleets from 1992 to 2000 (including cephalopods and crustaceans).*

With regard to the marketing and distribution system, the strong increase in the number of export companies that have processing plants is noticeable throughout the 1990s. There are some fifty of these companies today of which 43, based in NDB and NKC, have obtained export authorizations according to the quality and health regulations of the EU. These companies target the European and Asian (Japanese) markets, and the Mauritanian production of demersal species is primarily destined for these export markets.

Fishery products are exported fresh or frozen, often whole (or eviscerated) and sometimes filleted. Traditional Imraguen processing is done by women utilizing mullets. However, since six or seven years, commercial fishing for exports has become more important, and artisanal processing is being done less and less to the point of disappearing in some places. Mullet fishing goes on, but it has lost its primacy of before. There is also a fishery oriented towards the

subregional markets, where the demand for processed fish (dried and salted or fermented and dried, the "guedj") is very strong. Some of the processors are foreigners, but there is but a faint participation of women in this subsector, particularly in NDB. Ray and shark fin exports to Asia also often go through a chain of subregional middlemen. Local markets usually are stocked only with fish that cannot be exported.

A large portion of the catches by foreign industrial fleets – particularly small pelagic fishes, hakes, tunas and shrimps - are exempted from the general rule of having to land on Mauritanian soil. Their processing is done on board, and the catch is transshipped at sea or directly landed in foreign ports. Volume-wise, these catches are significant and, according to the available statistics, probably represent some 90-95% of the total production, consisting especially of small pelagics. In 2000, the total industrial fishery catches attained over 632,000 tonnes (DSPCM, 2001). Figure 8.I.2 shows the distribution of this volume among the main species groups.

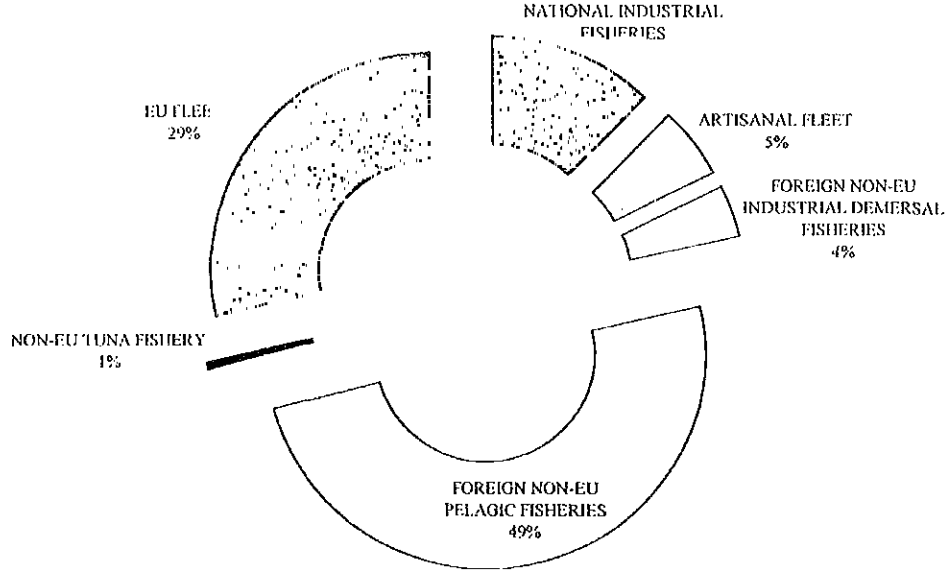


Source : DSPCM, 2001.

Figure 8.I.2 Industrial fishery catches by main species groups in 2000.

There is a lack of reliable information on artisanal fishery catches, and it is difficult to make a good estimate. An approximate estimate based on official statistics for the years 1991-1998 (CNROP, 1998c and 1999) gives a total volume of demersal catches of about 6,000 tonnes. However, according to the analysis of profit and loss accounts made in the present survey, the artisanal fleet targeting demersal species (including finfishes, rays and sharks, and cephalopods) needs to capture between 12,000 and 17,000 tonnes in order to show an overall operational account (see Table 8.I.15). Figure 8.I.3 illustrates, in a schematic way, the relative importance of the production – expressed in values – of the main fleets. For this end, the production of the artisanal subsector has been estimated to 10,000 tonnes in 2000, and this production quantity

has been recalculated into approximate export values[1].



Sources : DSPCM, 2001; SMCP, 2000; FAO, 2000; Seafood International, 2001;estimates.

Figure 8.I.3 Estimated division of catch value by the main fleets in 2000.

It can be seen that artisanal fisheries is relatively more important when expressed in values (5% of the total value) than in quantity (1–2% of the total quantity). It is also interesting to note that the prices paid to the artisanal fishers are higher than those obtained by the industrial subsector, thanks to the better quality of the former's production. Also, it must be emphasized that artisanal fisheries are an important component of the captures effectively landed in Mauritania. Only a small part of the non-EU industrial fleet lands its production locally.

(6) Macroeconomic importance of the fisheries sector

Fishery product exports represent a large portion of the budgetary revenues and the foreign currency earnings of Mauritania. In 1998, the total market value of fishery product exports represented some US$ 140 million, corresponding to 40% of the overall exports of the country (ONS, 1999 and 2000). Yet exports dropped in 1998 and 1997 in relation to 1996, when revenues were about US$ 265 million. For the years 1999 and 2000, no overall figures have been found, but according to the fishery statistics of the Customs Office and of the SMCP, exports have increased slightly in recent years, both in quantity and in value (SMCP, 2000).

[1] Values per species groups were estimated by using SMCP, 2000; FAO, 2000 and Seafood International, 2001: cephalopods / industrial fisheries 2.30 US$ /kg; cephalopods / pot traps, artisanal fisheries 2.60 US$/kg; tunas 1.50 US$/kg; hakes 2.50 US$/kg ; mixed demersal fishes / industrial fisheries 2.10 US$/kg; mixed demersal fishes / artisanal fisheries 2.50 US$/kg; pelagic fishes 0.50 US$/kg; shrimps 8.00 US$/kg; other crustaceans 4.50 US$/kg. Thus, the total value of the production in 2000 is estimated to be 493.6 million US$.

Nevertheless, despite its importance for national export earnings, the direct contribution of the fisheries sector to the GDP remains relatively insignificant: it represented about 6% in 1997 and had oscillated between 6 and 10% in previous years (CNROP, 1998a). This low added value indicates a trend to export raw, low-value products from Mauritanian territory, despite the increase in the number of processing plants for export products. It is, however, possible that the sector plays a more important role in an indirect way. It is hardly probable that the fishery export sector is isolated from the rest of the Mauritanian economy; it appears clear that the foreign currency earnings generated by the industry are used to finance imports – sometimes of vital importance to the country – through other sectors.

The fisheries sector is also a non-negligible generator of employment. An estimate made in 1998 indicates that some 32,000 permanent jobs exist in the sector (Hamadi *et* Ahmed, 1998). An estimate made in the present study gives a similar result: almost 30,000 people are employed by the sector (see Table 8.I.9). Of a working population of about 30% of the total population, the fisheries sector hence represent 4-5%.

Given the mostly agropastoral tradition of Mauritania, fish has never played a significant role in the nourishment of the country, except in the fishermen communities and for those living in the Senegal River basin. However, according to FAO (2000), the annual availability of fish for per capita consumption in 1997 was about 14 kg [2], which can be compared to the world average value of 16 kg (expressed in live fish weight; Laureti, 1999). Nevertheless, it appears that the role given to the fisheries sector within the strategic framework of the fight against poverty is to contribute to food security indirectly, through the creation of employment and income generation, rather than directly through food supplies.

(7) Management of fishery resources: the socioeconomic context

Like in many other countries and as noted above, the fisheries sector in Mauritania plays an important social and economic role. This contribution to the well-being of the population depends on a steady and sustainable production from the existing fishery resources. Accordingly, there is a great incentive for exploiting the resources in an efficient and careful manner, and thus for resource and fisheries management.

There is no clear and exact definition of resource and fisheries management. The Code of Conduct for Responsible Fisheries provides the following definition:

> *«The integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and accomplishment of other fisheries objectives* » (FAO, 1999a, page 7).

Based on this definition, it appears clear that management is a process that involves many

[2] This value seems too high, however, and its validity is questionable.

more aspects than only pure fish resources survey and research, which is in fact only one important element among many others. The Code of Conduct establishes that "humans are an integral part of fisheries systems and fisheries systems cannot be understood unless the social and cultural features and the economic characteristics of the people and communities within the system are understood" (FAO, 1999a, page 32). Therefore, it is necessary to ensure that the socioeconomic and political aspects are taken into consideration in all phases of the process of resource management. Factors to be taken into account include, among others, the role of the institutions involved in the sector, the characteristics of interest groups and their economic and social dependence on the fisheries sector, the economic costs and benefits resulting from the fisheries to the State, for the region and locally, the generation of employment for different interest groups, and the actual status of the access to the resources and the ownership of these resources. These aspects are often very dynamic, and thus it is important to regularly monitor the factors. It is equally important to understand the historical roles of different actors, and to know the past and present conflicts, as well as their causes, to allow those in charge of management coordination to better negotiate with the interest groups and avoid future conflicts. The fisheries sector, being based on resources that are the object of competition among their users, is often marked by diverse and even contradictory interests of these users and interest groups. If management plans are not generally accepted by those groups, or if they do not make allowance for the social, political and economic reality, they risk ending up having very little success (see also Section 8.I.2.(4) 2)).

(8) The socioeconomic studies of the Project and general methodology

The field of socioeconomics is vast, and when speaking of a socioeconomic study, it could cover many different quantitative and qualitative aspects. In Mauritania, there is a general lack of organized information on this matter, and even the collection and analysis of basic data is often difficult. Consequently, a careful choice of precise topics to study appeared necessary for the implementation of the socioeconomic part of the Project. The criteria for the selection of these study topics were:

- Their importance for the objective of the Project as a whole of formulating recommendations for a resource management plan;
- Their conformity with the priorities and other activities of CNROP and DEARH/MPEM, and their development partners;
- Their sustainability and importance beyond the duration of the Project itself;
- Their feasibility within the context of the time period and means available for the socioeconomic part of the Project.

The socioeconomic studies finally selected and implemented, and their respective objectives, are summarized in Table 8.I.2.

Table 8.I.2 Socioeconomic studies and their objectives.

Study	*Expected results and objectives*
Description of the marketing and distribution system and of the export industry, and its role in financing the primary production subsector.	A better understanding of the role of the export companies in the decision-making on the utilization of resources, so that the actual power structure of the industry can be considered in the formulation of recommendations for the management measures.
Analysis of the labor structure and the importance of the employment generated by the fisheries sector (on land and at sea, direct and indirect employment).	A better knowledge of the employment and people who will be affected by the management measures to be recommended.
Review of the management measures hitherto applied, and their advantages and shortcomings from a sociopolitical perspective.	A better idea of the features of the management measures hitherto applied and their apparent impact and efficacy, allowing for taking these experiences into consideration for the formulation of future management measures.

In addition to the main studies, work has been carried out on other themes related to the selected studies, namely:

- Discussions on the need of a socioeconomic data base that would allow for a regular supply of data related to the process of resource and fisheries management;
- Development of exploratory profit and loss accounts for the artisanal fisheries in order to better understand their financial structure and the economic conditions under which the subsector operates;
- Discussions on the importance of management in partnership and of participatory approaches to the efficacy of the implementation of management plans.

Figure 8.I.4 shows the work plan for the socioeconomic components and their relationship with the expected results of the overall Project, i.e., the recommendations for a management plan.

The socioeconomic studies were carried out during the consultant's four trips to Mauritania and in collaboration with her counterpart and other colleagues of CNROP. The data and information collection was done by means of interviews and discussions with resource persons, through semistructured interviews with various actors of the sector, field observations and questionnaires. The two large towns, NDB and NKC, demanded more attention than other sites as they are the most important fishery centers (they represent some 90% of the fishery activities of the country). In addition, two surveys covering the entire coast were also carried out. Appendices I and II give more details on the itinerary of the study team and the methodology utilized.

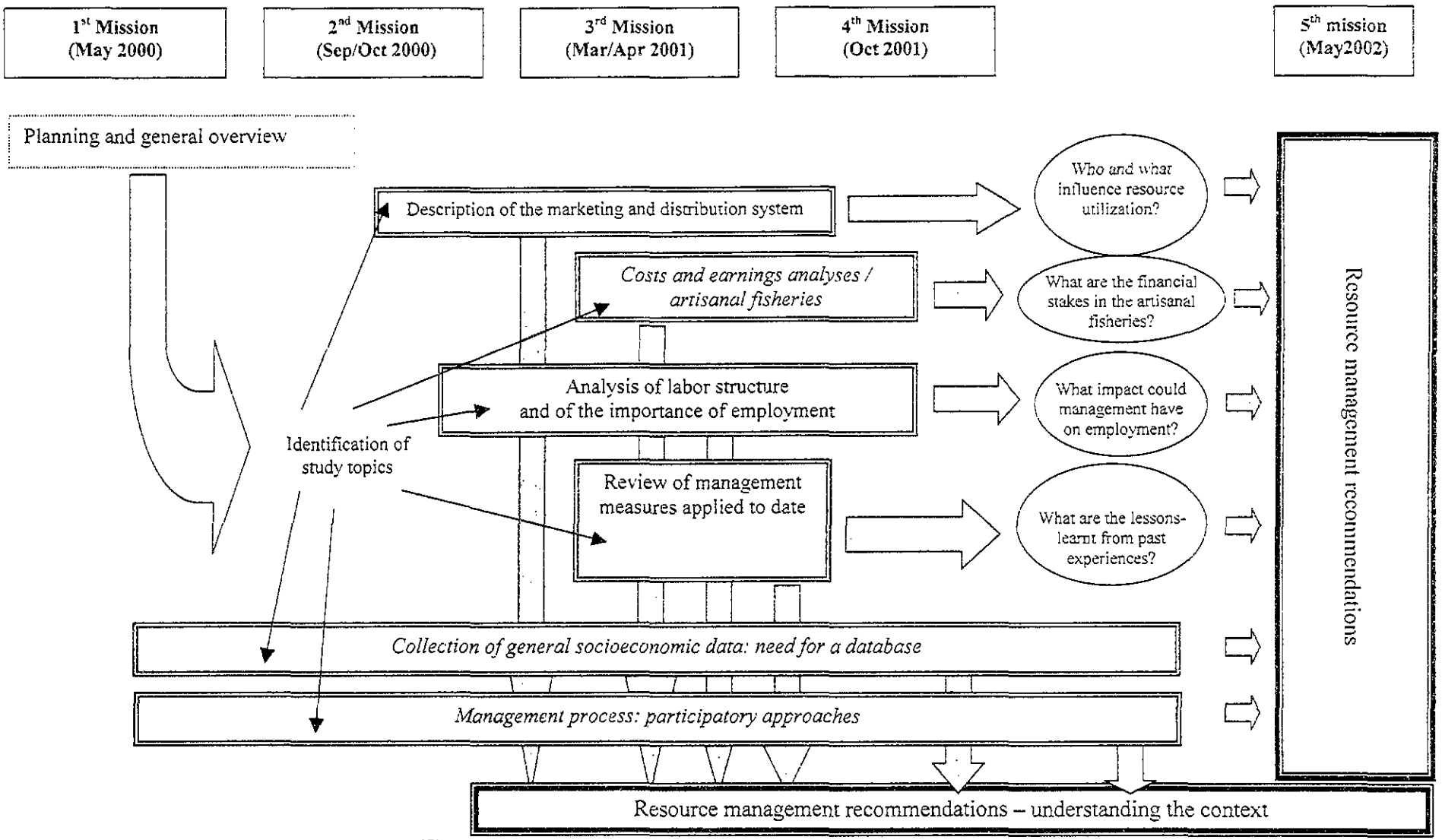


Figure 8.I.4 Flow chart showing the socioeconomic components.

8.1.2 Survey results

(1) The marketing and distribution system

1) Contents and objective of the survey

The current Project focuses on the management of demersal species, and the presentation in this chapter will therefore concentrate on the marketing and the exports of cephalopods and demersal finfishes. This choice of focus is also justified by the fact that these two species groups are the ones that are landed - at least in part - in Mauritania. The pelagics and crustaceans are generally transshipped outside NDB or directly landed in foreign ports by the industrial fishery fleets, and therefore do not affect the local socioeconomic system in the same way[3].Sharks and rays play an important role in particular for fin exports to Asia (the meat is sold in Africa) and together with the mullets, they are the main species caught by the Imraguen. There are also subregional marketing networks, particularly for salted and dried products. However, these subjects are only briefly touched upon, as sales to Europe and Japan by the licensed export companies and processing plants are the main focus of interest.

The objective of the current study was to test the hypothesis that a strong dependence of the primary production sector - particularly the artisanal fishermen - on the export companies have developed, who in their turn depend on international fish traders. The study was carried out with a view to get a better understanding of the role of the export companies and the down-stream industry in making decisions regarding resource utilization and to reveal the real power structure of the industry in order to be able to more accurately target future resource management measures. In this context, the artisanal fisheries subsector was given particular attention due to its socioeconomic importance.

2) Exports and markets

As it is well known, and also mentioned in the introduction above, exports of fishery products represent an important part of the budgetary revenues and foreign currency earnings of Mauritania. It is also important to point out again that the fish production of Mauritania is entirely export oriented. The local market outlets are limited and only supplied with low value or damaged products that cannot be sold in the more lucrative export market.

As Table 8.1.3 shows, the most important species group for exports, in value terms, is without doubt cephalopods, among which the predominant species is octopus. However, a recent decrease of the relative share of cephalopods and an increase in exports of other demersal species has been noted recently. In 2000, according to the Customs Office statistics, 26,500 tonnes of cephalopods and 15,500 tonnes of other demersal fishes (in product weight) were exported (DEARH, 2001). Hence, octopus still remains by far the main fishery product.

This strong dependence on a single type of export product appears even more serious when examining the countries of destination for Mauritanian exports. Figure 8.1.5 shows cephalopod exports from the SMCP to Japan and to EU countries. It can be noted that Japan is the most

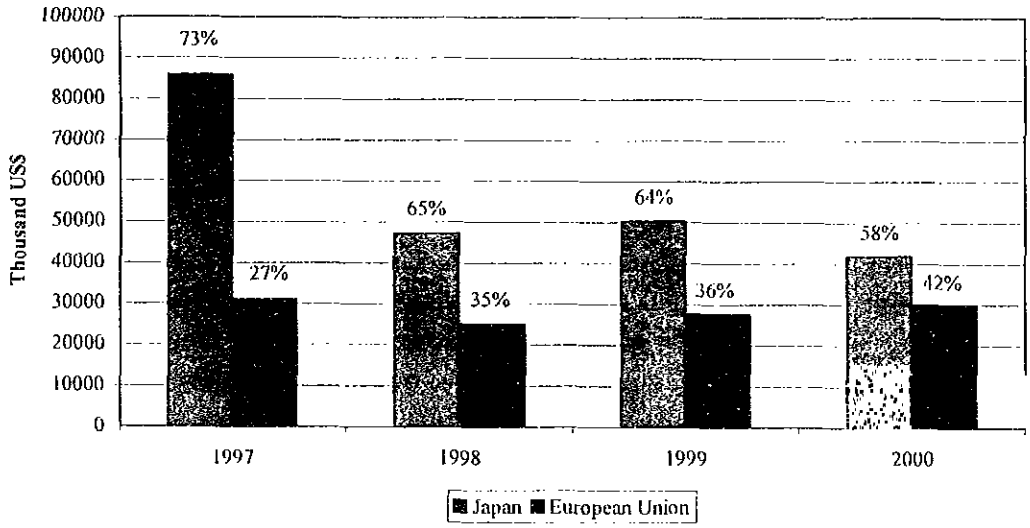
[3] It should be noted that there are, both in NDB and NKC, artisanal small pelagic fisheries supplying bait to other fishing operations as well as – at least to some extent – local markets.

important recipient of Mauritanian fish exports, even if its importance has decreased during the study period. The number of customers in each market is also limited: the SMCP has eight customers in Japan, and in Europe the four main clients absorb 60% of the sales (SMCP, 2000).

Table 8.I.3 Exports by species group in millions of UMs in 1993-2000.

	1993	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Cephalopods	16,224	17,264	20,035	18,401	17,752	13,442	16,956	16,634
Demersals	1,762	803	2,476	3,339	2,625	2,967	3,011	4,404
Crustaceans	31	11	40	155	250	238	245	811
Pelagics	8,024	6,574	9,456	12,079	6,453	8,163	10,416	11,108
Fish meal	1,202	453	858	1,410	809	922	1,056	1,080
Fish oil	80	34	72	83	23	43	52	47
Dried & salted and cans	321	557	1,013	980	860	1,032	872	1,358
TOTAL	*27,644*	*25,696*	*33,950*	*36,447*	*28,772*	*26,807*	*32,372*	*35,442*
% cephalopods	59%	67%	59%	50%	62%	50%	52%	47%
% demersals	6%	3%	7%	9%	9%	11%	9%	12%

Source : DEARH, 2001 (originally from the Mauritanian Customs Office; numbers include transferred products and fishing rights).



Source : SMCP, 2000.

Figure 8.I.5 Cephalopod exports by market in thousands of US$ from 1997 to 2000.

If the market and client analysis is extended to export companies that do not export through the SMCP, i.e., exporters of fresh fish, processed products and other non-frozen products mainly in NKC, they all show a tendency to have only a limited number of customers. Among the 43 companies officially licensed to export that are currently (October 2001) operational in NDB and NKC, thirty were surveyed with regard to the number of markets and clients and the results are shown in Table 8.I.4. It can be noted that over one-third of them has only one customer overseas. Octopus export companies work mostly with local Japanese import companies having local representatives (generally based in Las Palmas) and hiring foreign fish

graders. Among the companies targeting European markets, some are joint ventures with European partners. The occasional clients are generally Europeans coming to Mauritania to make direct purchases of quite modest quantities.

Table 8.I.4 Structure of the marketing channels of licensed export companies.

Category according to market structure	*Number of companies by category*
1 fixed customer	1
1 fixed customer in Japan + 1-3 fixed customers in Europe	2
1 fixed customer in Japan + 1-3 fixed customers in Europe + occasional customers	2
1 fixed customer in Japan + occasional customers	3
2-3 fixed customers in Japan + 2-3 customers in Europe	2
1 fixed customer in Europe	10
2-3 fixed customers in Europe	5
1-3 fixed customers in Europe + occasional customers	4
10 customers in Europe + occasional customers	1
TOTAL NUMBER OF SURVEYED COMPANIES	*30*

Source: Surveys in 2001.

3) Export companies and land-based infrastructure

As already stated, there are currently (October 2001) 43 licensed export companies with processing plants for sales to the EU and Asia in operation; 27 in NDB and 16 in NKC. In addition to these officially licensed companies, there are a limited number of small exporters subcontracting their production to the licensed companies, targeting the European and Asian markets. The types of products exported from NKC and NDB are not the same: the latter exports above all frozen products (particularly octopus), while in the capital fresh fish (high-value finfishes) is more important. Salted and dried, salted and pickled, and dried products are exported to Spain only from NDB, while dried mullet roe is produced mostly in NKC. In both towns, there is a small number of businesses which make more sophisticated products (such as pre-cooked fish) or keep live lobsters. The quality control demands imposed by importing countries have brought about a certain restructuring of the industry. This restructuring has taken place particularly in the fresh and highly processed products niche which today consists of only four or five companies in NKC, very professional and with close ties to the European buyers, having replaced the fifty or so companies that existed five years ago.

Most of the processing plants have their own freezing facilities: of the 38 surveyed plants, 28 declared to possess freezer tunnels or chambers. Based on these surveys, it is estimated that there is a total daily freezing capacity of 550-600 tonnes in Mauritania in the currently operational plants (approximately 400 tonnes in NDB and 150-200 tonnes in NKC)[4]. If this number is multiplied with 350 days, the total annual capacity can be estimated at about 200,000 tonnes, a number far exceeding the current production and export quantities. Other facilities

[4] Daily freezing capacity values have been calculated by converting the capacity values declared by the plants, expressed in tonnes per a given number of hours, into capacity values per 12 hours. Non-operational plants were excluded.

include, depending on the actual production of the processing plant in question, filleting rooms, storage rooms, salting basins and drying screens.

Table 8.I.5 shows the number of export companies in each town according to their main product types.

Table 8.I.5 Number of licensed exports companies by type of production.

Products	*Number of companies in NKC*	*Number of companies in NDB*	*Total number of companies*
Sophisticated products / live lobsters / dried mullet roe / mixed	7	3	10
Frozen products / filleted products / fresh products	10	4	14
Frozen products / filleted products	0	11	11
Frozen products / products storage	0	4	4
Salted and dried products	0	5	5
TOTAL	*17*	*27*	*43*

4) Procurement from suppliers

With regard to the systems for procuring fish, there are two kinds of companies: those that are ship or boat owners and also equip their own industrial fishery vessels, and those that work mainly with artisanal fishermen. Table 8.I.6 illustrates the number of export companies by type of supply source. Among the companies, there are some – having export licenses - that only work as subcontracts for non-licensed exporters and that thus have no suppliers or customers of their own.

Table 8.I.6 Number of licensed exports companies by supply source.

Supply source	*Number of companies in NKC*	*Number of companies in NDB*	*Total number of companies*
Artisanal fisheries	16	12	28
Industrial fisheries	4	0	4
Artisanal and industrial fisheries	4	3	7
Stocking / subcontracting	3	1	4
TOTAL	*27*	*16*	*43*

Companies basing their activities on production from artisanal fisheries try to limit the commercial freedom of the fishermen. At all levels of the distribution chain, there are contractual arrangements of various kinds, specially conceived to ensure exclusive access to fishery products. This is done through the prefinancing of fishery activities and by creating a

situation of dependency that forces the fisherman to remain loyal to a particular company. This phenomenon mainly started at the time of the boom of octopus fishing in the beginning of the 1990s. Today, the practice has been extended and more and more also applies to artisanal fisheries of other high-value demersal species. For the fishermen, the credit lines offered by the down-stream industry often are their only form of financing facility. Besides offering some quite modest loans, for instance to cover operational expenses or to buy minor materials, there are also companies that provide more significant prefinancing to fishermen for the purchase of transport vehicles: the latter then become indebted and in a situation of dependency vis-à-vis their creditor. It seems that today there are but very few fishermen who are not in this kind of financial situation with their contractors.

However, when asking the fishermen directly about this matter, there is a significant number of fishermen who declare that they are independent and do not receive any kind of financing (see Table 8.I.7). However, the reliability of this information is considered questionable. Among the fishermen who claim to be independent, most have a single fixed customer to whom they always sell their production. This would indicate that there is a close but unacknowledged loyalty relation, based on undeclared mutual advantages (see Table 8.I.8).

Table 8.I.7 Number of fishermen receiving financing by fishing method.

Fishing method	*Number of fishermen receiving financing*	*Number of fishermen not receiving financing*
Gillnet / fixed gillnet fishing	3	5
Hand line / long line fishing	8	1
Mullet fishing	2	1
Octopus fishing	15	15
Cuttlefish fishing	1	1
Flatfish gillnet fishing	14	9
TOTAL	*43*	*32*
Number of fishermen/method surveyed: 75		

Note: The term « financing » includes all forms of financing offered by the fisherman's client: advance payment on production, loans for the purchase of fishing craft or gear or for financing operational expenses, etc.

Table 8.1.8 Number of clients per fisherman by fishing method.

Fishing method	*Category: number of clients*	*Number of fishermen by category*
Gillnet / fixed gillnet fishing	ONE	2
Gil net / fixed gillnet fishing	A FEW	1
Gillnet / fixed gillnet fishing	MANY	4
Hand line / long line fishing	ONE	9
Mullet fishing	ONE	2
Mullet fishing	A FEW	1
Octopus fishing	ONE	24
Octopus fishing	A FEW	6
Cuttlefish fishing	ONE	2
Flatfish gillnet fishing	ONE	17
Flatfish gillnet fishing	A FEW	2
Flatfish gillnet fishing	MANY	1
All methods	ONE	56
All methods	A FEW	10
All methods	MANY	5
Number of fishermen/methods surveyed: 71		

NB : A FEW = 2-4 clients.

At the end of 1999, the Mauritanian Government signed an agreement with Senegal in order to regularize the entry of Senegalese fishermen into Mauritanian waters. Now both companies and fish wholesalers can subcontract with fishermen from St. Louis and charter their canoes. According to DSPCM, there were over 800 Senegalese canoes chartered in 2000 (Dia Abou/DSPCM, pers. comm.), directly contracted by export companies or through fish wholesalers, or by other commercial arrangements.

The charter contracts seem to be made in a well organized, commercially sound manner. In most cases, the foreign fishermen are organized in camps south and north of NKC that are managed either by a company or, with a view to minimize the risk to the latter, often by a fish wholesaler. In the camps, the Mauritanian party of the agreement is responsible for all supplies and materials for the activity, except for, normally, the canoe itself. The contract terms stipulate the value of these services, and the fisherman should pay back all prefinancing after his production has been sold according to the species ordered and prices agreed when the contract was signed. Prices in the camps are usually many times lower than at the NKC Fish Market (MPN). However, it can be noted that also the prices at the MPN and at the port of NDB often are subject to agreements and advance negotiations rather than established by a free market and subjected to open and equal-opportunity competition. In Mauritania, there is no auction system of the kind seen in many other countries.

The Senegalese fishermen camp system seems to be very popular among certain export companies. Investment costs for setting up a camp are relatively high in comparison to prefinancing independent Mauritanian fishermen or to working through a fish wholesaler. However, advantages in the form of superior performance of the fishermen – the Senegalese are considered to be better fishermen - and with regard to the control of the production as well as of purchase costs, rank above investment considerations. Nevertheless, there are also companies

that have tried the camp system and found it hard to manage. Despite all the contractual arrangements, there are always some fishermen who manage to get around them when more lucrative opportunities arise for the sale of their product. Thus, not all companies chose the camp system. There is still a significant number of middleman and wholesale traders. Most companies seem to utilize a combination of different arrangements for securing their supplies.

5) Summary of regional marketing structures

In summary, it can be noted that the structure of the marketing system is quite complex. Figure 8.I.6 shows the many actors and their relationships of the marketing system in NDB[5]. This structure varies from one geographical area to another in the same way as the fishing methods listed in Table 8.I.1:

- *NDB* is the center for the industrial fishery and the town has the only fishing ports of the country where industrial fishery vessels are authorized to land. Mainly frozen products are exported from here. Given the transportation constraints – there is no regular airfreight but from NKC – exports of fresh products from NDB represent less than half the quantities exported from the capital. There is a market niche for salted and dried fish at Las Palmas. Exports of dried and salted products for the African subregion generally pass through NKC.
- The *Imraguen zone in the PNBA* is a very particular case, given its geographical isolation and the existence of the National Park, created in 1976, which simultaneously protects and limits the activity of the fishermen. There are some 1,100 inhabitants distributed into eight villages (PNBA, 1999). Despite this relatively limited number, there is an amazing diversity among the different sites with respect to the social structure and the organization of activities. In summary, the traditional work methods of the Imraguen have drastically changed lately, and mullet fishing and processing are not the same as before. The globalization of international trade has also made itself felt in the PNBA, and fisheries are nowadays much more oriented towards exports: cartilaginous fishes (including shark fins), mullet products and fresh high-value fish species. There are many cases of people running into considerable debt and becoming financially dependent on exporters. Recently, precooperative groups – some already transformed into cooperative unions – have been established with the goal of creating an alternative to fish wholesalers and export companies for fish marketing and fishing gear supplies. These institutions are still new and have encountered various difficulties, partly due to the perception of the role of a cooperative union and related social structures, but still remain an important potential for the improvement of the commercial strength of the Imraguen fishermen in the National Park.
- The Imraguen in the *zone south of Cape Timris down to NKC* are under even greater influence of the export companies than the fishermen in the National Park. The zone harbors many seasonal camps, mainly for octopus fishing, in addition to the permanent villages to which also migrant fishermen from the south and from Senegal come during the main fishing seasons. In each village, there are a couple of major export companies represented along with a limited number of sometimes local - fish wholesalers. Like in the National Park, development organizations adopted the establishment of cooperative unions as a strategy in order to recover some independency from the large companies.

[5] For more details on the different professional subgroups of wholesalers, see section 8.I.2,(2),3),c).

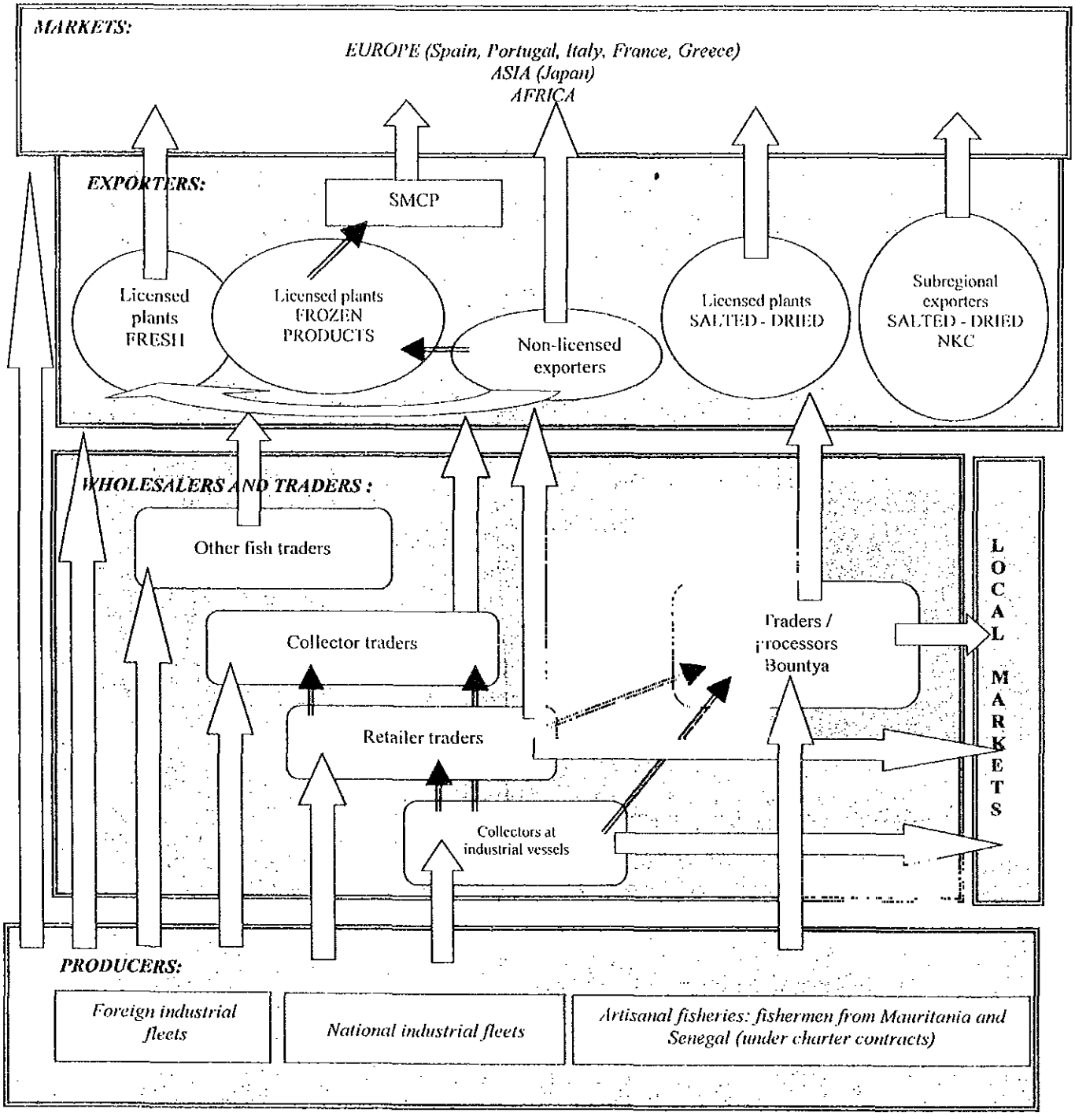


Figure 8.I.6 The operators of the fish marketing system in NDB.

However, it appears very difficult to implement such actions because of the existing close ties with businessmen based in NKC.

- The organization of the sector in *NKC* resembles somewhat that of NDB. There is, however, a stronger presence of companies exporting fresh and prepared products. These give the impression of being high-performance businesses and, as mentioned above, the sector was restructured and appears to work closely with foreign partners.
- The activity of fish marketing is concentrated to the NKC Fish Market (MPN), located on the shore where artisanal fishermen traditionally land. Industrial fishing vessels cannot land in NKC, but apparently a number of iceboats and freezer boats belonging to export companies do still operate from the capital.
- The coastline *between N'Diago and NKC* is characterized by fishermen camps, mostly for Senegalese, managed by middlemen or directly by representatives of the export companies. Most of the camps are seasonal, but at PK 28 and PK 65 the sites have become permanent and, during the fishing season, important places of convergence for migrant fishermen. In those places there are also fish processors (for cartilaginous fishes and mollusks) for subregional exports.
- Even if many Mauritanian fishermen are from N'Diago, there are today no fisheries based in the village. It is difficult to export village products because of the lack of road infrastructure and there is a ban on landing or selling fish in St. Louis, an important Senegalese town that would be easily accessible by land, sea or river, and these difficulties may at least partially explain the fishermen's preference to migrate to NKC or to the north.

6) Marketing structure: conclusions

In conclusion, it seems that the vertical integration hypothesis has been confirmed. The sector is for the most part guided by the export companies and their foreign clients, and the primary production subsector depends on the down-stream industry. The main results that support this conclusion are the following:

- Export companies generally have very close ties with foreign importers, and their products are destined to well-defined buyers who are thus likely to have a significant influence on the production patterns.
- Most of the means of production, both industrial and artisanal, are directly or indirectly financed by export companies, which are often associated with foreign partners (even if not always acknowledged).
- The local price formation process is not transparent but depends on the relationships between fishermen and buyers (the export companies) who simultaneously are the creditors and financers of fishery operations. As the fishermen are often in a situation of dependency on these creditors, their negotiation power is considerably weakened.

In addition, it should be noted that fish exports overall bring only a low level of added value. This lack of enhanced product value is, of course, particularly remarkable for the industrial fishing fleet not landing in Mauritania.

(2) Employment in the sector and labor structure

1) Context and objective of the survey

The fisheries sector is often mentioned as being very important in generating employment, but the actual numbers on how many persons are economically dependent on the activity are not well known. Likewise, very little is known regarding the characteristics and structure of the labor force of the sector, particularly concerning the level of job insecurity, the potential for redeployment or retraining of employees (in the sector itself or in other economic activities) or its current mobility. In the context of an uncertain situation with respect to the state of resources, it is important for those in charge of resource management to better know the jobs and the people involved in the sector who would be affected by the management measures to be applied.

The objective of the survey, therefore, was to gain a better knowledge of the jobs and employees of the sector. The work consisted of updating and carrying out a more in-depth analysis based on two surveys done by LASE in 1998 and 1999 on direct employment in the fisheries sector (Dia *et* Thiam, 1998; Dia *et al.*, 1999). It is believed that the results of this survey will also help in improving the methodology for further follow-up work as well as in the continuous collecting of data on employment in the fisheries industry, an activity that the CNROP should continue.

2) Employment in the sector

As for the review of the various fishing methods (Table 8.I.1) and the study on the marketing structure (see Section 8.I.2, (1), 5)), five geographical zones were defined for the employment survey and analysis. The field surveys were essentially conducted in NDB and NKC while the estimates of employment in other zones were mainly based on already existing information. The global estimates made for the number of employees in the different categories of jobs in the Mauritanian fisheries sector are presented in Table 8.I.9.

The category «Others, IF and AF» includes employment related to the production and supply of fishing gear and other goods in the sector, the transportation of those goods and of fishery products, and repairs and other services for both artisanal and industrial fisheries. Indirect jobs refer to employment created by stores, restaurants and snack-shops, taxis and phone communications, etc., located at the fishing sites and ports and serving people directly employed by the sector. Counting the latter, the fisheries sector employs some 29,000 – 30,000 persons, about half of who have land-based jobs. Estimating the dependency ratio at 1.8, it can be concluded that over 80,000 people depend directly or indirectly on the fisheries sector for their subsistence [6].

More detailed estimates for the employment and number of jobs in NDB and NKC are presented in Appendix III.

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[6] The dependency ratio has been calculated by dividing the number of persons economically dependent upon someone else by the number of people presumed economically active. Children under 10, people defined as elderly, and 75% of the adult women (non elderly), were classified as dependent. *Source: Survey 2001 and ONS 2001.*

Table 8.I.9 Approximate number of jobs in the fisheries sector of Mauritania, according to zones and main professions.

	NDB	*PNBA*	*SOUTH OF CAP TIMRIS*	*NKC*	*SOUTH*	*MIGRANT FISHER MEN*	*TOTAL*
IF Crew and administrative staff	3,600	-	-	-	-	-	3,600
Export companies and processing plants	1,200	-	-	1,400	-	-	2,600
AF fishermen	3,900	400	300	3,300	200	4,000	12,100
Processors and fish traders	4,300	60	190	2,040	90	-	6,680
Others, IF and AF	2,400	10	10	930	10	-	3,360
TOTAL FISHERIES	*15,400*	*470*	*500*	*7,670*	*270*	*4,000*	*28,340*
INDIRECT JOBS	400	130	100	430	-	-	1,060
GRAND TOTAL	*15,800*	*600*	*600*	*8,100*	*300*	*4,000*	*29,400*

Note: IF = Industrial fisheries; AF = Artisanal fisheries; Fishermen = boat owners, captains, crew.

3) Labor structure

a) The survey

The survey on the labor structure was conducted by submitting a questionnaire for the collection of relevant information from the sector's employees. Questions asked referred to, among other things, educational level, professional experience and place of birth (see Appendix II). In total, 508 people were interviewed. The distribution of these interviewees by main professional groups and by locality (geographical zone) is shown in Table 8.1.10. 9% of the interviewees were women: they work mainly with fish processing or at the bottom end of the fish marketing system, as well as in indirect jobs in restaurants or as bissap peddlers.

As shown in Table 8.1.10, certain professions are better represented in this sample population than others are. This is because it was decided to concentrate the survey effort on the job categories that generate most employment, especially direct jobs in the main town, i.e., the fishermen/captains based in NDB and the fish wholesalers operating in NKC. These two professional groups are thus analyzed below.

Table 8.1.10 Number of surveyed people by main occupations and by zone.

Sector (professional groups)	*Geographical zone*	*Number surveyed*
Artisanal fisheries (boat owners and crew)	NDB	145
Artisanal fisheries (boat owners and crew)	NKC	10
Artisanal fisheries (boat owners and crew)	South of NKC	10
Artisanal fisheries (boat owners and crew)	South of Cap Timris	9
Artisanal fisheries (boat owners and crew)	Parc National du Banc d'Arguin	7
Industrial fisheries (administrative staff and crew)	NDB	7
Processors and traders	NKC	99
Processors and traders	NDB	53
Processors and traders	South of Cap Timris	21
Processors and traders	South of NKC	9
Processors and traders	Parc National du Banc d'Arguin	2
Fisheries transports (fish and other items)	NDB	20
Fisheries transports (fish and other items)	Parc National du Banc d'Arguin	1
Fisheries transports (fish and other items)	South of Cap Timris	1
Export companies	NDB	19
Export companies	NKC	9
Trade in inputs for the fisheries sector	NDB	19
Services (*mechanics, carpenters etc.*)	NDB	18
Other fishing industry (ship and boat construction)	NKC	1
Other jobs in the fisheries sector (dockers, guards, *etc.*)	NDB	4
Shops, restaurants, hotels	NDB	36
Shops, restaurants, hotels	NKC	5
Shops, restaurants, hotels	South of Cap Timris	1
Transport and telecommunications	NDB	2
TOTAL		*508*

b) The NDB fishermen/captains

For the survey, artisanal fishermen were classified in three categories: (a) boat owners who do not go out fishing themselves; (b) fishermen/boat captains who either own the boat or work for an owner; and (c) fishermen/crew members. Special attention was given to the second category and 100 captains were interviewed, where of 78 in NDB. 29% of them are boat owners, i.e., they go out fishing in their own canoes. The remaining 71% are hired by boat owners. The basic data on this group are summarized in Table 8.I.11.

Table 8.I.11 NDB fishermen-captains.

Estimated total number of captains in NDB	*Number of interviewees*	*% sampled*	*Average age*	*Nationality / ethnicity*				
				Mauritanians			*Senegalese*	*Other foreigners*
				Maure	*Wolof*	*Poular*		
600	78	13%	34 years	51%	22%	9%	15%	3%

82% of the captains are Mauritanian nationals, the majority being Maure: the Wolof and Poular make up for 22% and 9%, respectively. The Senegalese represent 15%. Only 12% of the fishermen are actually from NDB: about half comes from the southern regions (Trarza, Brakna, Gorgol and Assaba - see Figure 8.I.7). These are mostly Wolof and Poular. Apparently, few people in NDB who work in the fisheries sector are actually local: of all persons sampled (all professions together), only 9% of the interviewees declared NDB as their place of birth.

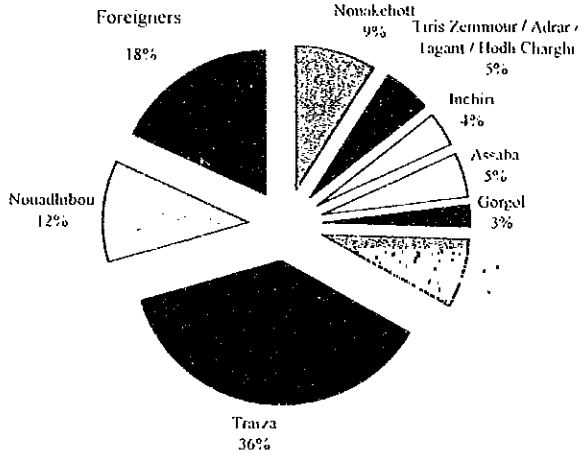

Figure 8.I.7 NDB fishermen/captains: place of birth.

It is also the Poular and Wolof who, among the Mauritanian fishermen, have a wider knowledge of different fishing techniques. Of the nine different fishing gear mentioned in the questionnaire, a Poular fisherman/captain would, on average, declare to know how to use six, while a Wolof would do so for five or six. These gear include the various types of fixed gillnets and gillnets, the hand lines and the longlines, as well as the octopus traps. The average number

of known fishing techniques by foreign fishermen is even higher – they claim to know about seven different fishing techniques – while that for Mauritanian Maures is considerably lower: four, among which the various types of nets and particularly the octopus traps are the most widely used (see Figure 8.I.8).

Many Mauritanians who currently work as fishermen do not do so by tradition: they began in the profession during the octopus fishing boom in the early 1990s. The octopus trap is a gear easy to master, and many of the beginner fishermen used it as they did not know any other fishing technique. Today, it appears that there are more and more of these fishermen who use also other kinds of gear, e.g., flatfish gillnets, in particular during the period when the octopus fishery is closed. However, many of them still go on holidays during the two months of "biological closure" and rejoin their families in other parts of the country. Sometimes they engage in other activities during this holiday period, but usually in a family context.

By analyzing the training and previous experiences of the boat captains, it is noted that foreign fishermen have generally always worked as artisanal fishermen: none of them indicated any other occupation. The Mauritanian Wolof also appear to be "pure" fishermen, while among the Maure and Poular some 40% have worked on something else before becoming artisanal fishermen. They have often had other jobs within the fisheries sector, for instance as crewmembers on industrial boats or as fish wholesalers (37%). Still, some 47% had jobs not related to fisheries. Today, in most cases, they are employees rather than owners of the boats they work on.

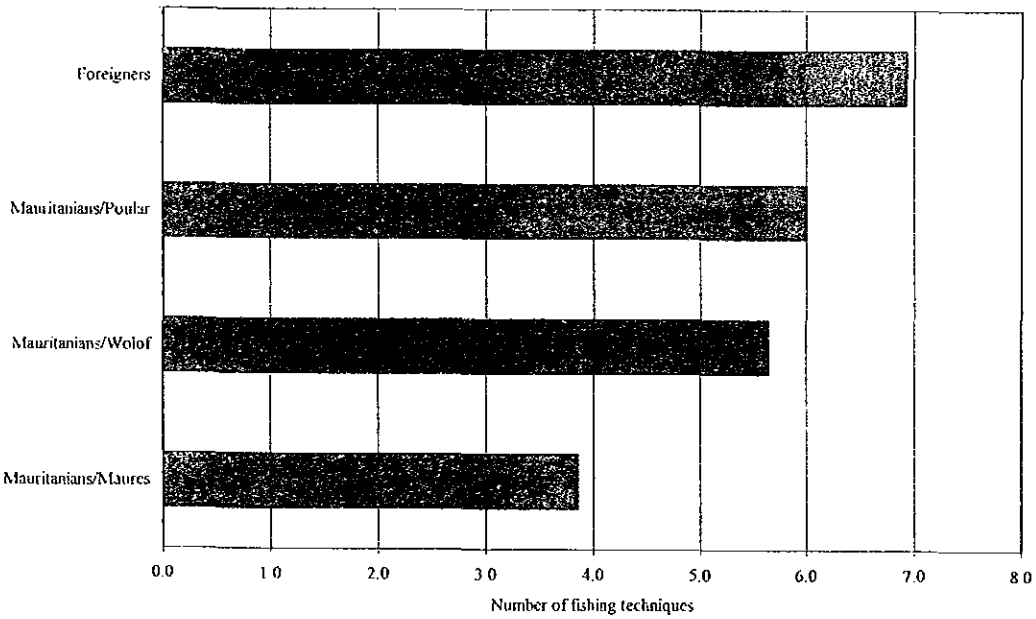

Figure 8.I.8 NDB fishermen/captains: knowledge of fishing techniques.

As for their education level, most of the fishermen/captains have undergone either Koranic school or elementary school (see Figure 8.I.9). Data on the Maure and Wolof reveal somewhat higher educational levels overall than the foreigners or the Poular, but the differences between the groups are not significant.

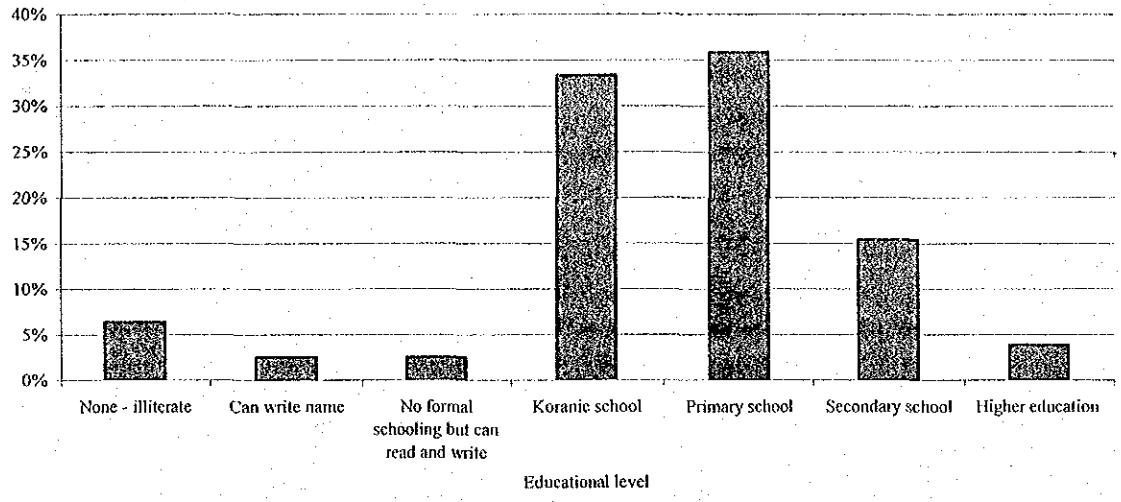

Figure 8.I.9 NDB fishermen/captains: educational level.

c) The NKC fish wholesalers

Fish trading, in spite of its importance, is still a poorly organized activity with many different professional subgroups, and characterized by an important mobility among the operators who do not always remain loyal to their profession. They often work simultaneously in other professions, according to an opportunistic strategy or out of necessity. However, information obtained during the survey conducted in April 2001 seemed to indicate that this situation was about to change. Both at the NKC market (MPN) and at the artisanal fisheries port in NDB (EPBR), an organization called the Association of Mauritanian Fish Wholesalers (AMM) was being set up. It appears that this association is no longer active (see 8.I.2, (3), 4)), but it was interesting to observe from the registration lists that AMM utilized a typology of fish wholesalers that recognized five homogeneous categories according to their activity profile:

- Financing wholesalers, who manage and finance boats and fishermen.
- Importing wholesalers, who transport the products to the main markets from camps and other landing sites. In NKC, this category also includes traders who collect fish from industrial fishing vessels.
- Freezer wholesalers, who possess equipment for freezing and cold storage, often as freezing chambers capable of holding a couple of hundred kilos. This category includes wholesalers who also operate as retailers.
- Collector wholesalers, who collect fresh fish products to be resold to a financing wholesaler or a foreign customer.
- Retailer wholesalers, who specialize in selling products to retailers who in turn resell them to consumers in the local market level.

In addition to the above categories of fish wholesalers, one can identify, especially in NKC, a number of forwarding agents and processed product wholesalers. These export fresh and processed fish, respectively, to markets inside the country and to neighboring countries. Many of them are foreigners. There are also wholesale agents who work directly for export companies and manage boats and collect products on their behalf.

The identified categories of fish wholesalers seem to reflect, in a practical way, the various profiles of fish trading. Still, during the survey, it turned out to be difficult to exactly classify individual actors. Therefore, in the following presentation, all operators involved in wholesales at large were grouped together and are here simply referred to as *fish wholesalers*. Nevertheless, it is important to emphasize that it is a group of actors that is not as homogeneous as its denomination might imply. It should also be mentioned that the great majority of the interviewees in the survey were independent operators (96%), rather than their employees (4%). Some indicators concerning the interviewed fish wholesalers are presented in Table 8.I.12.

Table 8.I.12 The NKC fish wholesalers.

Estimated total number of wholesalers in NKC	*Number of interviewees*	*% sampled*	*Average age*	*Nationality / ethnicity*			
				Mauritanians			*Senegalese*
				Maure (and Imraguen)	*Wolof*	*Poular*	
550	83	15%	39 years	88%	2%	6%	4%

Compared to the NDB fishermen/captains, there are very few foreigners working as fish wholesalers in NKC and the Maures dominate the profession. However, like for the fishermen/captains, relatively few wholesalers operate in the village where they were born: only 13% of the interviewees declared NKC as their place of birth. Over two-thirds come from the southern regions; 43% from Trarza and 24% from Brakna, Gorgol and Assaba (see Figure 8.I.10).

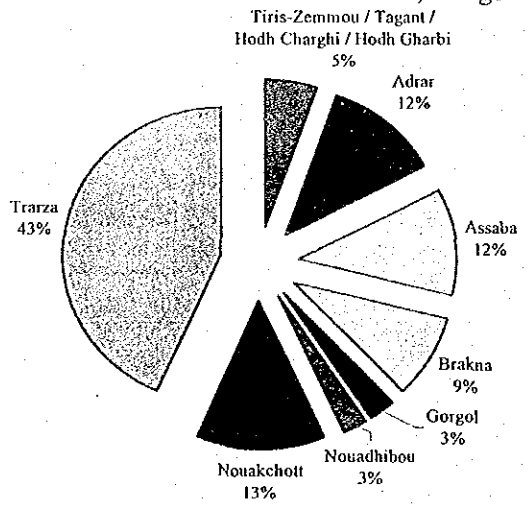

Figure 8.I.10 NKC fish wholesalers: place of birth.