10) Canary dentex *Dentex canariensis*

a) Body length range and mean body length

Table 3.89 (page 3-271) presents the minimum, maximum and mean fork length obtained for the Canary dentex.

In the area surveyed by the *Amrigue*, the fork length varied in the course of the survey between 82 and 270 mm. In each season, the mean fork length was between 139 and 270 mm and was higher in the cold season than in the warm season. The mean fork length by area was higher in the Banc d'Arguin (Phase 1).

In the area surveyed by the *Al-Awam*, the fork length was between 68 and 352 mm. In each survey season, the mean fork length by area varied between 154 and 215 mm in the Northern area and between 159 and 242 mm in the Central area. It was higher in the cold season in Phase 1 and in the warm season in Phase 2. In the Southern area, the mean fork length by season varied between 130 and 199 mm, being higher in the cold season. The mean fork length by stratum in each area increased with depth.

b) Size composition

Figure 3.61 (page 3-268, 3-272 to 3-275) presents the evaluation of the size composition for the Canary dentex stock. The fork length class is indicated at intervals of 1cm. To analyze this composition, four groups were defined: (i) juveniles (fork length less than 10cm), (ii) small-size (length between 10 and 20cm), (iii) medium-size (length between 20 and 30cm), (iv) large-size (length over 30cm).

No group of newborn juveniles was observed in the cold season, but one such group was especially conspicuous in the warm season, particularly in Phase 1. For all seasons except in the Phase 1 cold season, the total stock size in number of this species was primarily composed of the small-size group (in the Phase 2 warm season, size gets closer to that of the medium-size group). In the Phase 1 cold season, the total stock size in number of this species mainly comprised the medium-size group (the small-size group was also very close to the medium-size group). Distribution of the modes for those size groups varied with survey season. The predominant modes classes of the small-size group in the cold season were observed at the 17-18cm (Phase 2) and 19-20cm (Phase 1) and, in the warm season, at the12-13cm (Phase 1) and 19-20cm (Phase 2: peak is low, but there is another mode at 13-14cm class). The predominant modes of the medium-size group were salient in Phase 1 (at the 24-25cm class in the cold season and 20-21cm class in the warm season), but not clearly defined in Phase 2. Mode for the large-size group was not determined because of the poor number of samples of individuals over 30cm.

The study of the distribution of those size groups was done from a size composition analysis at each stratum in each area. In Phase 1, the juveniles group, who only appeared in the warm season, was distributed all over but mainly at the 30-80 m stratum in the Northern area, while in Phase 2, this group only showed up at the 3-20 m stratum in the Central area. For all seasons, the small-size group was distributed over the entire area and concentrated in the Central and Southern areas (except in the Phase 2 warm season, when the focus moved to the 3-20 m stratum in the Northern area). The medium-size group had a distribution similar to that of the small-size group, but centered in the Central area or Southern area in Phase 1 and in the Northern area in Phase 2. Finally, the occurrence of the large-size group varied seasonally and the frequency of individuals was always low.

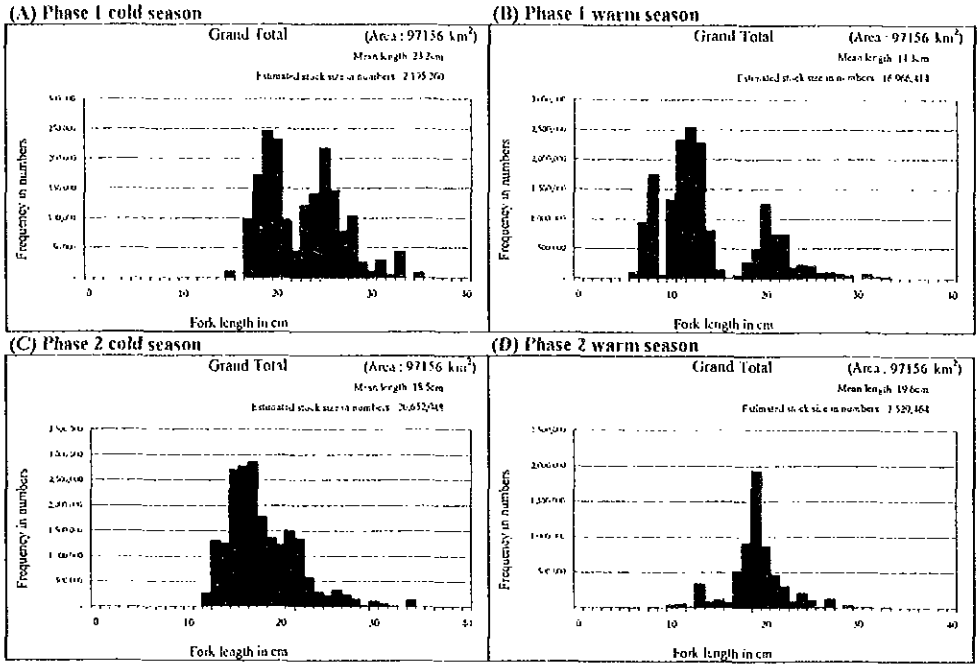


Figure 3.61 Size composition for Canary dentex *Dentex canariensis.*

c) Length-weight relationship

Figure 3.62 (page 3-269) presents the relationship between the fork length and weight for the Canary dentex. The length-weight equations were the following:

Phase 1 cold season	: BW=	$1.771\times10^{-2}\times TL^{3.072}$	(r=0.9948)
Phase 1 warm season	: BW=	$2.301\times10^{-2}\times TL^{2.971}$	(r=0.9918)
Phase 2 cold season	: BW=	$2.280\times10^{-2}\times TL^{2.988}$	(r=0.9853)
Phase 2 warm season	: BW=	$2.438\times10^{-2}\times TL^{2.973}$	(r=0.9931)

where, BW : body weight (g), FL : fork length (cm) and r : the coefficient of correlation.

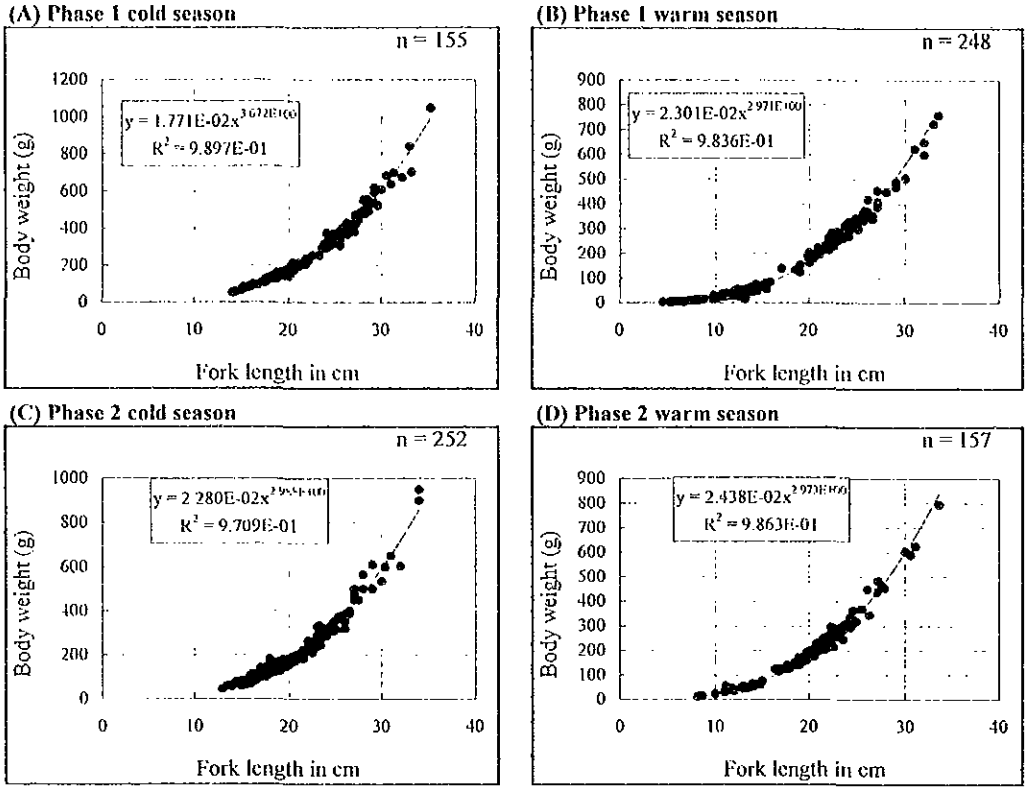


Figure 3.62 Length-weight relationship for Canary dentex *Dentex canariensis.*

d) Length and weight by sex

Table 3.90 (page 3-276) summarizes the fork length and body weight observed in each sex for the Canary dentex.

In the area surveyed by the *Amrigue*, the fork length varied between 117 and 200 mm for males and between 141 and 270 mm for females. The mean fork length by sex was between 120 and 194 mm for males and between 173 and 176 mm for females.

In the area surveyed by the *Al-Awam*, the fork length varied between 112 and 340 mm for males and between 100 and 352 mm for females. The mean fork length by sex was between 201 and 244 mm for males and between 203 and 232 mm for females. In the cold season, the mean male size was a little larger than that of females, but in the warm season, females were in turn slightly larger than males.

The fork length of individuals with gonads developed enough to allow sex determination by visual inspection was between 15 and 18cm in the cold season and between 10 and 13cm in the warm season. Females would mature earlier than males.

e) Sex ratio and female maturity stage

Table 3.91 (page 3-277) summarizes the sex ratio and the female maturity stage for the Canary dentex. Figure 3.63 (page 3-278) presents their distribution by length class.

Females were largely dominant regardless of season, the overall sex ratio being between 0.27 and 0.38. Similarly, the sex ratio by area and by stratum (with a few exceptions) showed a clear predominance of females.

The female maturity ratio in the entire area varied between 14 and 29% in the cold season and between 1 and 8% in the warm season. According to the Fish Base the spawning period of the Canary dentex in the East Atlantic is between July and September. It is likely that this species grows during the transitional period between the cold season (April-May) and the warm season (September-October) before entering the main spawning period. However, even considering a low number of samples, the fact that one of the four females captured in the Banc d'Arguin was at a post-spawning stage (while none was found in the area surveyed by the *Al-Awam*) suggests that there should be geographical difference in spawning.

The sex ratio by length class did not show the size-dependent change. With a few exceptions, females are in the majority for all classes, although the ratio undergoes much fluctuation under 100%.

The fork length at first maturity was observed at the 21-22cm class in the cold season and at the 25-26cm class in the warm season.

f) Feeding habits

Table 3.92 (page 3-279) shows the stomach condition and the stomach content composition of the Canary dentex in each survey season. Figure 3.64 (page 3-280) presents the relationship between the fork length and SSI and SCW. Those results were based on all data collected by both the *Amrigue* and the *Al-Awam*.

The ratio of the empty stomach varied between 52 and 68%. The ratio of the stomach eversion was of a small percentage according to the survey season. The relationship between the fork length and SSI and SCW showed that the largest individuals consume great quantities of food, while the small-size individuals are voracious eaters in relation to their body weight.

The Canary dentex is a carnivore feeding mainly on fish (painted eel *Echelus myrus*, various carangids, gobies, soles *etc.*) and crustaceans (crabs, shrimp, gammarids, anomurans etc.). It also feeds on sipunculoids, mollusks (cuttlefish, octopus, *etc.*) and polychaetes.

Table 3.89 Body length range and mean body length for Canary dentex *Dentex canariensis* : FL in mm.

(A) ***Amrigue* survey area**

Northern coastal area (Stratum: 3-20m)	Phase 1						Phase 2					
	Cold season			Warm season			Cold season			Warm season		
	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
Banc d'Arguin	9	142 ~ 270	174.0	10	98 ~ 125	114.4	0			0		
Other	10	140 ~ 194	160.5	23	46 ~ 149	85.8	2	140 ~ 145	142.5	8	82 ~ 211	138.8
All area	19	140 ~ 270	166.9	33	46 ~ 149	94.5	2	140 ~ 145	142.5	8	82 ~ 211	138.8

(B) ***Al-Awam* survey area**

Subarea	Stratum	Phase 1						Phase 2					
		Cold season			Warm season			Cold season			Warm season		
		Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
North	3-20m	-	-	-	-	-	-	98	130 ~ 340	200.6	45	164 ~ 300	205.9
	20-30m	4	209 ~ 285	244.0	12	190 ~ 220	209.2	30	138 ~ 280	181.6	20	130 ~ 220	202.8
	30-80m	13	152 ~ 272	206.4	20	75 ~ 215	121.1	9	162 ~ 222	199.8	9	200 ~ 260	223.6
	80-200m	0			0			0			0		
	200-400m	0			0			-	-	-	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	17	152 ~ 285	215.2	32	75 ~ 220	154.1	137	130 ~ 340	196.4	74	130 ~ 300	207.2
Central	3-20m	-	-	-	91	68 ~ 257	141.9	39	170 ~ 290	188.9	50	86 ~ 306	196.8
	20-30m	35	181 ~ 305	212.7	32	120 ~ 154	137.1	0			0		
	30-80m	61	182 ~ 352	258.9	20	190 ~ 335	273.5	22	180 ~ 252	204.7	5	246 ~ 336	287.6
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	96	181 ~ 352	242.1	143	68 ~ 335	159.2	61	170 ~ 290	194.6	55	86 ~ 336	205.1
South	3-20m	-	-	-	0			4	186 ~ 300	220.5	0		
	20-30m	16	172 ~ 247	191.7	20	109 ~ 129	114.0	36	165 ~ 320	202.7	0		
	30-80m	7	174 ~ 252	203.7	20	170 ~ 320	225.0	12	170 ~ 200	179.7	20	110 ~ 142	129.9
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	23	172 ~ 252	195.3	40	109 ~ 320	169.5	52	165 ~ 320	198.8	20	110 ~ 142	129.9

Remark. - : no trawl.

Figure3.61 (A) continued.

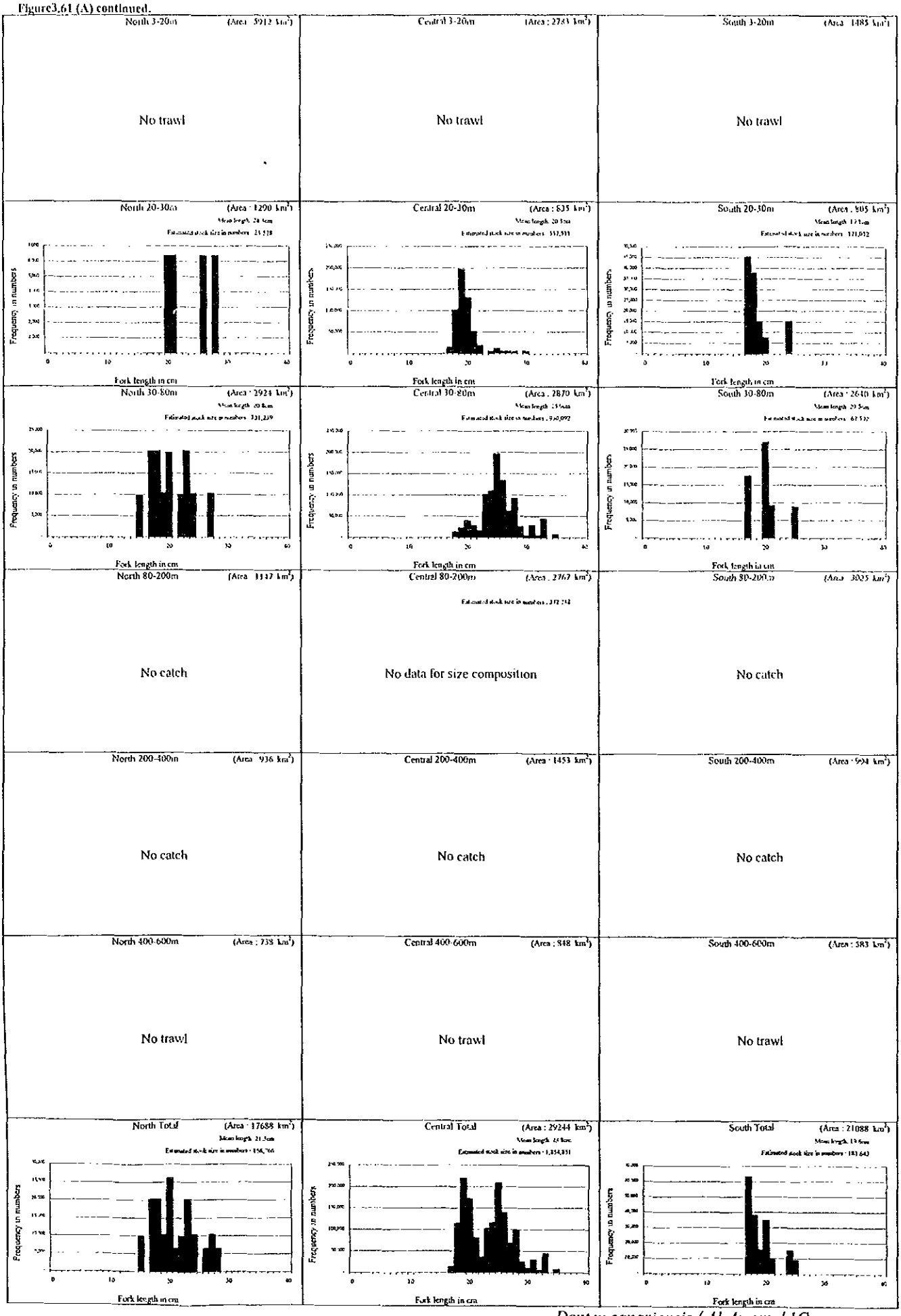


Figure3.61 (B) continued.

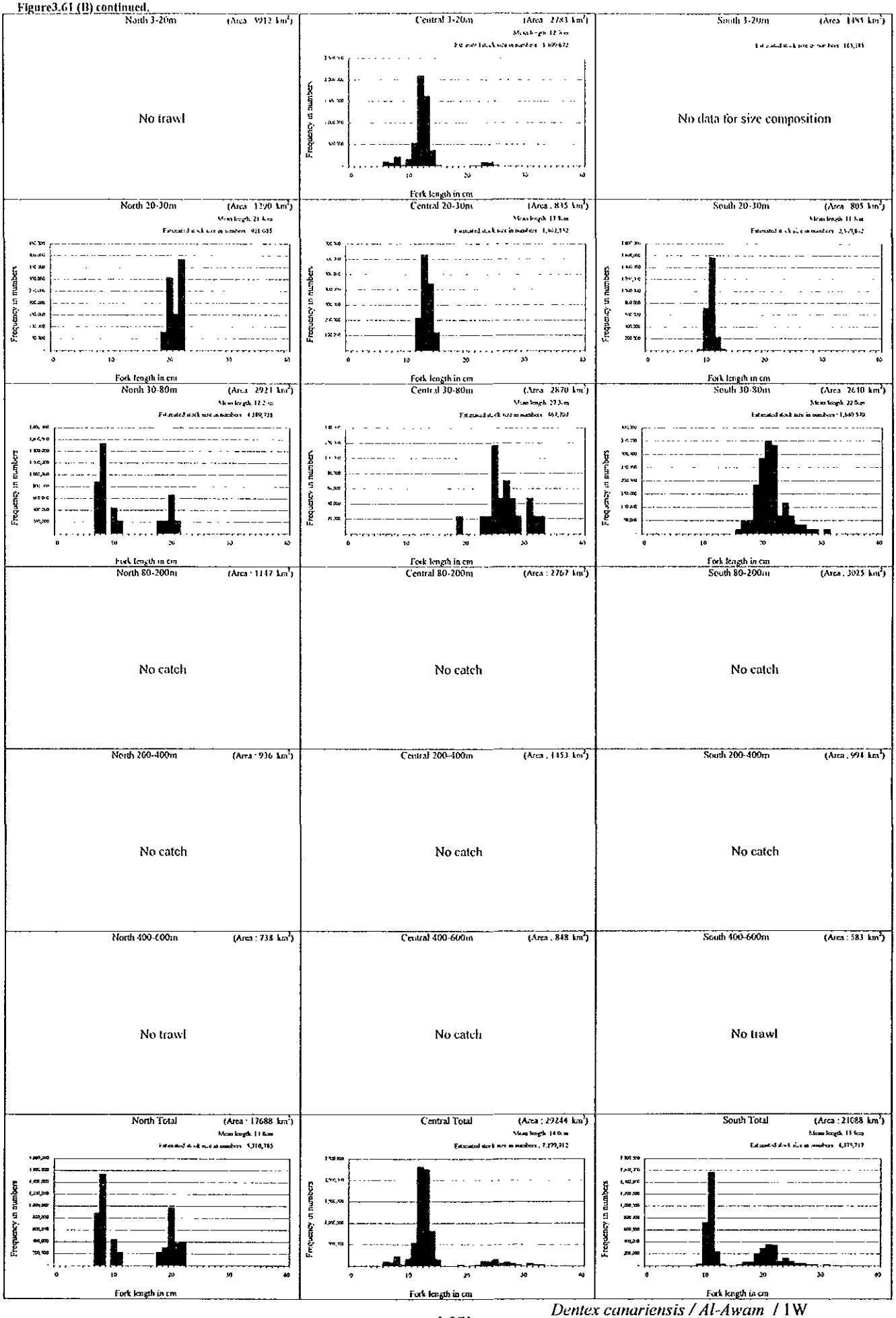


Figure3.61 (C) continued.

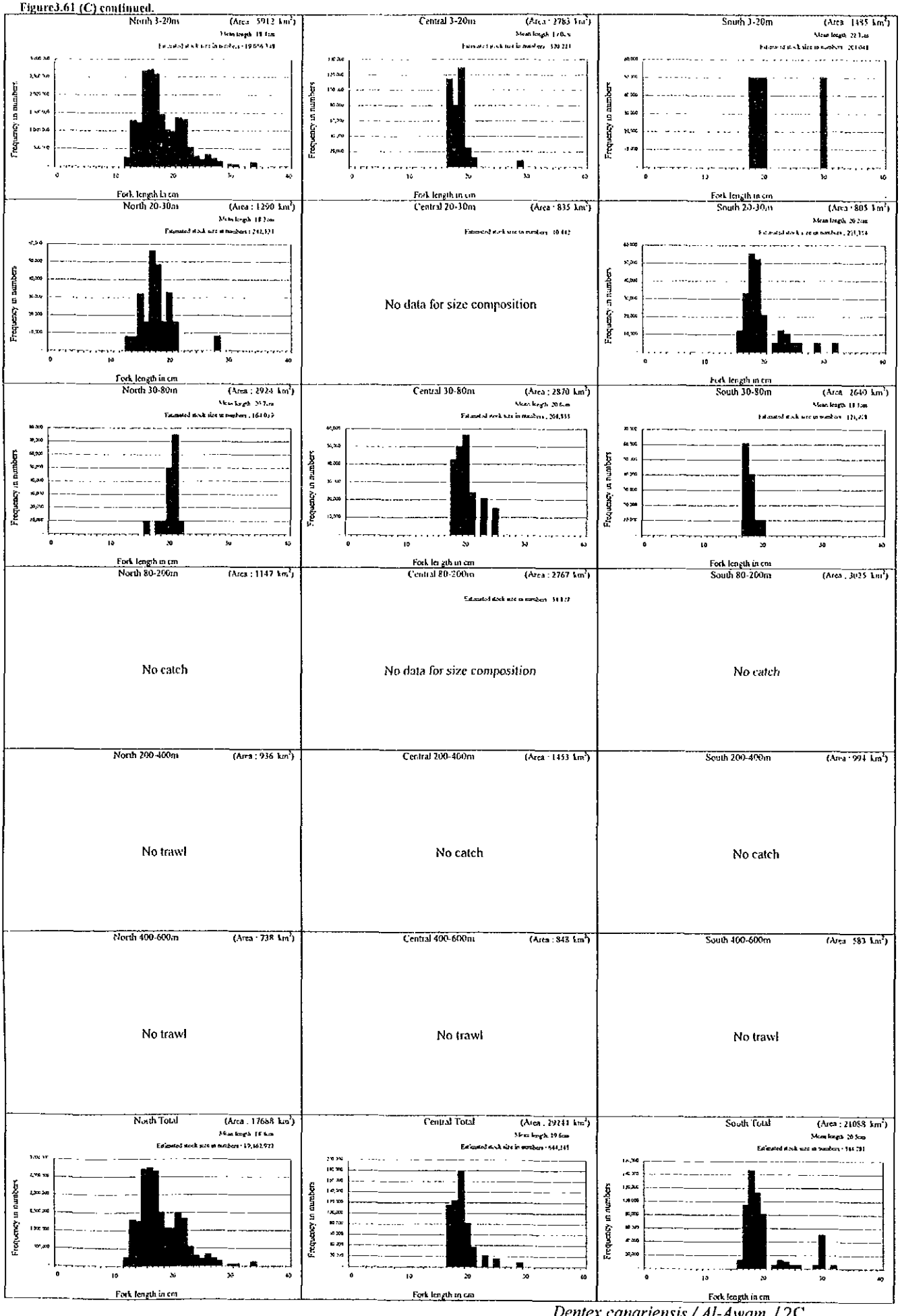


Figure3.61 (1) continued.

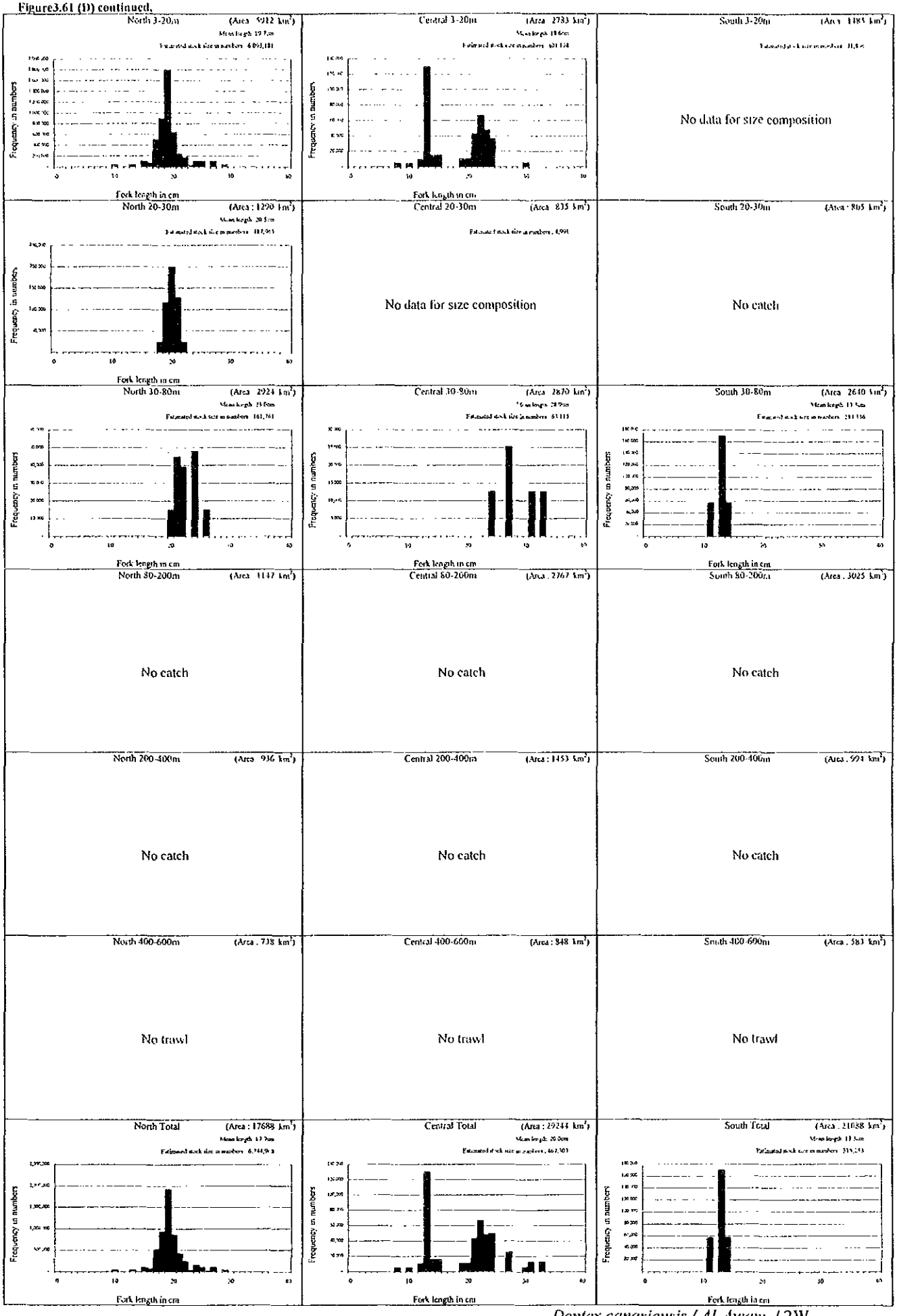


Table 3.90 Body length and weight by sex for Canary dentex *Dentex canariensis*.

(A) *Amrigue* survey area

Phase	Season	Sex	Individuals of specimens	Fork length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	2	188 ~ 200	194.0	131.0 ~ 145.0	138.0
		Female	9	142 ~ 270	176.0	59.0 ~ 380.0	125.7
		Indeterminate	8	140 ~ 167	149.9	55.0 ~ 99.0	69.4
		Total	19	140 ~ 270	166.9	55.0 ~ 380.0	103.3
	Warm	Male	2	118 ~ 121	119.5	30.0 ~ 32.0	31.0
		Female	0				
		Indeterminate	31	46 ~ 149	92.9	3.0 ~ 69.0	20.8
		Total	33	46 ~ 149	94.5	3.0 ~ 69.0	21.5
2	Cold	Male	0				
		Female	0				
		Indeterminate	2	140 ~ 145	142.5	61.0 ~ 68.0	64.5
		Total	2	140 ~ 145	142.5	61.0 ~ 68.0	64.5
	Warm	Male	2	117 ~ 194	155.5	37.0 ~ 170.0	103.5
		Female	3	141 ~ 211	173.3	55.0 ~ 200.0	123.3
		Indeterminate	3	82 ~ 111	93.0	12.0 ~ 55.0	26.7
		Total	8	82 ~ 211	138.8	12.0 ~ 200.0	82.1

(B) *Al-Awam* survey area

Phase	Season	Sex	Individuals of specimens	Fork length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	30	181 ~ 310	243.7	135.0 ~ 685.0	339.2
		Female	97	174 ~ 352	231.6	115.0 ~ 1,050.0	308.3
		Indeterminate	9	152 ~ 200	179.9	85.0 ~ 165.0	130.6
		Total	136	152 ~ 352	230.8	85.0 ~ 1,050.0	303.3
	Warm	Male	22	112 ~ 330	210.8	30.0 ~ 725.0	240.5
		Female	62	112 ~ 335	211.0	25.0 ~ 760.0	244.6
		Indeterminate	131	68 ~ 280	127.9	5.0 ~ 450.0	53.2
		Total	215	68 ~ 335	160.4	5.0 ~ 760.0	127.5
2	Cold	Male	53	160 ~ 340	210.2	100.0 ~ 900.0	234.1
		Female	141	148 ~ 340	203.4	65.0 ~ 950.0	202.4
		Indeterminate	56	130 ~ 205	166.0	45.0 ~ 180.0	102.3
		Total	250	130 ~ 340	196.4	45.0 ~ 950.0	186.7
	Warm	Male	29	130 ~ 336	201.2	50.0 ~ 795.0	214.3
		Female	107	100 ~ 306	203.4	23.0 ~ 605.0	209.8
		Indeterminate	13	86 ~ 140	124.0	17.0 ~ 55.0	44.4
		Total	149	86 ~ 336	196.0	17.0 ~ 795.0	196.2

Table 3.91 Sex ratio and female maturity stage for Canary dentex *Dentex canariensis.*

(A) *Amrigue* survey area

Northern coastal area (Stratum: 3-20m)	Phase 1 cold season							Phase 1 warm season							Phase 2 cold season							Phase 2 warm season						
	Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
Banc d'Arguin	4	2	0.50	75.0	0.0	0.0	25.0	0	2	E					0	0	E					0	0	E				
Other	5	0	0.00	100.0	0.0	0.0	0.0	0	0	E					0	0	E					3	2	0.67	66.7	33.3	0.0	0.0
All area	9	2	0.22	88.9	0.0	0.0	11.1	0	2	E					0	0	E					3	2	0.67	66.7	33.3	0.0	0.0

(B) *Al-Awam* survey area

Subarea	Stratum	Phase 1 cold season							Phase 1 warm season							Phase 2 cold season							Phase 2 warm season						
		Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
		♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
North	3-20m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	16	0.31	53.8	25.0	21.2	0.0	32	13	0.41	46.9	50.0	3.1	0.0
	20-30m	3	1	0.33	33.3	0.0	66.7	0.0	10	2	0.20	60.0	40.0	0.0	0.0	12	8	0.67	83.3	8.3	8.3	0.0	14	5	0.36	100.0	0.0	0.0	0.0
	30-80m	9	2	0.22	77.8	11.1	11.1	0.0	1	1	1.00	100.0	0.0	0.0	0.0	9	0	0.00	88.9	0.0	11.1	0.0	6	3	0.50	83.3	16.7	0.0	0.0
	80-200m	0	0	E					0	0	E					0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E					-	-	-	-	-	-	-	0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	12	3	0.25	66.7	8.3	25.0	0.0	11	3	0.27	63.6	36.4	0.0	0.0	73	24	0.33	63.0	19.2	17.8	0.0	52	21	0.40	65.4	32.7	1.9	0.0
Central	3-20m	-	-	-	-	-	-	-	16	8	0.50	56.3	43.8	0.0	0.0	18	20	1.11	72.2	22.2	5.6	0.0	45	3	0.07	80.0	20.0	0.0	0.0
	20-30m	21	13	0.62	81.0	9.5	9.5	0.0	9	1	0.11	100.0	0.0	0.0	0.0	0	0	E					0	0	E				
	30-80m	46	14	0.30	19.6	32.6	47.8	0.0	14	5	0.36	61.5	0.0	38.5	0.0	18	2	0.11	77.8	0.0	22.2	0.0	3	2	0.67	33.3	66.7	0.0	0.0
	80-200m	0	0	E					0	0	E					0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	67	27	0.40	38.8	25.4	35.8	0.0	39	14	0.36	68.4	18.4	13.2	0.0	36	22	0.61	75.0	11.1	13.9	0.0	48	5	0.10	77.1	22.9	0.0	0.0
South	3-20m	-	-	-	-	-	-	-	0	0	E					2	2	1.00	100.0	0.0	0.0	0.0	0	0	E				
	20-30m	11	0	0.00	81.8	9.1	9.1	0.0	1	0	0.00	100.0	0.0	0.0	0.0	22	5	0.23	63.6	31.8	4.5	0.0	0	0	E				
	30-80m	7	0	0.00	85.7	14.3	0.0	0.0	11	5	0.45	100.0	0.0	0.0	0.0	8	0	0.00	100.0	0.0	0.0	0.0	7	3	0.43	100.0	0.0	0.0	0.0
	80-200m	0	0	E					0	0	E					0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	18	0	0.00	83.3	11.1	5.6	0.0	12	5	0.42	100.0	0.0	0.0	0.0	32	7	0.22	75.0	21.9	3.1	0.0	7	3	0.43	100.0	0.0	0.0	0.0
All	3-20m	-	-	-	-	-	-	-	16	8	0.50	56.3	43.8	0.0	0.0	72	38	0.53	59.7	25.6	16.7	0.0	77	16	0.21	66.2	32.5	1.3	0.0
	20-30m	35	14	0.40	77.1	8.6	14.3	0.0	20	3	0.15	80.0	20.0	0.0	0.0	34	13	0.38	70.6	23.5	5.9	0.0	14	5	0.36	100.0	0.0	0.0	0.0
	30-80m	62	16	0.26	35.5	27.4	37.1	0.0	26	11	0.42	80.0	0.0	20.0	0.0	35	2	0.06	85.7	0.0	14.3	0.0	16	8	0.50	81.3	18.8	0.0	0.0
	80-200m	0	0	E					0	0	E					0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	97	30	0.31	50.5	20.6	28.9	0.0	62	22	0.35	73.8	18.0	8.2	0.0	141	53	0.38	68.8	17.7	13.5	0.0	107	29	0.27	72.9	26.2	0.9	0.0

Remarks. * I: Immature, II: Semi-mature, III: Mature, IV: Spent. -: no trawl. E: Error. blank: no data.

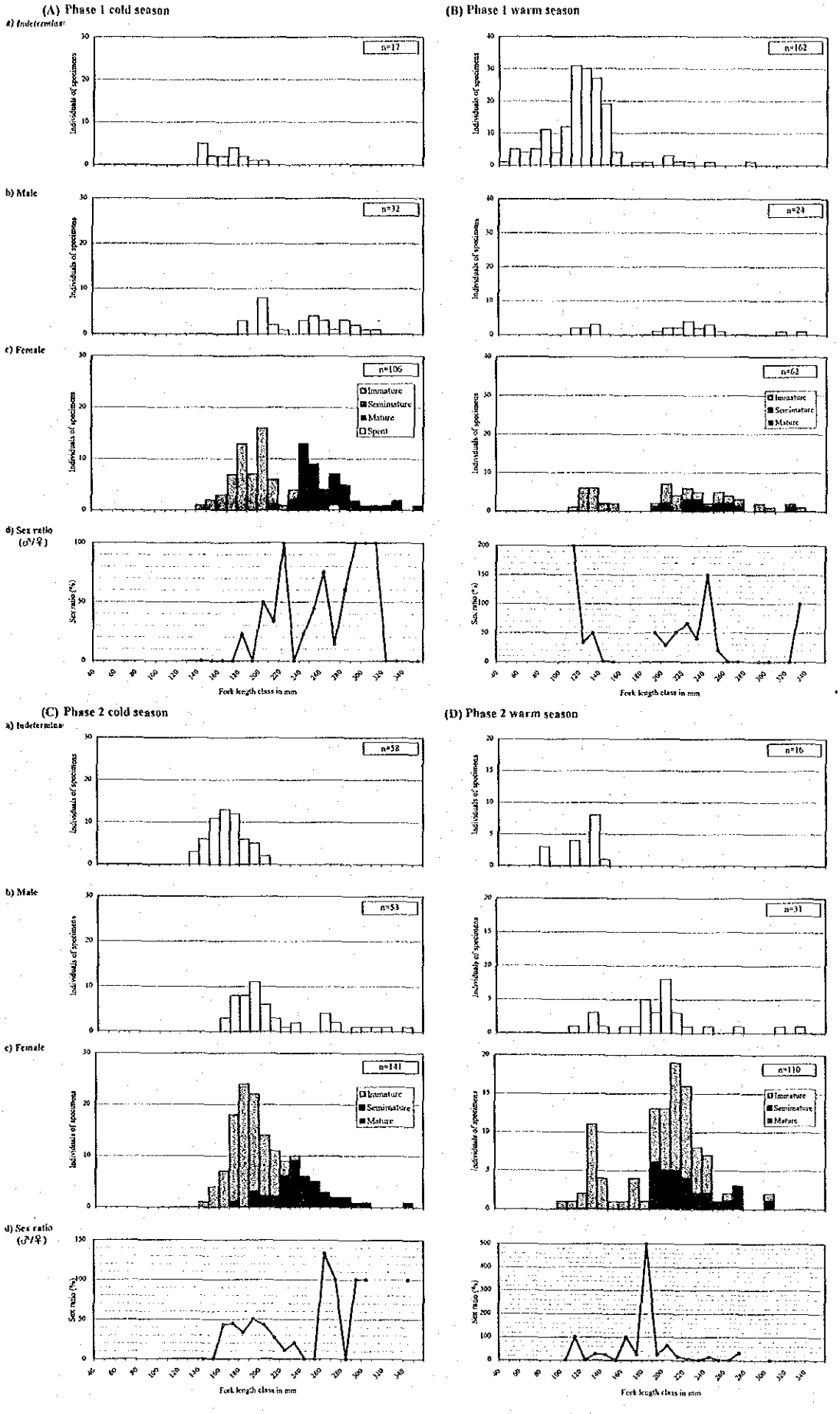


Figure 3.63 Sex ratio and female maturity stage by length class for Canary dentex *Dentex canariensis*.

Table 3.92 Stomach content analysis of Canary dentex *Dentex canariensis*.

(A) Stomach condition

Phase	Season	Stomach condition				Stomach content Somatic Index (SSI)			
		n*	Empty (%)	Evert (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	155	59.35	3.23	37.42	145	0.00	54.55	5.13
	Warm	217	65.44	0.00	34.56	217	0.00	81.82	6.05
2	Cold	199	68.34	0.00	31.66	192	0.00	76.97	7.04
	Warm	144	52.08	0.69	47.22	143	0.00	46.86	7.71

* number of individuals

(B) Stomach contents

Phase	Season	n*	Sipunculo -idea	Mollusca				Polychaeta	Crustacea	
				Decapoda	*Sepia* sp.	Octopoda	Other		Gammaridae	Crab
1	Cold	58	1.72	1.72		1.72		10.34		
	Warm	75		6.67				5.33	8.00	2.67
2	Cold	64		3.17	1.59	1.59	1.59	1.59		3.17
	Warm	63			1.59			4.76		22.22

(Continued)

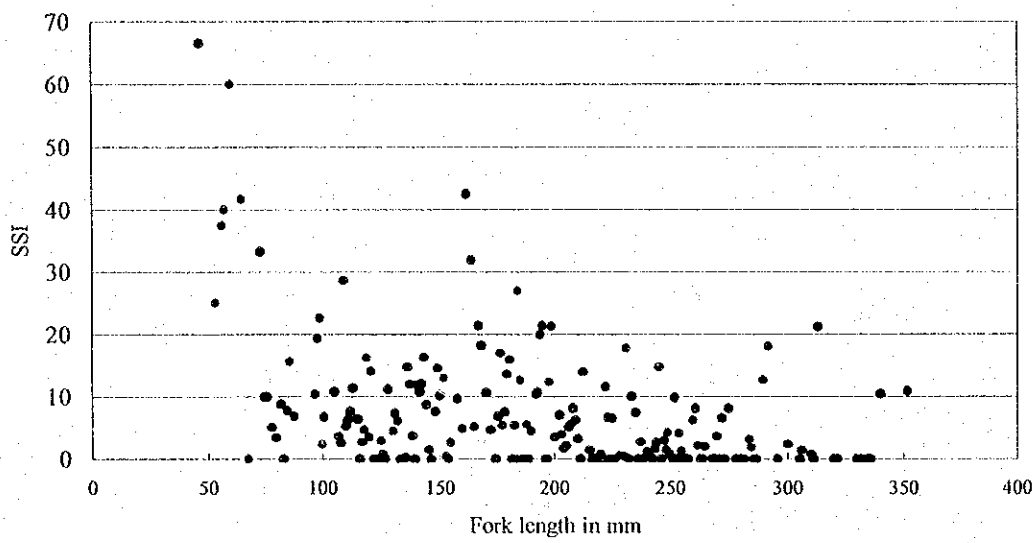
Phase	Season	Crustacea			Fish					
		Anomura	Shrimp	Other	*Echelus myrus*	Carangidae sp.	Gobiidae sp.	*Cynoglossus* sp.	Soleidae sp.	Other
1	Cold			41.38		1.72			1.72	22.41
	Warm		8.00	4.00						4.00
2	Cold			4.76						31.75
	Warm	3.17	9.52	15.87	3.17		3.00	1.59	3.17	30.16

(Continued)

Phase	Season	Unknown
1	Cold	24.14
	Warm	65.33
2	Cold	52.38
	Warm	12.70

* number of individuals

(A) Relationship between fork length and SSI



(B) Relationship between fork length and SCW

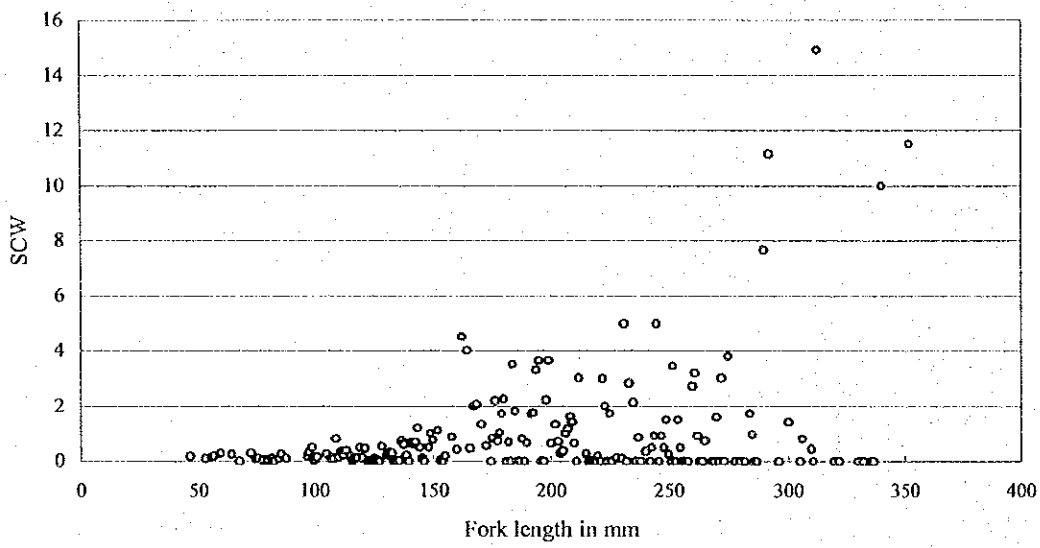


Figure 3.64 Relationship between body length and SSI (A) and SCW (B) for Canary dentex *Dentex canariensis*.

11) Red pandora *Pagellus bellottii*

a) Body length range and mean body length

Table 3.93 (page 3-285) presents the minimum, maximum and mean fork length obtained for the red pandora.

In the *Amrigue* survey area, the fork length of 39 individuals sampled varied between 46 and 132 mm. In different seasons (no sample was obtained in the Phase 2 cold season), the mean fork length was between 72 and 113 mm, being larger in the cold season than in the warm season.

In the *Al-Awam* survey area, the fork length varied between 36 and 295 mm throughout the suvey. The mean fork length by area was within the following ranges: 120 and 166 mm in the Northern area, 145 and 169 mm in the Central area and 143 and 170 mm in the Southern area. The mean fork length by area was greater in the warm season in the Northern area and in the cold season in the Central area, but no seasonal variation was verified in the Southern area. With a few exceptions, the mean fork length by stratum in each area increased with depth.

b) Size composition

Figure 3.65 (page 3-282, 3-286 to 3-289) presents the evaluation of the size composition for the red pandora. The fork length class is indicated at intervals of 1cm. For convenience, three groups were defined: (i) small-size (fork length less than 10cm), (ii) medium-size (length between 10 and 20cm), (iii) large-size (length over 20cm).

In the cold season, the total stock size in number of this species essentially comprised the small-size group with the predominant mode at the 8-9cm class. However, in the warm season, it was composed of the small-size group (in Phase 1, the group of individuals larger than 5cm; in Phase 2, the group with the predominant mode at the 8-9cm class) and the medium-size group (in Phase 1, the group with the predominant mode at the 15-16cm class; in Phase 2, the group with the modes at the 12-13 and 17-18cm classes, hereinafter referred to as Ms group and Mℓ group respectively). The large-size group appeared in all seasons, but without a conspicuous mode. The fact that the small-size group was found in both seasons suggests that the spawning should either take a long period or happen in more than one period.

The distribution of those three groups was studied from the size composition by stratum and by area. The small-size group was distributed in all areas in each season, mainly in the Northern area in the Phase 1 cold season and in the Phase 2 warm season, and in the Central and/or Southern areas in other seasons. It was concentrated at the 30-80 m stratum in each of these areas. The medium-size group was also distributed in all areas in each season, but mainly at the 30-80 m stratum in the Northern area (Phase 1) or in the Southern area (Phase 2 cold season). The Ms and Mℓ groups were widespread over the survey area in the Phase 2 warm season, both at the 30-80 m stratum, the former mainly in the Northern area and the latter mainly in the Southern area. The large-size group occurred in all areas in each season, but without an area of concentration throughout the survey.

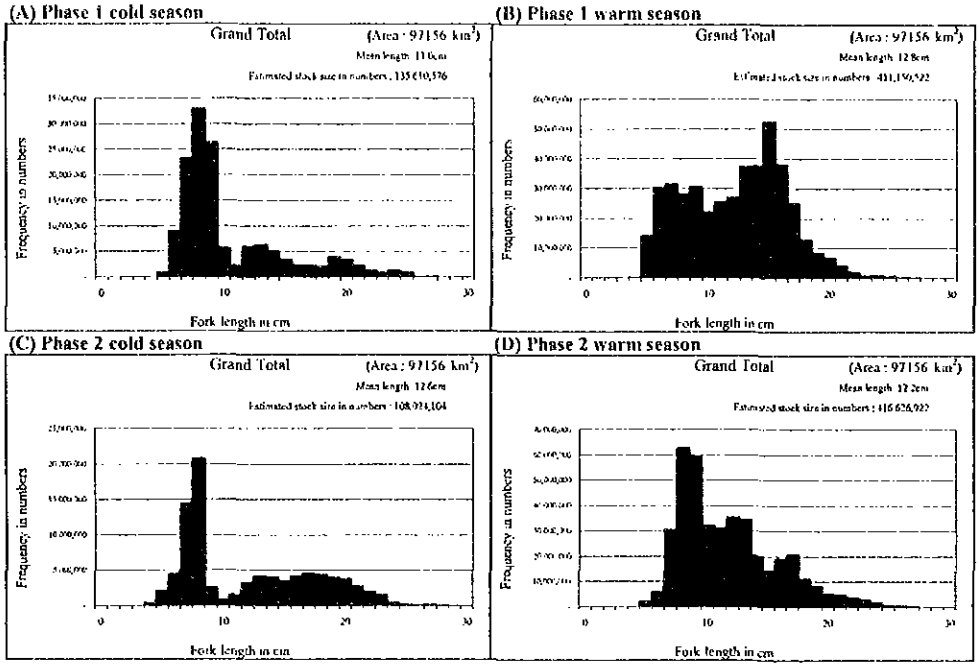


Figure 3.65 Size composition for red pandora *Pagellus bellottii.*

c) Length-weight relationship

Figure 3.66 (page 3-283) shows the relationship between the fork length and weight for the red pandora. The length-weight equations obtained were the following:

Phase 1 cold season	: $BW = 1.865\times10^{-2}\times TL^{3.029}$	(r=0.9897)
Phase 1 warm season	: $BW = 2.055\times10^{-2}\times TL^{2.988}$	(r=0.9863)
Phase 2 cold season	: $BW = 2.130\times10^{-2}\times TL^{2.966}$	(r=0.9889)
Phase 2 warm season	: $BW = 1.799\times10^{-2}\times TL^{3.034}$	(r=0.9890)

where, BW : body weight (g), FL : fork length (cm) and r : the coefficient of correlation.

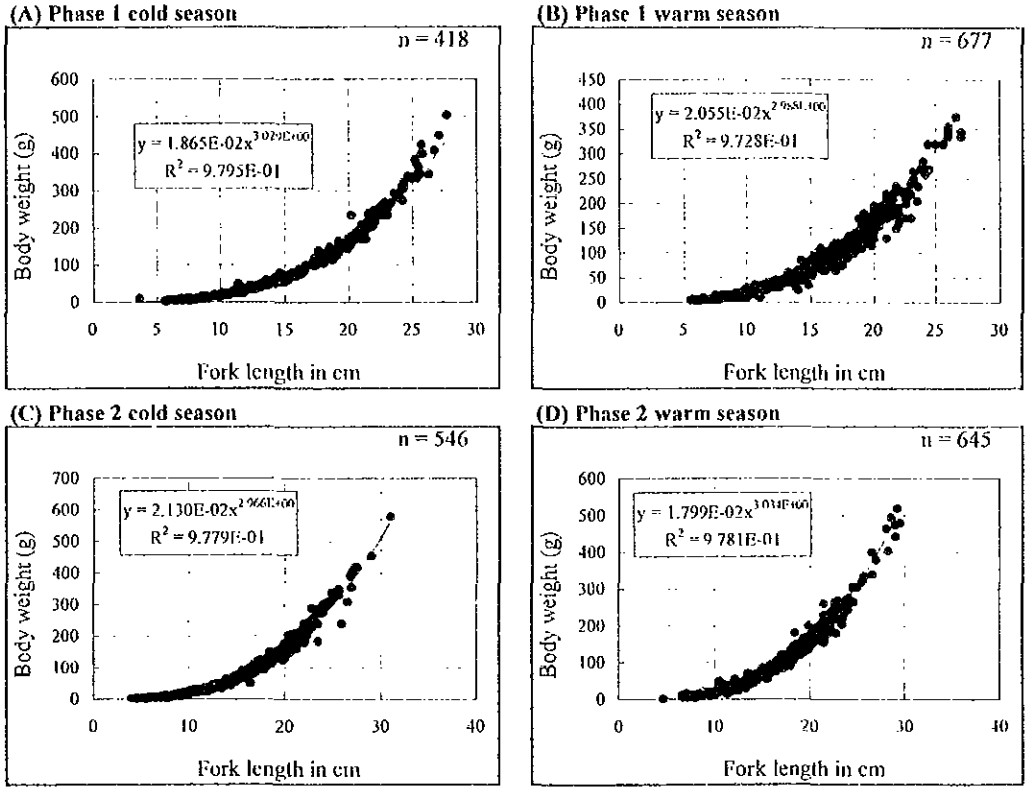


Figure 3.66 Length-weight relationship for red pandora *Pagellus bellottii*.

d) Length and weight by sex

Table 3.94 (page 3-290) presents the fork length and body weight observed in each sex for the red pandora.

In the *Amrigue* survey area, the fork length of the four males varied between 105 and 132 mm, and that of the ten females between 78 and 130 mm.

In the *Al-Awam* survey area, the fork length varied between 82 and 292 mm for males and between 36 and 310 mm for females. In each survey season, the mean fork length of males varied between 164 and 180 mm, and that of females between 150 and 179 mm. The average males were larger than females in all seasons.

The fork length of females with gonads developed enough to allow sex determination by visual inspection was approximately 4cm for the earlier individuals and 10cm for the late ones; in males, the fork length was 8cm for the early individuals. According to the Fish Base the red pandora is a protogynic hermaphrodite. The results showed that females developed their gonads at smaller sizes than males and verified those observations.

e) Sex ratio and female maturity stage

Table 3.95 (page 3-291) summarizes the sex ratio and the female maturity stage for the red pandora. Figure 3.67 (page 3-292) presents their distribution by length class.

The overall sex ratio was, in survey order, 1.13, 1.43, 1.22 and 0.92, meaning that the male population

was more numerous or equivalent to that of females. As for the sex ratio by stratum and by area, no geographic- and depth-dependent change was observed.

The female maturity ratio over the entire area varied between 7 and 11% in the cold season and between 11 and 31% in the warm season; it increased in the more recent seasons. The female maturity ratio by area was between 15 and 17% in the Central area in the cold season and between 14 and 53% in the Northern area in the warm season (in Phase 2, the ratio in the Southern area was also high: 47%). In each season, the depth-dependent change of the maturity ratio differed according to the area. These results suggest that: ①the spawning of the red pandora took place at least near both the cold and the warm seasons, ②the main spawning period happened before the warm season (one could also infer that from the fact the population of small-size group described above is much more significant then than in the cold season), ③the main spawning grounds were the Central area in the cold season and the Northern and Southern areas in the warm season, and ④the spawning didn't take place all at once, but there are geographical and vertical differences.

The size-dependent change of the sex ratio was acute in the Phase 2 warm season. There were no males in size classes smaller than 80 mm, but between 80 and 250 mm, the ratio increased progressively, with some intermediate fluctuations, to turn from 0 to 300%; beyond 250 mm, the ratio decreased to 50%. It is conceivable that this result indicates sex reversal, as the red pandora is a protogynic hermaphrodite, as mentioned above. But it should also be noted that in the three other seasons, the size-dependent aspect is not the same. In both seasons of Phase 1, the ratio apparently tended to depend on length, but that was not very clear; in the Phase 2 cold season, the state of male/female equilibrium was more or less maintained in all length classes.

The fork length at first maturity in the cold season was observed at the 19-20cm class, and in the warm season at the 11-12cm class. According to Franqueville (1979), the length at firtst maturity would vary between 10 and 17cm. The results obtained were not in contradiction with those findings.

f) Feeding habits

Table 3.96 (page 3-293) presents the stomach condition and the stomach content composition of the red pandora in each survey season. Figure 3.68 (page 3-294) presents the relationship between the fork length and SSI and SCW. Those results were based on all data collected by both the *Amrigue* and the *Al-Awam*.

The ratio of the empty stomach was comparatively high, varying between 56 and 88%. Throughout the survey, two individuals with the everted stomach were observed. The relationship between the fork length and SSI and SCW showed that the largest individuals consume great quantities of food, while the small-size individuals are voracious eaters in relation to their body weight. Particularly, the SSI of individuals with a fork length of less than 100 mm increased abruptly near 60-70 mm.

The red pandora is an omnivorous species. It fed mainly on polychaetes, crustaceans (shrimp, crabs, anomurans, isopods, *etc.*) and fish. In Phase 2, seaweed and echinoderms were also found in the stomach of this species.

Table 3.93 Body length range and mean body length for red pandora *Pagellus bellottii* : FL in mm.

(A) *Amrigue* survey area

Northern coastal area (Stratum: 3-20m)	Phase 1						Phase 2					
	Cold season			Warm season			Cold season			Warm season		
	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
Banc d'Arguin	18	72 ~ 132	112.5	6	59 ~ 85	74.5	0			8	46 ~ 88	71.9
Other	0			7	66 ~ 94	77.3	0			0		
All area	18	72 ~ 132	112.5	13	59 ~ 94	76.0	0			8	46 ~ 88	71.9

(B) *Al-Awam* survey area

Subarea	Stratum	Phase 1						Phase 2					
		Cold season			Warm season			Cold season			Warm season		
		Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
North	3-20m	-	-	-	-	-	-	40	75 ~ 290	137.9	33	95 ~ 225	184.1
	20-30m	60	64 ~ 218	104.1	37	62 ~ 230	134.0	40	70 ~ 260	144.3	40	77 ~ 295	146.8
	30-80m	120	69 ~ 246	127.6	80	142 ~ 266	164.8	49	65 ~ 275	160.4	80	76 ~ 290	168.2
	80-200m	0			0			0			0		
	200-400m	0			0			-	-	-	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	180	64 ~ 246	119.8	117	62 ~ 266	155.1	129	65 ~ 290	148.4	153	76 ~ 295	166.0
Central	3-20m	-	-	-	78	86 ~ 236	132.4	80	45 ~ 250	147.8	69	76 ~ 160	125.1
	20-30m	40	36 ~ 246	149.1	40	74 ~ 256	145.4	60	45 ~ 243	128.2	75	69 ~ 230	148.8
	30-80m	69	63 ~ 271	167.9	200	55 ~ 270	154.6	100	65 ~ 270	146.2	140	65 ~ 282	152.8
	80-200m	14	202 ~ 258	234.2	40	104 ~ 220	142.6	20	155 ~ 273	192.6	0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	123	36 ~ 271	169.3	358	55 ~ 270	147.4	260	45 ~ 273	146.1	284	65 ~ 282	145.0
South	3-20m	-	-	-	0			0			0		
	20-30m	37	130 ~ 240	191.6	20	116 ~ 150	133.1	57	40 ~ 250	160.1	40	105 ~ 220	153.2
	30-80m	60	59 ~ 277	113.4	169	57 ~ 260	161.7	100	70 ~ 310	175.7	160	71 ~ 292	167.2
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	97	59 ~ 277	143.3	189	57 ~ 260	158.6	157	40 ~ 310	170.1	200	71 ~ 292	164.4

Remark. - : no trawl.

Figure3.65 (A) continued.

North 3-20m (Area : 5912 km²)

No trawl

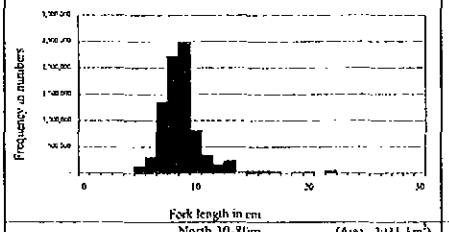
Central 3-20m (Area : 2783 km²)

No trawl

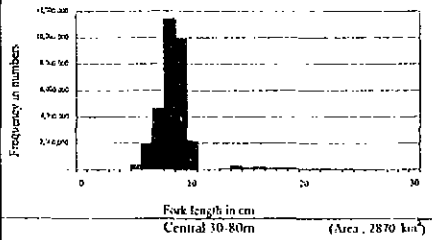
South 3-20m (Area : 1385 km²)

No trawl

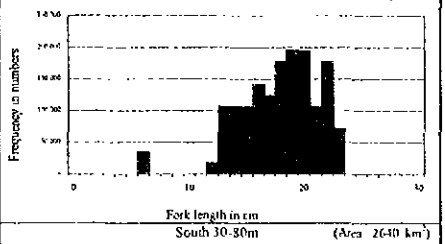
North 20-30m (Area : 1290 km²)



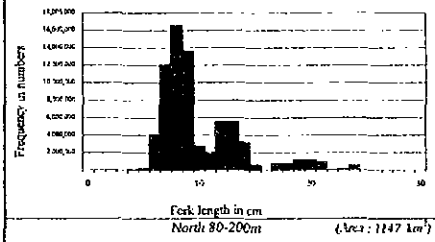
Central 20-30m (Area : 835 km²)



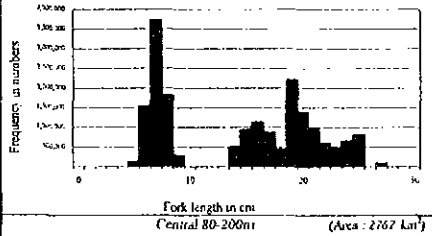
South 20-30m (Area : 805 km²)



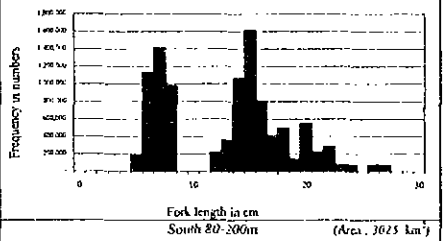
North 30-80m (Area : 2924 km²)



Central 30-80m (Area : 2870 km²)



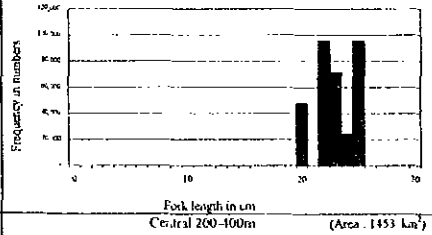
South 30-80m (Area : 2640 km²)



North 80-200m (Area : 1147 km²)

No catch

Central 80-200m (Area : 2767 km²)



South 80-200m (Area : 3025 km²)

No catch

North 200-400m (Area : 936 km²)

No catch

Central 200-400m (Area : 1453 km²)

No catch

South 200-400m (Area : 994 km²)

No catch

North 400-600m (Area : 738 km²)

No trawl

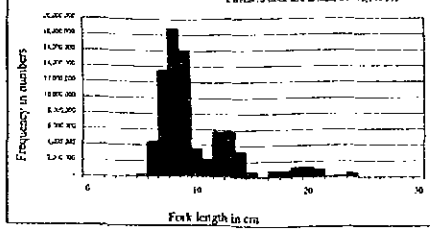
Central 400-600m (Area : 818 km²)

No trawl

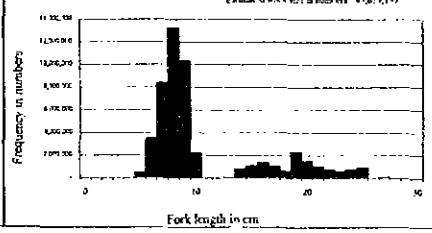
South 400-600m (Area : 583 km²)

No trawl

North Total (Area : 17688 km²)



Central Total (Area : 29244 km²)



South Total (Area : 21028 km²)

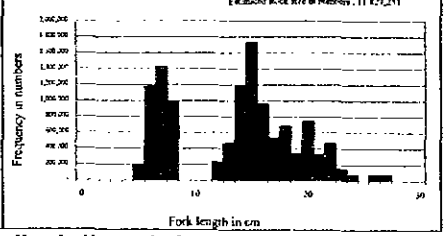


Figure3.65 (B) continued.

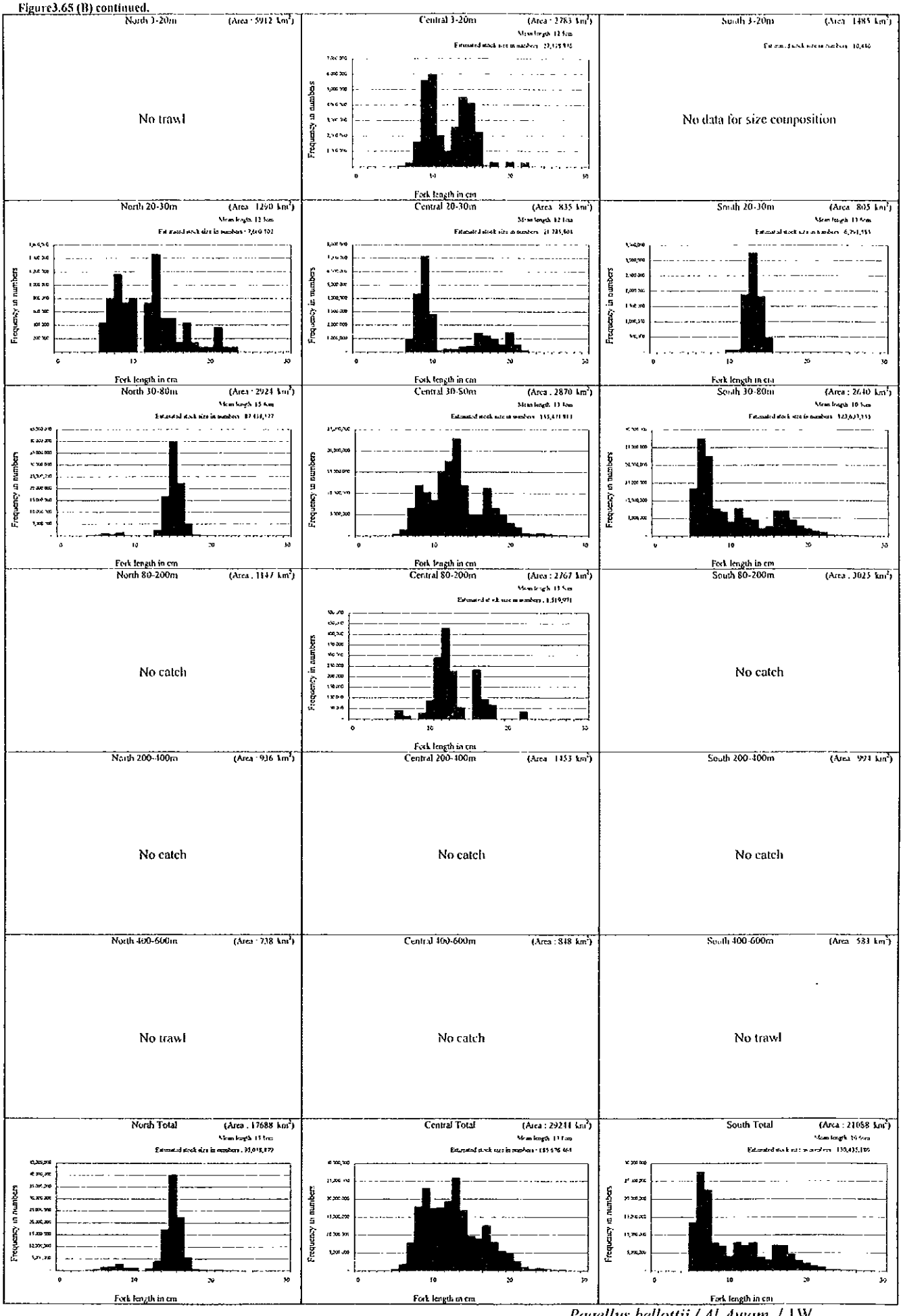


Figure3.65 (C) continued.

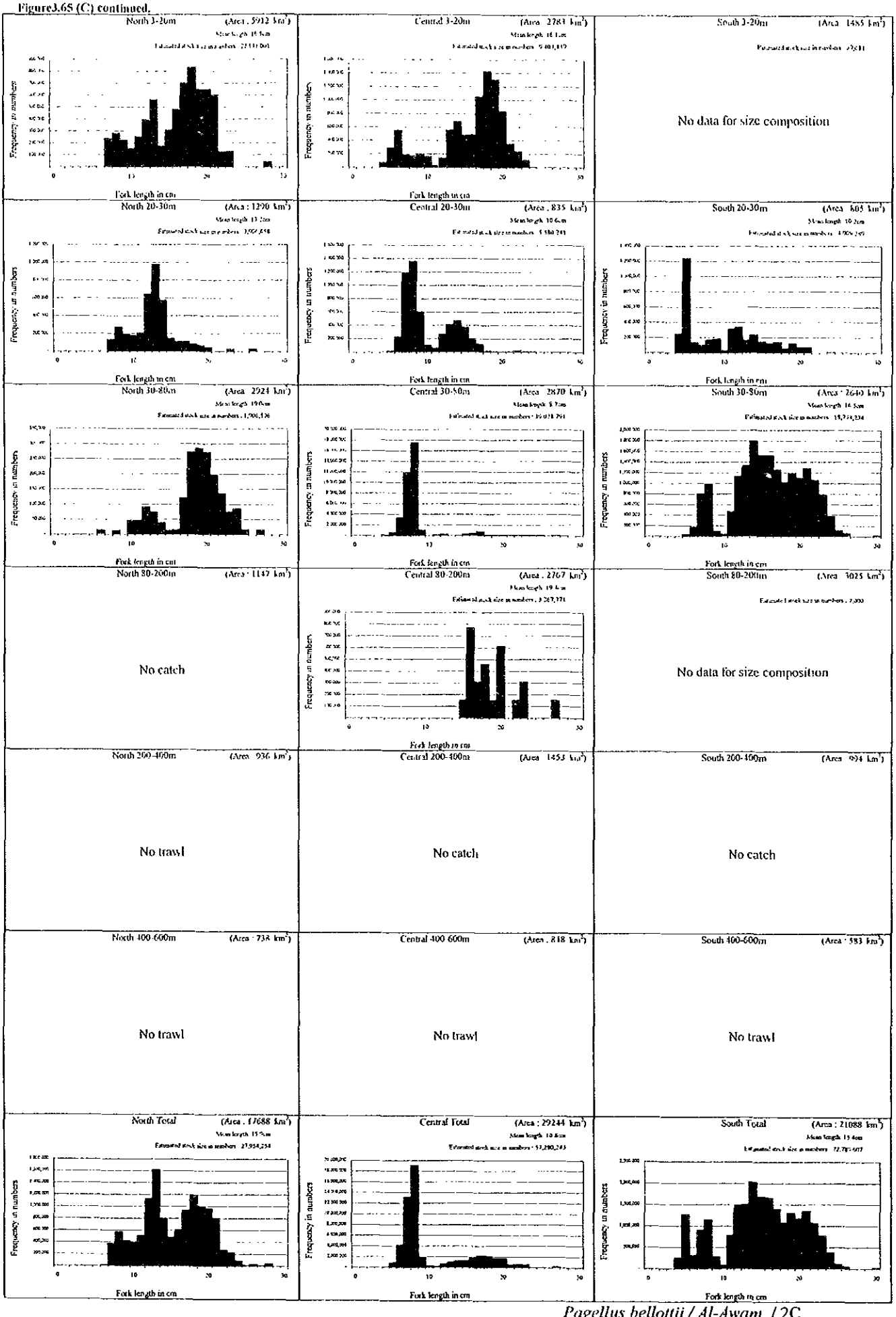


Figure3.65 (D) continued.

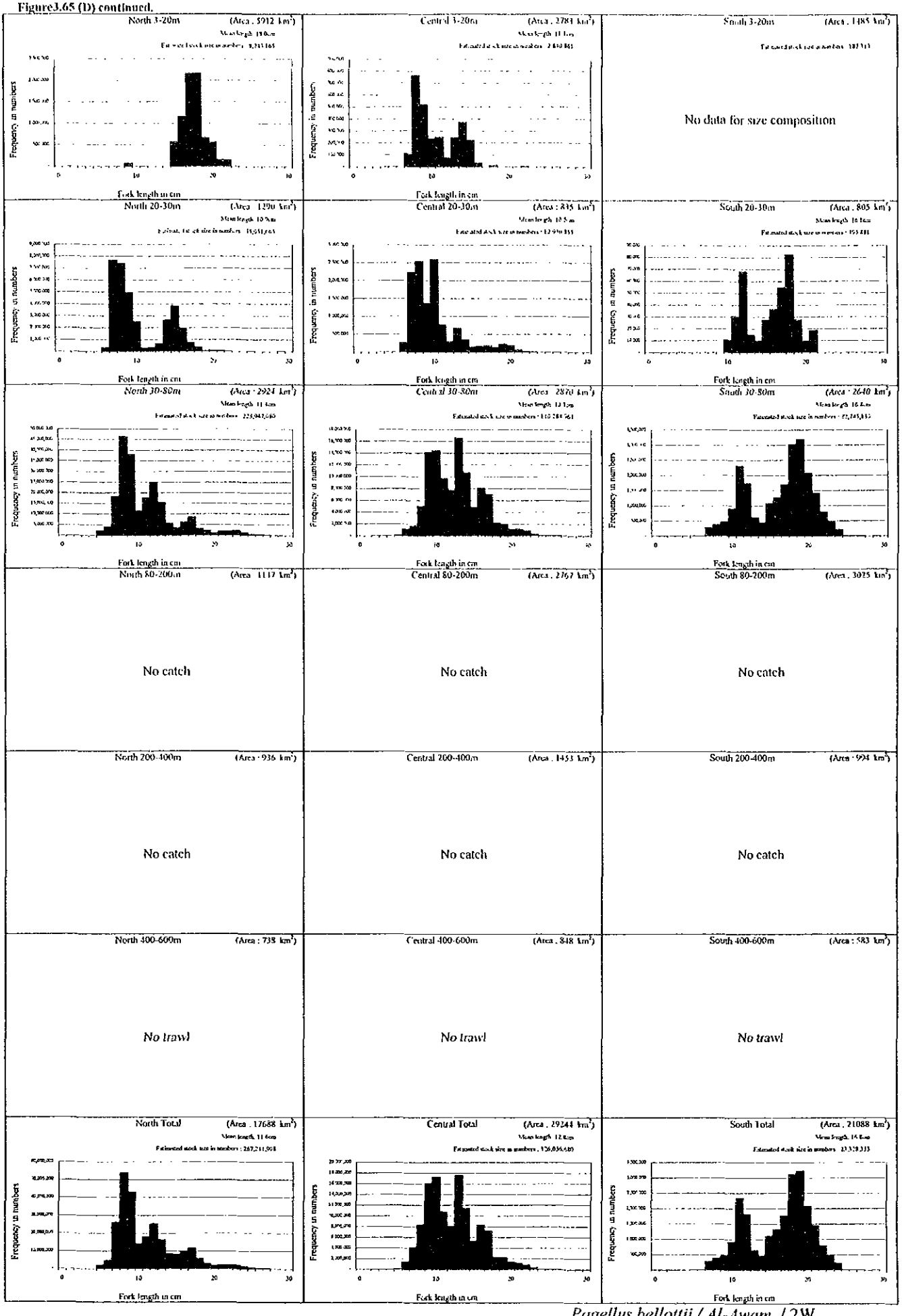


Table 3.94 Body length and weight by sex for red pandora *Pagellus bellottii*.

(A) *Amrigue* survey area

Phase	Season	Sex	Individuals of specimens	Fork length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	4	105 ~ 132	120.3	25.0 ~ 48.0	36.3
		Female	8	100 ~ 130	117.5	19.0 ~ 45.0	33.8
		Indeterminate	6	72 ~ 121	100.7	7.0 ~ 36.0	21.0
		Total	18	72 ~ 132	112.5	7.0 ~ 48.0	30.1
	Warm	Male	0				
		Female	2	78 ~ 94	86.0	9.0 ~ 15.0	12.0
		Indeterminate	11	59 ~ 85	74.2	4.0 ~ 12.0	7.7
		Total	13	59 ~ 94	76.0	4.0 ~ 15.0	8.4
2	Cold	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	0				
		Female	0				
		Indeterminate	8	46 ~ 88	71.9	2.0 ~ 13.0	8.0
		Total	8	46 ~ 88	71.9	2.0 ~ 13.0	8.0

(B) *Al-Awam* survey area

Phase	Season	Sex	Individuals of specimens	Fork length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	164	85 ~ 263	164.3	10.0 ~ 425.0	116.4
		Female	145	36 ~ 277	149.6	5.0 ~ 505.0	102.2
		Indeterminate	91	56 ~ 230	84.0	4.0 ~ 235.0	17.4
		Total	400	36 ~ 277	140.7	4.0 ~ 505.0	88.7
	Warm	Male	268	92 ~ 266	171.0	10.0 ~ 375.0	110.1
		Female	188	57 ~ 270	168.6	6.0 ~ 345.0	107.1
		Indeterminate	208	55 ~ 260	112.4	4.0 ~ 345.0	35.5
		Total	664	55 ~ 270	152.0	4.0 ~ 375.0	85.9
2	Cold	Male	204	97 ~ 290	180.1	15.0 ~ 455.0	128.9
		Female	167	100 ~ 310	178.8	23.0 ~ 580.0	127.8
		Indeterminate	175	40 ~ 188	98.4	2.8 ~ 135.0	24.0
		Total	546	40 ~ 310	153.5	2.8 ~ 580.0	94.9
	Warm	Male	260	82 ~ 292	178.0	12.0 ~ 520.0	128.0
		Female	282	69 ~ 295	155.2	8.0 ~ 495.0	94.9
		Indeterminate	93	65 ~ 183	97.6	5.0 ~ 110.0	19.5
		Total	635	65 ~ 295	156.1	5.0 ~ 520.0	97.4

Table 3.95 Sex ratio and female maturity stage for red pandora *Pagellus bellottii.*

(A) *Amrigue* survey area

Northern coastal area (Stratum: 3-20m)	Phase 1 cold season							Phase 1 warm season							Phase 2 cold season							Phase 2 warm season						
	Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
Banc d'Arguin	8	4	0.50	100.0	0.0	0.0	0.0	0	0	E					0	0	E					0	0	E				
Other	0	0	E					2	0	0.00					0	0	E					0	0	E				
All area	8	4	0.50	100.0	0.0	0.0	0.0	2	0	0.00					0	0	E					0	0	E				

(B) *Al-Awam* survey area

Subarea	Stratum	Phase 1 cold season							Phase 1 warm season							Phase 2 cold season							Phase 2 warm season						
		Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
		♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
North	3-20m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	12	0.71	82.4	17.6	0.0	0.0	15	17	1.13	0.0	66.7	33.3	0.0
	20-30m	24	17	0.71	91.7	4.2	4.2	0.0	12	10	0.83	25.0	41.7	33.3	0.0	12	16	1.33	91.7	8.3	0.0	0.0	13	21	1.62	46.2	23.1	30.8	0.0
	30-80m	39	66	1.69	94.9	5.1	0.0	0.0	23	57	2.48	21.7	73.9	4.3	0.0	23	20	0.87	56.5	30.4	13.0	0.0	29	35	1.21	24.1	3.4	72.4	0.0
	80-200m	0	0	E					0	0	E					0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E					-	-	-	-	-	-	-	0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	63	83	1.32	93.7	4.8	1.6	0.0	35	67	1.91	22.9	62.9	14.3	0.0	52	48	0.92	73.1	21.2	5.8	0.0	57	73	1.28	22.8	24.6	52.6	0.0
Central	3-20m	-	-	-	-	-	-	-	16	23	1.44	68.8	31.3	0.0	0.0	20	21	1.05	35.0	30.0	35.0	0.0	39	19	0.49	97.4	2.6	0.0	0.0
	20-30m	14	16	1.14	71.4	21.4	7.1	0.0	11	9	0.82	0.0	54.5	45.5	0.0	12	15	1.25	66.7	25.0	8.3	0.0	40	26	0.65	52.5	22.5	25.0	0.0
	30-80m	32	26	0.81	75.0	21.9	3.1	0.0	42	74	1.76	40.5	47.6	11.9	0.0	25	36	1.44	20.0	72.0	8.0	0.0	70	51	0.73	55.7	27.1	17.1	0.0
	80-200m	7	7	1.00	0.0	0.0	100.0	0.0	19	19	1.00	52.6	42.1	5.3	0.0	12	8	0.67	66.7	33.3	0.0	0.0	0	0	E				
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	53	49	0.92	64.2	18.9	17.0	0.0	88	125	1.42	43.2	44.3	12.5	0.0	69	80	1.16	40.6	44.9	14.5	0.0	149	96	0.64	65.8	19.5	14.8	0.0
South	3-20m	-	-	-	-	-	-	-	0	0	E					0	0	E					0	0	E				
	20-30m	12	22	1.83	33.3	66.7	0.0	0.0	8	3	0.38	100.0	0.0	0.0	0.0	13	27	2.08	15.4	46.2	38.5	0.0	15	20	1.33	40.0	6.7	53.3	0.0
	30-80m	17	10	0.59	82.4	17.6	0.0	0.0	57	73	1.28	29.8	61.4	8.8	0.0	33	49	1.48	72.7	27.3	0.0	0.0	61	71	1.16	29.5	24.6	45.9	0.0
	80-200m	0	0	E					0	0	E					0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	29	32	1.10	62.1	37.9	0.0	0.0	65	76	1.17	38.5	53.8	7.7	0.0	46	76	1.65	56.5	32.6	10.9	0.0	76	91	1.20	31.6	21.1	47.4	0.0
All	3-20m	-	-	-	-	-	-	-	16	23	1.44	68.8	31.3	0.0	0.0	37	33	0.89	56.8	24.3	18.9	0.0	54	36	0.67	70.4	20.4	9.3	0.0
	20-30m	50	55	1.10	72.0	24.0	4.0	0.0	31	22	0.71	35.5	35.5	29.0	0.0	37	58	1.57	56.8	27.0	16.2	0.0	68	67	0.99	48.5	19.1	32.4	0.0
	30-80m	88	102	1.16	85.2	13.6	1.1	0.0	122	204	1.67	32.0	59.0	9.0	0.0	81	105	1.30	51.9	42.0	6.2	0.0	160	157	0.98	40.0	21.9	38.1	0.0
	80-200m	7	7	1.00	0.0	0.0	100.0	0.0	19	19	1.00	52.6	42.1	5.3	0.0	12	8	0.67	66.7	33.3	0.0	0.0	0	0	E				
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	145	164	1.13	76.6	16.6	6.9	0.0	188	268	1.43	37.8	51.1	11.2	0.0	167	204	1.22	55.1	34.1	10.8	0.0	282	260	0.92	47.9	20.9	31.2	0.0

Remarks. * I: Immature, II: Semi-mature, III: Mature, IV: Spent. -: no trawl. E: Error. blank: no data.

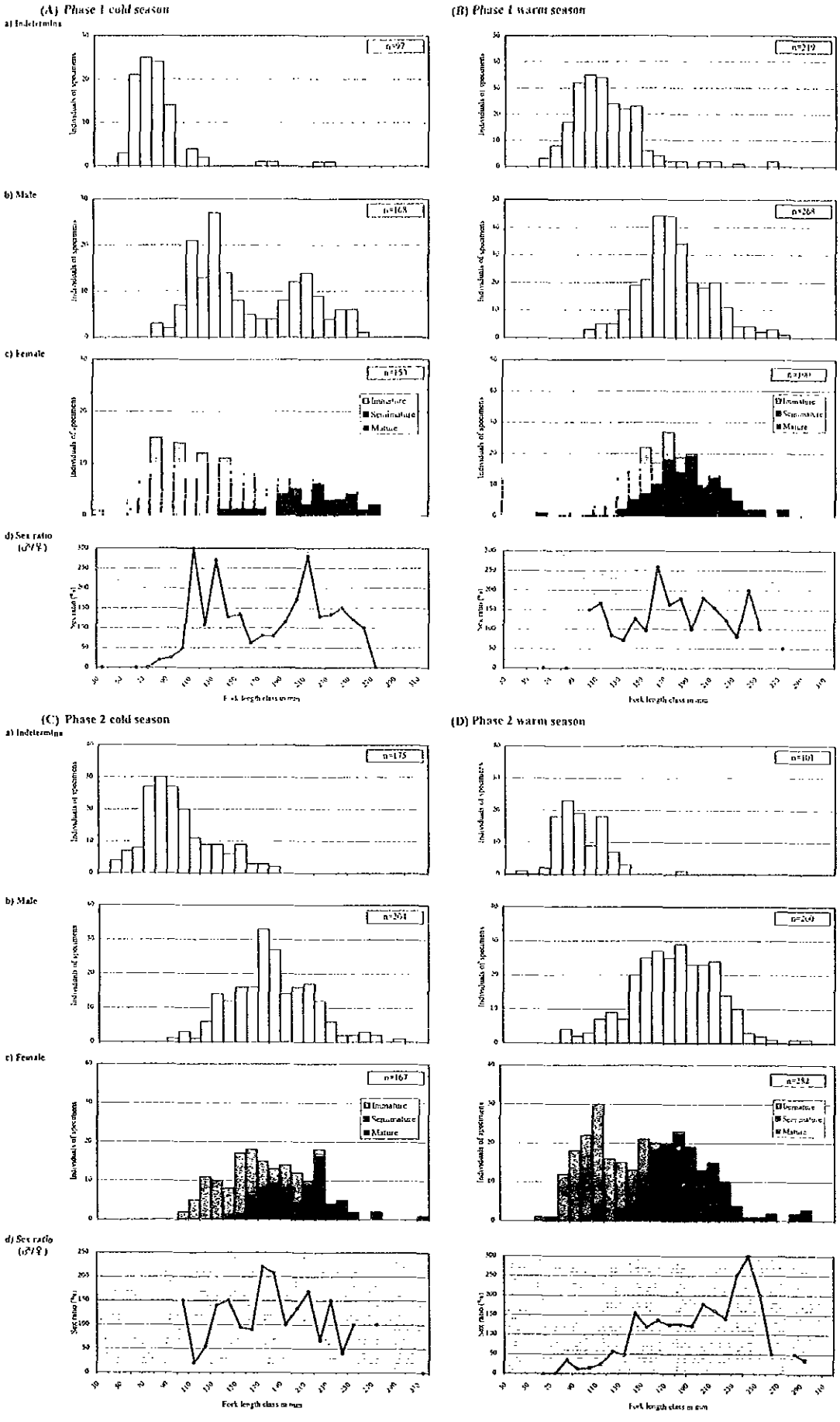


Figure 3.67 Sex ratio and female maturity stage by length class for red pandora *Pagellus bellottii*.

Table 3.96 Stomach content analysis of red pandora *Pagellus bellottii.*

(A) Stomach condition

Phase	Season	Stomach condition				Stomach content Somatic Index (SSI)			
		n*	Empty (%)	Evert (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	418	56.46	0.24	43.30	397	0.00	218.18	12.96
	Warm	627	87.88	0.00	12.12	625	0.00	52.50	1.23
2	Cold	389	81.75	0.00	18.25	368	0.00	190.70	5.01
	Warm	584	73.80	0.17	26.03	570	0.00	50.00	2.42

(B) Stomach contents

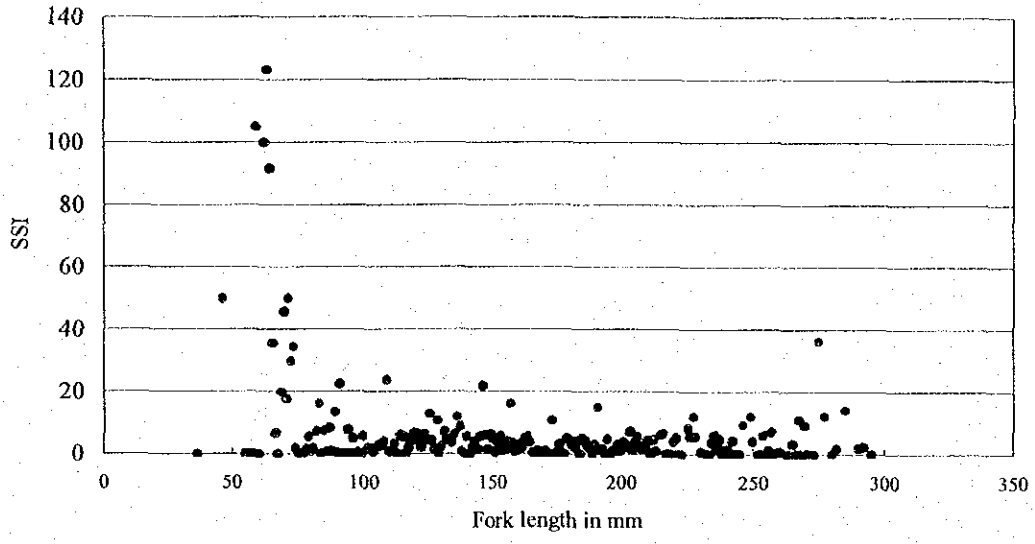
Phase	Season	n*	Algae	Mollusca				Polychaeta
				Gastropoda	Bivalvia	Decapoda	Other	
1	Cold	181			0.55	2.21		25.97
	Warm	76		1.32		3.95		2.63
2	Cold	71				1.41	1.41	1.41
	Warm	152	1.32	0.66	7.24	1.32	0.66	13.16

(Continued)

Phase	Season	Crustacea					Echinodermata	Fish	Unknown
		Isopoda	Crab	Anomura	Shrimp	Other			
1	Cold	0.55	1.10		2.21	16.57		14.36	38.67
	Warm					13.16		2.63	76.32
2	Cold		1.41		1.41	1.41		12.68	78.87
	Warm			1.32	5.92	16.45	0.66	3.29	51.97

Remark. * : Individuals of specimens.

(A) Relationship between fork length and SSI



(B) Relationship between fork length and SCW

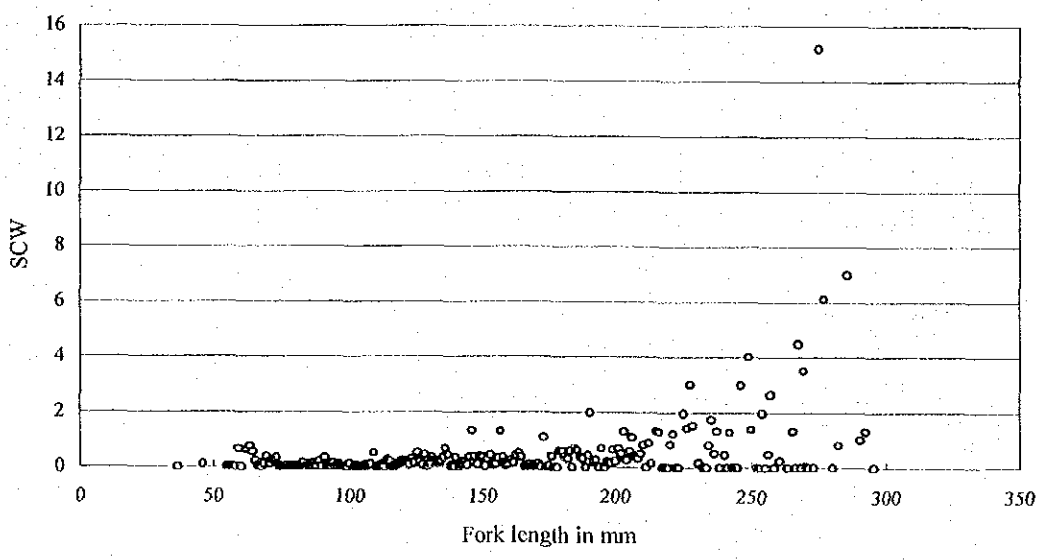


Figure 3.68 Relationship between body length and SSI (A) and SCW (B) for red pandora *Pagellus bellottii*.

12) Narrowhead grey mullet *Mugil capurrii*

Only two individuals of the narrowhead grey mullet were subjected to the multi-item biological measurement: one captured at the 3-20 m stratum in the Southern area in the Phase 2 cold season (referred to below as *M1*), and another caught at the 80-200 m stratum in the same area and season (*M2*).

The biological findings on *M1* and *M2* were the following:

M1: fork length 462 mm, weight 1,215 g; immature female, stomach empty.
M2: fork length 550 mm, weight 2,150 g; mature female, stomach empty.

13) Flathead mullet *Mugil cephalus*

Only fifteen individuals of the flathead mullet were obtained in *Al-Awam* survey area in Phase 2 and measured as to their biological characteristics.

The biological findings obtained on those individuals are presented below for each season:

a) Fourteen samples in the cold season: thirteen at the 3-20 m stratum in the Central area and one at the 3-20 m stratum in the Southern area

fork length	: between 118 and 650 mm (mean 404 mm)
weight	: between 110 and 3,395 g (mean 1,058 g)
fork length of males	: between 118 and 520 mm (mean 358 mm)
fork length of females	: between 340 and 650 mm (mean 453 mm)
length-weight relationship	: $BW=0.3247\times FL^{2.127}$ ($r=0.9348$), BW in g and FL in cm
sex ratio	: 0.43
female maturity ratio	:29% (1 mature female in the Southern area)
length at first maturity	:590 mm
rate of empty stomachs	:93%
feeding habits	: not determined

b) One sample in the warm season at the 30-80 m stratum in the Northern area

fork length :571mm
weight :2,365 g
mature female
stomach empty

14) Senegalese sole *Solea senegalensis*

The forty individuals the Senegalese sole obtained in the *Al-Awam* survey area and the further forty individuals obtained by the *Amrigue* survey area were subjected to the multi-item biological measurement.

a) Body length range and mean body length

Table 3.97 (page 3-300) shows the minimum, maximum and mean total length for the Senegalese sole.

In the *Amrigue* survey area, the total length varied between 208 and 370 mm, while the mean total length varied between 302 and 331 mm. The mean total length was larger in the cold season than in the warm season. Also, the mean total length by area was smaller in the Banc d'Arguin.

In the *Al-Awam* survey area, the total length varied between 197 and 458 mm. The mean total length by area varied between 230 and 390 mm and seemed larger in the Northern area.

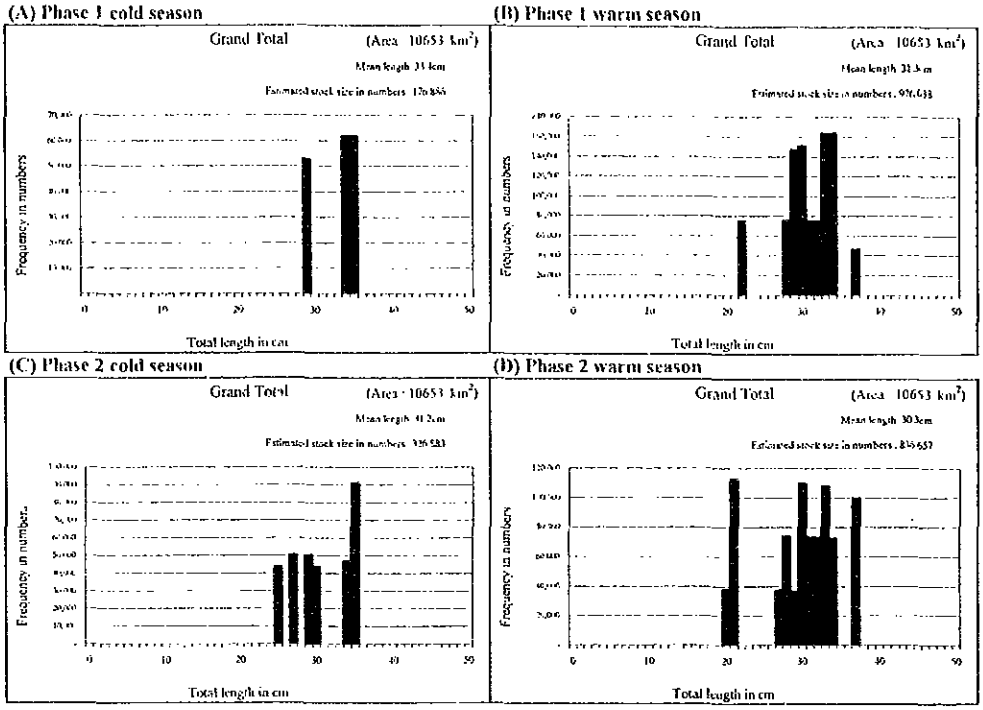
b) Size composition

Figure 3.69 (page 3-297, 3-301 to 3-303) shows the evaluation of the size composition for the Senegalese sole stock. The size composition in the *Amrigue* survey area is only presented for the total stock size in number. The total length class is indicated at intervals of 1cm. For convenience, three groups were defined: (i) small-size (total length less than 20cm), (ii) medium-size (length between 20 and 40cm), (iii) large-size (length over 40cm).

In the *Amrigue* survey area, the total stock size in number comprised only the medium-size group. In the *Al-Awam* survey area, the size groups that make up the stock differed according to the season. In survey order after the Phase 1 warm season, the groups that constituted the stock were successively formed by individuals that were: ① medium- and large-sizes; ② small-, medium- and large- sizes; ③ medium-size. The small-size group was distributed at the 3-20 m stratum in the Central area and the large-size group in the Northern and/or Central areas.

The medium-size group mainly formed the stock size in number in the two areas surveyed by the *Al-Awam* and the *Amrigue*. It was not possible to determine the classes corresponding to the modes of those three groups due to the scarcity of available data.

Amrigue survey area



Al-Awam survey area

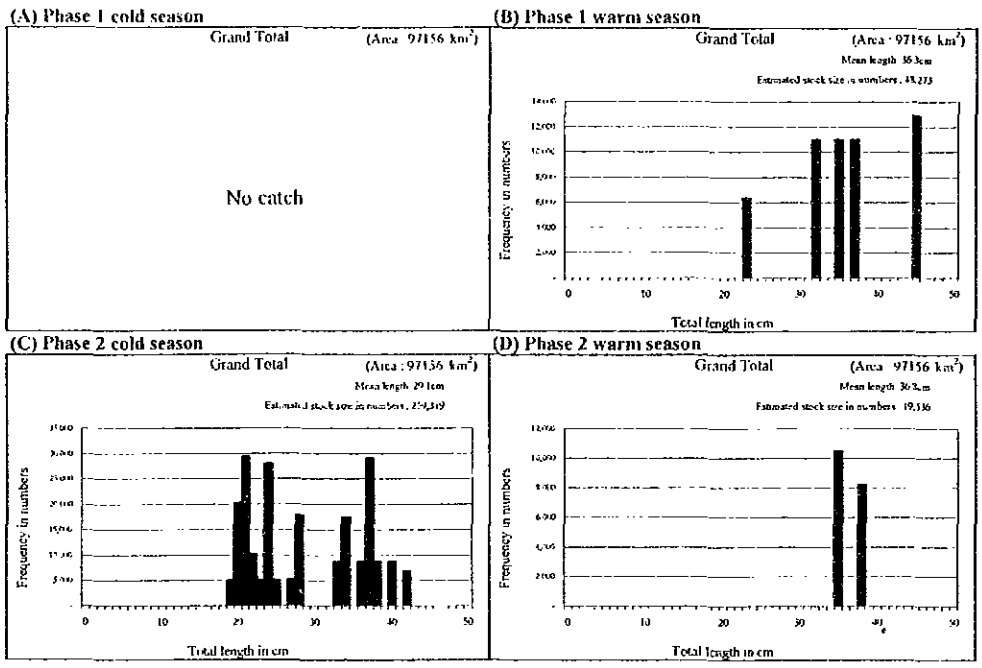


Figure 3.69 Size composition for Senegalese sole *Solea senegalensis.*

c) Length-weight relationship

Figure 3.70 presents the relationship between the total length and weight for the Senegalese sole. The length-weight equations obtained were the following:

Phase 1 cold season	: BW=	$4.673\times10^{-3}\times TL^{3.168}$	(r=0.9897)
Phase 1 warm season	: BW=	$2.887\times10^{-3}\times TL^{3.317}$	(r=0.9863)
Phase 2 cold season	: BW=	$5.492\times10^{-3}\times TL^{3.154}$	(r=0.9889)
Phase 2 warm season	: BW=	$1.062\times10^{-2}\times TL^{2.954}$	(r=0.9890)

where, BW : body weight (g), TL : total length (cm) and r : the coefficient of correlation

According to the Fish Base, the relation between body length and weight is given by the equation: $BW = 0.0051\times TL^{3.104}$ (N=173, TL: 26.5-50.0cm, Portugal, 1992-94). This equation is very close to that obtained in the Phase 2 cold season, in which data were relatively numerous (N=40).

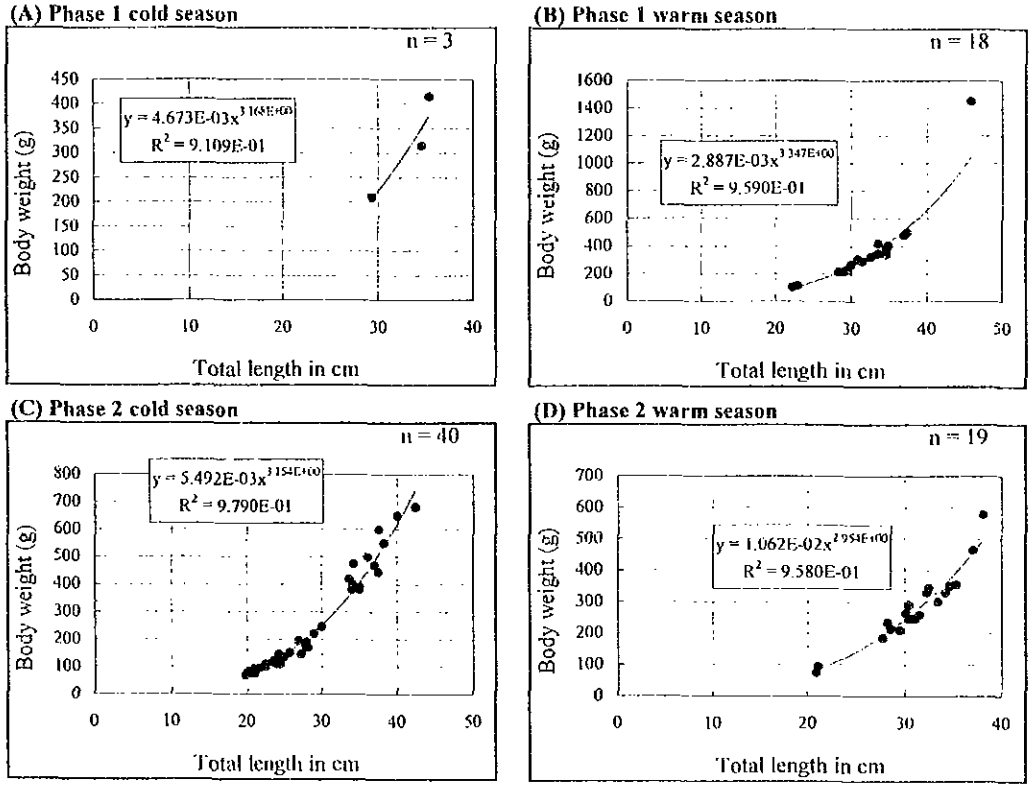


Figure 3.70 Length-weight relationship for Senegalese sole *Solea senegalensis*.

d) Length and weight by sex

Table 3.98 (page 3-304) presents the total length and body weight observed in each sex for the Senegalese sole.

In the *Amrigue* survey area, the total length varied between 250 and 350 mm for males and between 210 and 371 mm for females. The mean total length varied between 300 and 314 mm for males and between 300 and 331 mm for females.

In the *Al-Awam* survey area, the total length varied between 197 and 370 mm for males and between 210 and 458 mm for females.

In both areas, the mean female size was larger than that of males. The minimum length of individuals with gonads enough developed to allow for sex determination by visual inspection was 21cm for females and 20cm for males.

e) Sex ratio and female maturity stage

Table 3.99 (page 3-305) summarizes the sex ratio and the female maturity stage for the Senegalese sole. Figure 3.71 (page 3-306) presents their distribution by length class.

In the *Amrigue* survey area, the sex ratio of this species was between 0.15 and 0.50 (only females in the Phase 1 cold season). In the *Al-Awam* survey area, it was 0.43 (only females in the warm season of both Phases). The amount of data was insufficient to allow for definitive conclusions to be drawn on the sex ratio, but it seems that females were clearly in the majority.

The mature females were observed in both areas surveyed (*Amrigue* and *Al-Awam*). It seems that the maturity ratio was higher in the warm season overall. In the area surveyed by the *Al-Awam*, apparently the female maturity ratio was high in the Northern area. These results suggest there would be at least two spawning periods for the Senegalese sole, and that the main one should be in the warm season.

No size-dependent change of the sex ratio was observed. In all length classes, the sex ratio was less than 100%, indicanting a predominance of females. The length at first maturity for female was observed at the 27-28cm class in the cold season and at the 28-29cm class in the warm season.

f) Feeding habits

Table 3.100 (page 3-307) presents the stomach condition and the stomach content composition of the Senegalese sole in each survey season. Figure 3.72 (pgae 3-308) shows the relationship between body length and SSI and SCW.

The ratio of the empty stomach varied between 33 and 84%. The relationship between the fork length and SSI and SCW showed that the largest individuals consume great quantities of food, while the small-size individuals are voracious eaters in relation to their body weight. The SSI of the Senegalese sole was higher in the cold season, suggesting that they eat more in the cold season than in the warm season.

The Senegalese sole fed mainly on mollusks (bivalves, *etc.*), but sometimes also on polychaetes and crustaceans.

Table 3.97 Body length range and mean body length for Senegalese sole *Solea senegalensis* : TL in mm.

(A) ***Amrigue*** **survey area**

Northern coastal area (Stratum: 3-20m)	Phase 1						Phase 2					
	Cold season			Warm season			Cold season			Warm season		
	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
Banc d'Arguin	1	293	293.0	9	223 ~ 371	301.7	7	250 ~ 350	307.1	15	208 ~ 346	294.9
Other	2	346 ~ 354	350.0	4	336 ~ 348	341.8	0			2	333 ~ 370	351.5
All area	3	293 ~ 354	331.0	13	223 ~ 371	314.0	7	250 ~ 350	307.1	17	208 ~ 370	301.6

(B) ***Al-Awam*** **survey area**

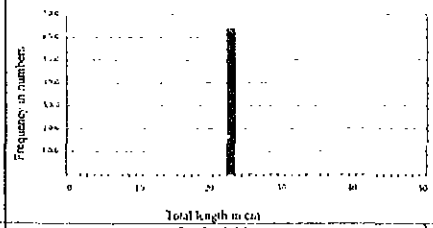
Subarea	Stratum	Phase 1						Phase 2					
		Cold season			Warm season			Cold season			Warm season		
		Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
North	3-20m	-	-	-	-	-	-	2	370 ~ 424	397.0	0		
	20-30m	0			3	326 ~ 375	350.3	1	375	375.0	1	352	352.0
	30-80m	0			1	458	458.0	0			1	380	380.0
	80-200m	0			0			0			0		
	200-400m	0			0			-	-	-	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	0			4	326 ~ 458	377.3	3	370 ~ 424	389.7	2	352 ~ 380	366.0
Central	3-20m	-	-	-	0			27	197 ~ 400	265.9	0		
	20-30m	0			0			3	210 ~ 273	236.0	0		
	30-80m	0			0			0			0		
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	0			0			30	197 ~ 400	262.9	0		
South	3-20m	-	-	-	1	230	230.0	0			0		
	20-30m	0			0			0			0		
	30-80m	0			0			0			0		
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	0			1	230	230.0	0			0		

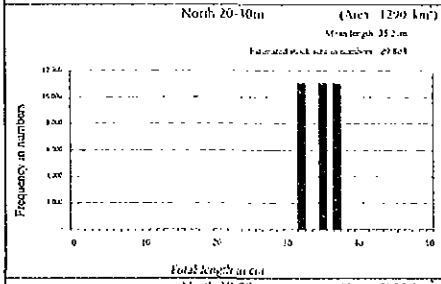
Remark. - : no trawl.

Figure3.69 (B) continued.

North 3-20m (Area : 5912 km²)
No trawl

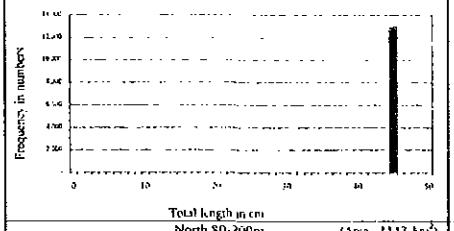
Central 3-20m (Area : 2781 km²)
No catch

South 3-20m (Area : 1485 km²)


North 20-30m (Area : 1290 km²)


Central 20-30m (Area : 835 km²)
No catch

South 20-30m (Area : 805 km²)
No catch

North 30-80m (Area : 2924 km²)


Central 30-80m (Area : 2870 km²)
No catch

South 30-80m (Area : 2640 km²)
No catch

North 80-200m (Area : 1147 km²)
No catch

Central 80-200m (Area : 2767 km²)
No catch

South 80-200m (Area : 3025 km²)
No catch

North 200-400m (Area : 936 km²)
No catch

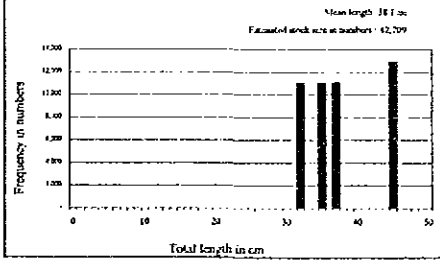
Central 200-400m (Area : 1453 km²)
No catch

South 200-400m (Area : 994 km²)
No catch

North 400-600m (Area : 738 km²)
No trawl

Central 400-600m (Area : 848 km²)
No catch

South 400-600m (Area : 583 km²)
No trawl

North Total (Area : 17688 km²)


Central Total (Area : 29244 km²)
No catch

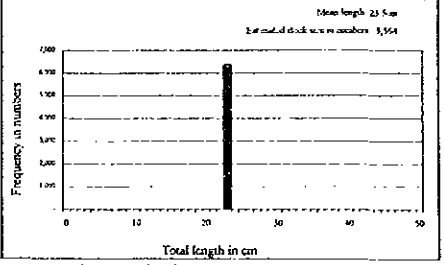
South Total (Area : 21088 km²)


Figure3.69 (C) continued.

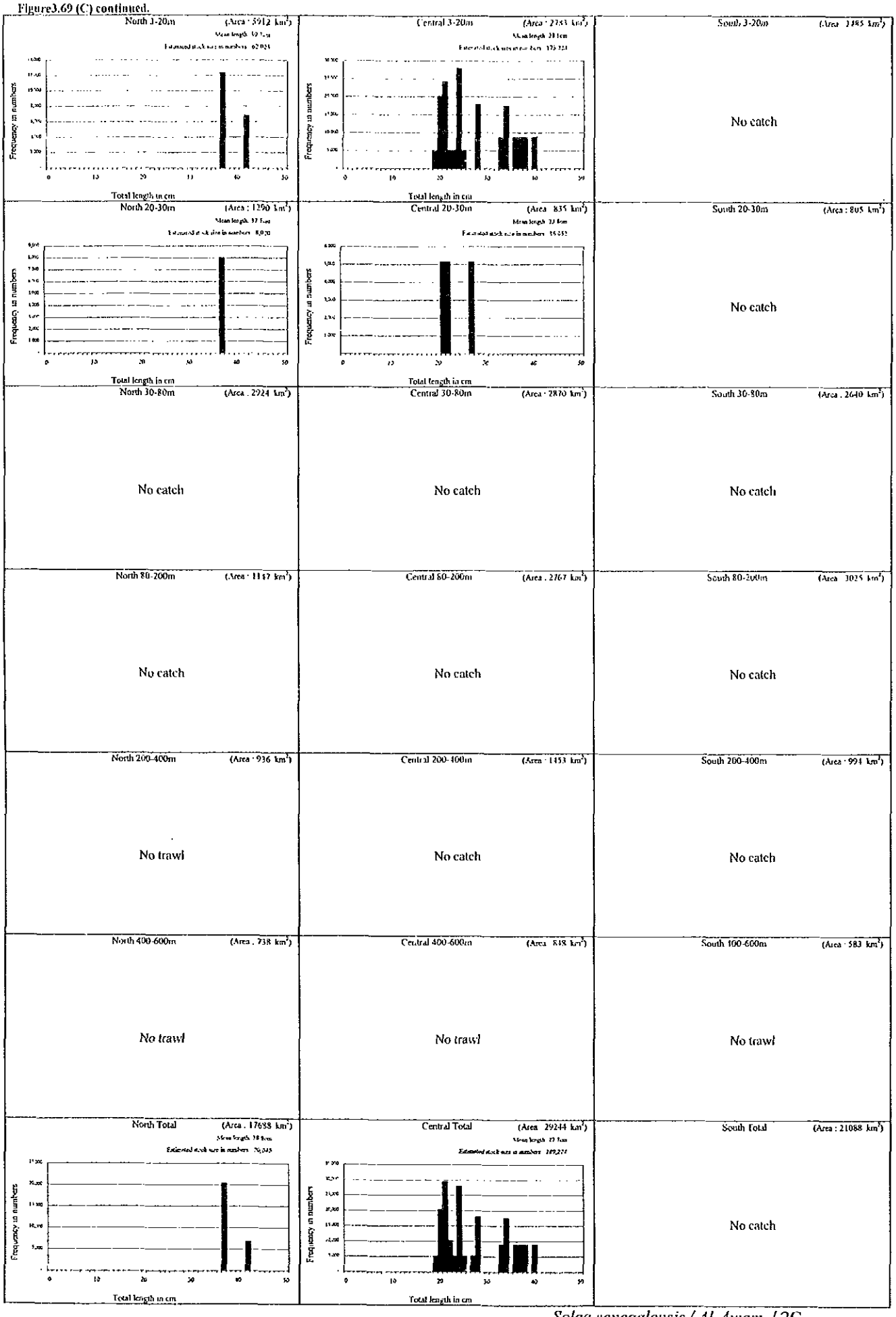


Figure3.69 (D) continued.

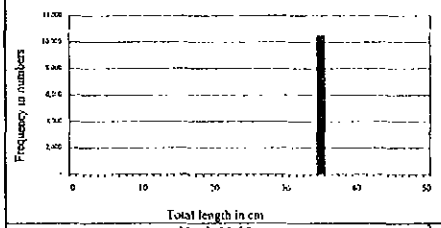
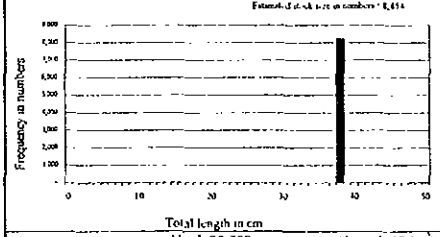
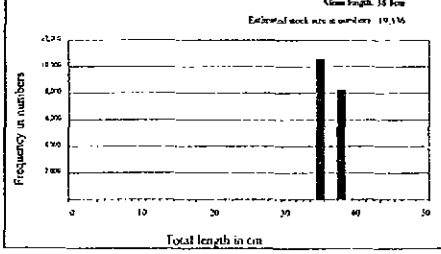
North 3-20m (Area 5912 km²) No catch	Central 3-20m (Area 2783 km²) No catch	South 3-20m (Area 1495 km²) No catch
North 20-30m (Area 1290 km²) 	Central 20-30m (Area 835 km²) No catch	South 20-30m (Area 805 km²) No catch
North 30-80m (Area 2925 km²) 	Central 30-80m (Area 2870 km²) No catch	South 30-80m (Area 2640 km²) No catch
North 80-200m (Area 1147 km²) No catch	Central 80-200m (Area 2767 km²) No catch	South 80-200m (Area 3025 km²) No catch
North 200-400m (Area 936 km²) No catch	Central 200-400m (Area 1453 km²) No catch	South 200-400m (Area 991 km²) No catch
North 400-600m (Area 738 km²) No trawl	Central 400-600m (Area 818 km²) No trawl	South 400-600m (Area 583 km²) No trawl
North Total (Area 17688 km²) 	Central Total (Area 29249 km²) No catch	South Total (Area 21088 km²) No catch

Table 3.98 Body length and weight by sex for Senegalese sole *Solea senegalensis*.

(A) *Amrigue* survey area

Phase	Season	Sex	Individuals of specimens	Total length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	0				
		Female	3	293 ~ 354	331.0	210.0 ~ 415.0	313.3
		Indeterminate	0				
		Total	3	293 ~ 354	331.0	210.0 ~ 415.0	313.3
	Warm	Male	3	284 ~ 336	303.3	210.0 ~ 345.0	256.7
		Female	10	223 ~ 371	317.2	105.0 ~ 480.0	313.5
		Indeterminate	0				
		Total	13	223 ~ 371	314.0	105.0 ~ 480.0	300.4
2	Cold	Male	2	250 ~ 350	300.0	135.0 ~ 390.0	262.5
		Female	4	270 ~ 340	300.0	195.0 ~ 380.0	260.0
		Indeterminate	1	350	350.0	380.0	380.0
		Total	7	250 ~ 350	307.1	135.0 ~ 390.0	277.9
	Warm	Male	2	295 ~ 333	314.0	210.0 ~ 300.0	255.0
		Female	13	210 ~ 370	306.2	95.0 ~ 465.0	277.7
		Indeterminate	2	208 ~ 310	259.0	75.0 ~ 245.0	160.0
		Total	17	208 ~ 370	301.6	75.0 ~ 465.0	261.2

(B) *Al-Awam* survey area

Phase	Season	Sex	Individuals of specimens	Total length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	0				
		Female	5	230 ~ 458	347.8	115.0 ~ 1,450.0	559.0
		Indeterminate	0				
		Total	5	230 ~ 458	347.8	115.0 ~ 1,450.0	559.0
2	Cold	Male	9	197 ~ 370	236.2	70.0 ~ 470.0	136.1
		Female	21	210 ~ 424	298.6	95.0 ~ 680.0	299.8
		Indeterminate	3	205 ~ 245	220.0	75.0 ~ 110.0	86.7
		Total	33	197 ~ 424	274.5	70.0 ~ 680.0	235.8
	Warm	Male	0				
		Female	2	352 ~ 380	366.0	355.0 ~ 580.0	467.5
		Indeterminate	0				
		Total	2	352 ~ 380	366.0	355.0 ~ 580.0	467.5

Table 3.99 Sex ratio and female maturity stage for Senegalese sole *Solea senegalensis*.

(A) *Amrigue* survey area

Northern coastal area (Stratum: 3-20m)	Phase 1 cold season							Phase 1 warm season						
	Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
Banc d'Arguin	1	0	0.00	0.0	0.0	100.0	0.0	7	2	0.29	14.3	42.9	42.9	0.0
Other	2	0	0.00	0.0	0.0	50.0	50.0	3	1	0.33	0.0	66.7	33.3	0.0
All area	3	0	0.00	0.0	0.0	66.7	33.3	10	3	0.30	10.0	50.0	40.0	0.0

Northern coastal area (Stratum: 3-20m)	Phase 2 cold season							Phase 2 warm season						
	Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
Banc d'Arguin	4	2	0.50	50.0	25.0	25.0	0.0	12	1	0.08	50.0	0.0	50.0	0.0
Other	0	0	E	0.0	0.0	0.0	0.0	1	1	1.00	0.0	0.0	100.0	0.0
All area	4	2	0.50	50.0	25.0	25.0	0.0	13	2	0.15	46.2	0.0	53.8	0.0

(B) *Al-Awam* survey area

Subarea	Stratum	Phase 1 cold season							Phase 1 warm season						
		Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
		♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
North	3-20m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20-30m	0	0	E					3	0	0.00	0.0	0.0	33.3	66.7
	30-80m	0	0	E					1	0	0.00	0.0	0.0	100.0	0.0
	80-200m	0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	0	0	E					4	0	0.00	0.0	0.0	50.0	50.0
Central	3-20m	-	-	-	-	-	-	-	0	0	E				
	20-30m	0	0	E					0	0	E				
	30-80m	0	0	E					0	0	E				
	80-200m	0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E				
	All stratum	0	0	E					0	0	E				
South	3-20m	-	-	-	-	-	-	-	1	0	0.00	100.0	0.0	0.0	0.0
	20-30m	0	0	E					0	0	E				
	30-80m	0	0	E					0	0	E				
	80-200m	0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	0	0	E					1	0	0.00	100.0	0.0	0.0	0.0
All	3-20m	-	-	-	-	-	-	-	1	0	0.00	20.0	0.0	40.0	40.0
	20-30m	0	0	E					3	0	0.00	0.0	0.0	33.3	66.7
	30-80m	0	0	E					1	0	0.00	0.0	0.0	100.0	0.0
	80-200m	0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E				
	All stratum	0	0	E					5	0	0.00	20.0	0.0	40.0	40.0

Subarea	Stratum	Phase 2 cold season							Phase 2 warm season						
		Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
		♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
North	3-20m	1	1	1.00	0.0	0.0	100.0	0.0	0	0	E				
	20-30m	1	0	0.00	0.0	100.0	0.0	0.0	1	0	0.00	0.0	100.0	0.0	0.0
	30-80m	0	0	E					1	0	0.00	0.0	0.0	100.0	0.0
	80-200m	0	0	E					0	0	E				
	200-400m	-	-	-	-	-	-	-	0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	2	1	0.50	0.0	50.0	50.0	0.0	2		0.00		50.0	50.0	
Central	3-20m	17	8	0.47	23.5	52.9	11.8	11.8	0	0	E				
	20-30m	2	0	0.00	0.0	50.0	50.0	0.0	0	0	E				
	30-80m	0	0	E					0	0	E				
	80-200m	0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	19	8	0.42	21.1	52.6	15.8	10.5	0	0	E				
South	3-20m	0	0	E					0	0	E				
	20-30m	0	0	E					0	0	E				
	30-80m	0	0	E					0	0	E				
	80-200m	0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	0	0	E					0	0	E				
All	3-20m	18	9	0.50	22.2	50.0	16.7	11.1	0	0	E				
	20-30m	3	0	0.00	0.0	66.7	33.3	0.0	1	0	0.00	0.0	100.0	0.0	0.0
	30-80m	0	0	E					1	0	0.00	0.0	0.0	100.0	0.0
	80-200m	0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	21	9	0.43	19.0	52.4	19.0	9.5	2	0	0.00	0.0	50.0	50.0	0.0

Remarks. * I: Immature, II: Semi-mature, III: Mature, IV: Spent. -: no trawl. 0: no data. E: Error.

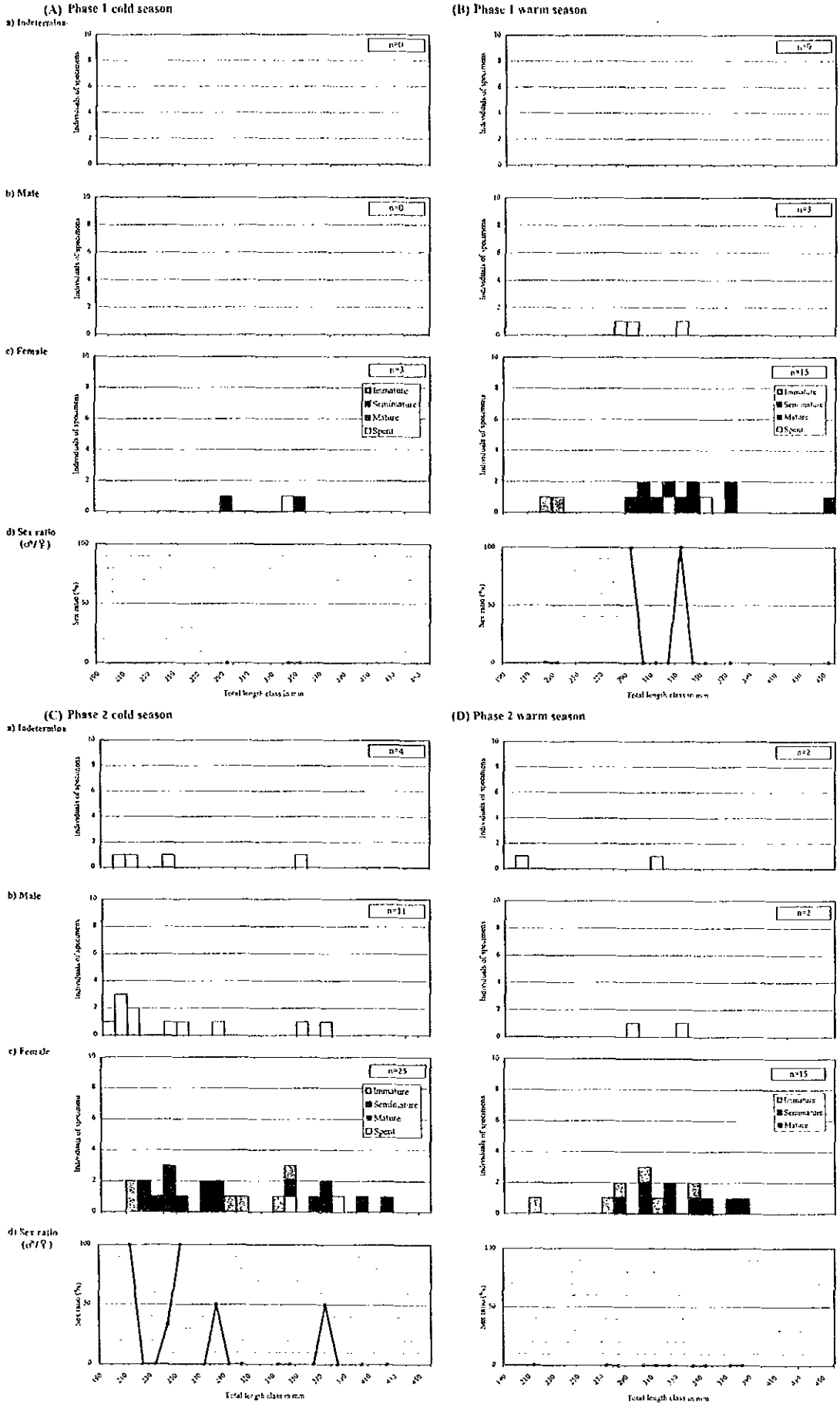


Figure 3.71 Sex ratio and female maturity stage by length class for Senegalese sole *Solea senegalensis*.

Table 3.100 Stomach content analysis of Senegalese sole *Solea senegalensis.*

(A) Stomach condition

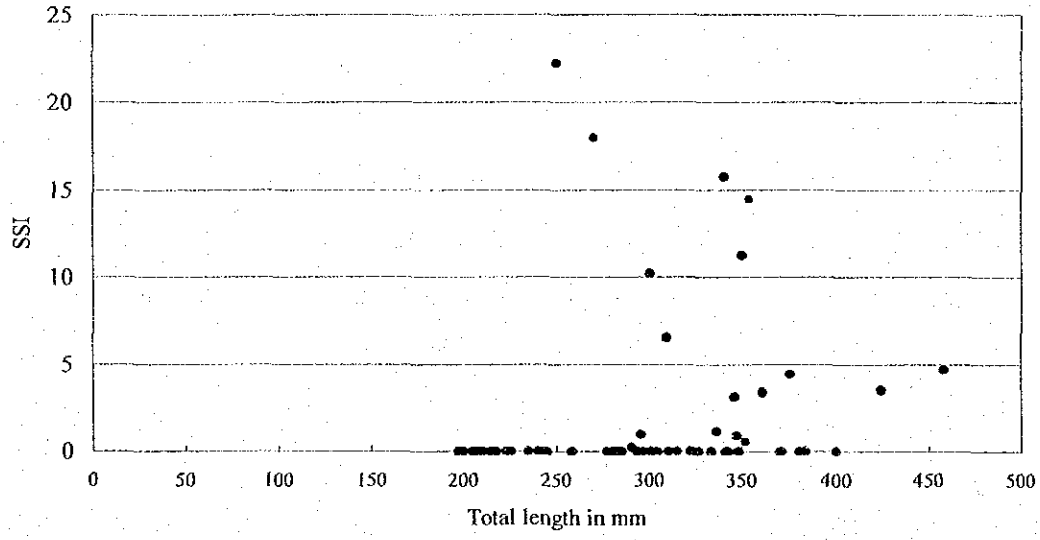
Phase	Season	Stomach condition				Stomach content Somatic Index (SSI)			
		n*	Empty (%)	Evert (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	3	33.33	0.00	66.67	3	0.00	14.46	6.94
	Warm	17	70.59	0.00	29.41	17	0.00	6.56	0.91
2	Cold	34	70.59	0.00	29.41	34	0.00	22.22	3.85
	Warm	19	84.21	0.00	15.79	18	0.00	0.95	0.08

(B) Stomach contents

Phase	Season	n*	Mollusca		Polychaeta	Crustacea	Unknown
			Bivalvia	Other			
1	Cold	2	100.00				
	Warm	5			40.00		60.00
2	Cold	10	70.00	10.00	10.00		10.00
	Warm	3	33.33			33.33	33.33

Remark. * : Individuals of specimens.

(A) Relationship between total length and SSI



(B) Relationship between total length and SCW

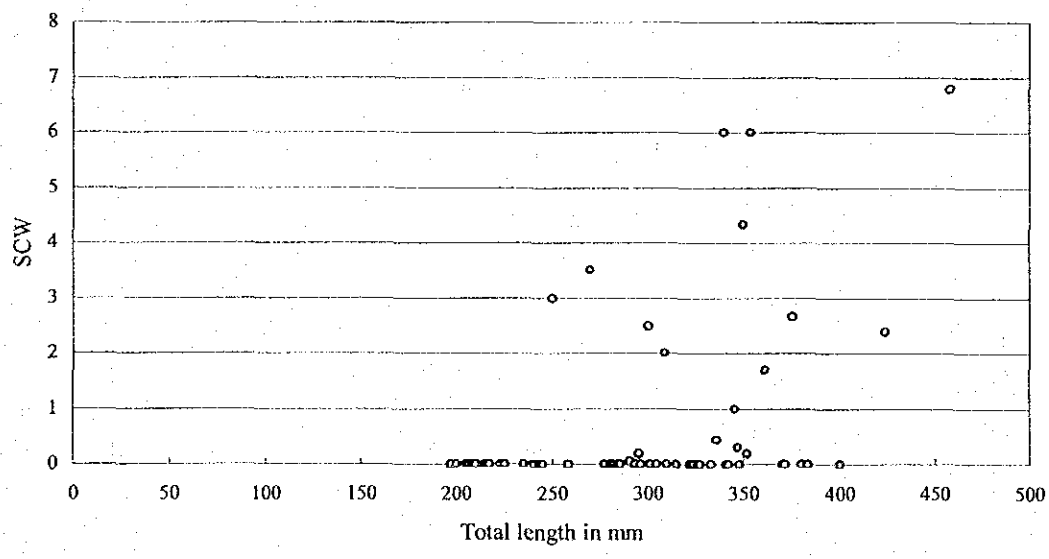


Figure 3.72 Relationship between body length and SSI (A) and SCW (B) for Senegalese sole *Solea senegalensis.*

(2) Cephalopods

Presented below are the biological findings obtained for the three species targeted in this survey.

1) European squid *Loligo vulgaris*

a) Body length range and mean body length

Table 3.101 (page 3-313) presents the minimum, maximum and mean mantle length obtained for the European squid.

In the *Amrigue* survey area, the number of individuals of specimens was only six: one in the Phase 1 cold season and five in the Phase 2 warm season. The mantle length of the individual in the cold season was 460 mm and those of the specimens in the warm season varied between 22 and 168 mm, the mean mantle length being 62 mm.

In the *Al-Awam* survey area, the mantle length of this species was between 28 and 540 mm. In the Phase 1 cold season, the mean mantle length by area was high in the Central area, while in the warm season of the same Phase it was high in the Northern area and low in the Southern area. In Phase 2, regardless of season, the mean length was high in the Southern area and decreased northwards. The mean mantle length by stratum in the Phase 2 cold season was very high at the 3-20 m stratum of all areas. This could suggest a migration of the European squid along the coast until reaching maturation. This possibility of migration will be focused further below.

b) Size composition

Figure 3.73 (page 3-310, 3-314 to 3-317) presents the evaluation of size composition for the European squid stock. The mantle length class is indicated at intervals of 1cm. For convenience of considering the size composition, three groups were defined: (i) small-size (mantle length less than 10cm), (ii) medium-size (length between 10 and 20cm), (iii) large-size (length over 20cm).

The size composition of the total stock size in number presented many modes, but the more predominant modes existed at the mantle length classes of less than 10cm throughout the survey. The mode for the small-size group, which was the majority of the stock size in number, was located within the two classes between 6 and 8cm. This strongly suggests that spawning of the European squid takes place over a long period. The main mode of the medium-size group was not salient, except in the Phase 1 cold season (mode within 15-17cm classes). The large-size group also displayed a certain number of modes, but always with low peaks (low frequency of individuals).

The distribution of those three size groups was examined based on the size composition by stratum and by area. The small-size group was distributed over different areas in all seasons, particularly at the 30-80 m stratum (at the 20-30 m stratum in the Phase 2 cold season) in the Northern area. In the Phase 1 cold season, only the small-size group was distributed at the 20-30 m stratum in the Southern area. The medium-size group exhibited a distribution pattern identical to that of the small-size group. The strata where only the medium-size group was distributed were the 30-80 m stratum in the Southern area in the Phase 1 cold season and the 3-20 m and 80-200 m strata in the Northern area in the Phase 2 warm season. The large-size group had also an identical distribution pattern. In the Phase 2 cold season, the frequency of occurrence of the large-size individuals was prominent at the 3-20 m stratum in each area, strongly

suggesting a migration displacement along the coastline for reproduction, as already mentioned.

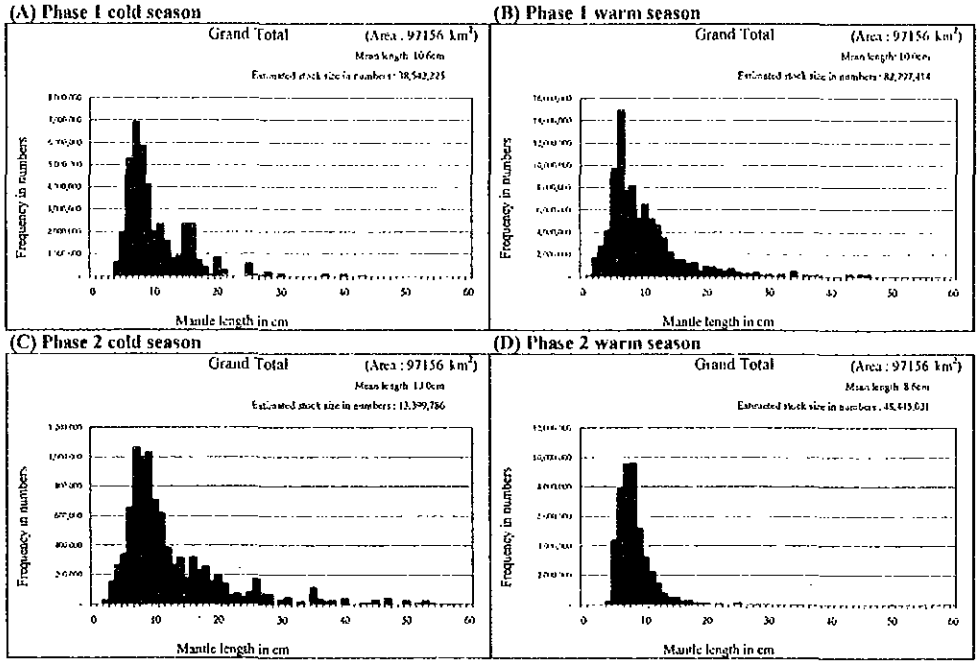


Figure 3.73 Size composition for European squid *Loligo vulgaris*.

c) Length-weight relationship

Figure 3.74 (page 3-311) presents the relationship between the mantle length and weight in the European squid. The length-weight equations obtained were the following:

Phase 1 cold season	: $BW = 0.1366 \times ML^{2.459}$	(r=0.9913)
Phase 1 warm season	: $BW = 0.1890 \times ML^{2.367}$	(r=0.9776)
Phase 2 cold season	: $BW = 0.1905 \times ML^{2.338}$	(r=0.9871)
Phase 2 warm season	: $BW = 0.1670 \times ML^{2.399}$	(r=0.9849)

where, BW : body weight (g), ML : mantle length (cm) and r : the coefficient of correlation.

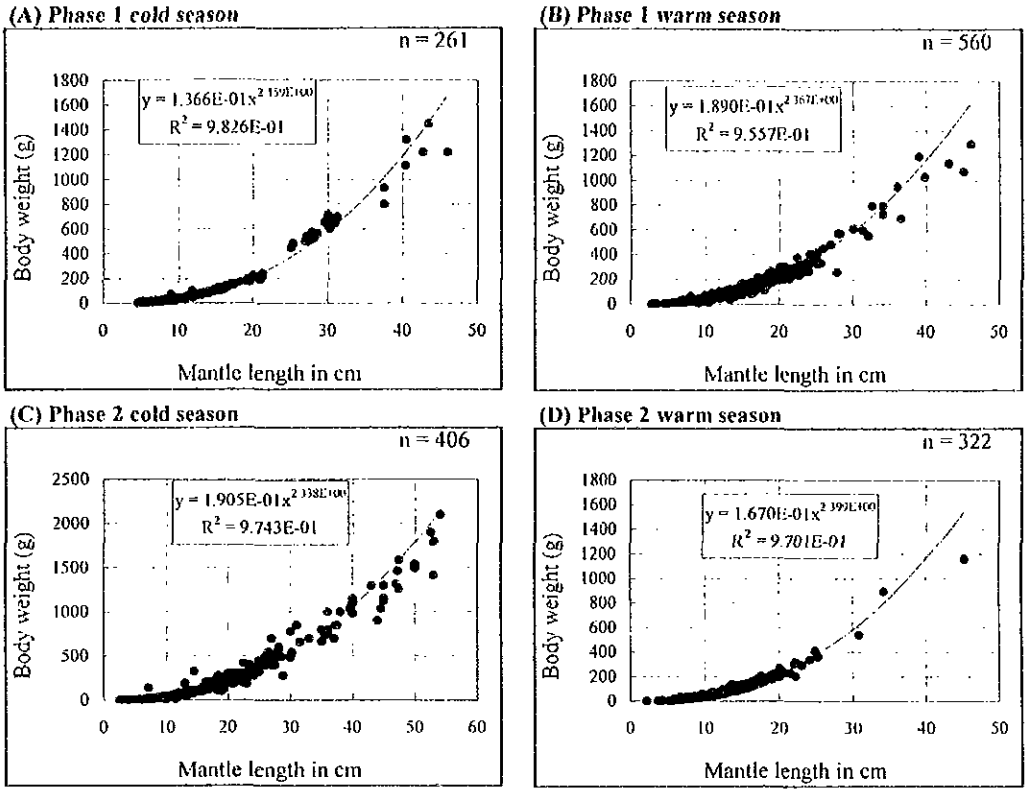


Figure 3.74 Length-weight relationship for European squid *Loligo vulgaris*.

d) Length and weight by sex

Table 3.102 (page 3-318) presents the mantle length and body weight observed in each sex for the European squid.

Among all specimens in the *Amrigue* survey area, the only two individuals for which sex determination was possible were a male (mantle length 460 mm) and a female (mantle length 168 mm).

The mantle length of the individuals of specimens in the *Al-Awam* survey area varied between 51 and 530 mm for males and between 47 and 540 mm for females. The weight varied between 5 and 1,900 g for males and between 5 and 2,100 g for females. The mean male size was slightly larger than that of females in all seasons except in the Phase 1 cold season, in which males and females were of the same size. The mantle length of individuals with enough developed gonads to allow sex determination by visual inspection was at least 5cm for both males and females.

e) Sex ratio and female maturity stage

Table 3.103 (page 3-319) summarizes the sex ratio and the female maturity stage in the European squid. Figure 3.75 (page 3-320) presents their distribution by length class. The mantle length class is indicated at intervals of 1cm. The maturation state of males is also indicated.

The individual in the *Amrigue* survey area was a mature female.

The overall sex ratio in the *Al-Awam* survey area varied between 1.03 and 1.07 in Phase 1 and between 1.57 and 1.78 in Phase 2. The state of male/female equilibrium was maintained in Phase 1, while in

Phase 2 males were in the majority. Areas where the sex ratio indicated a predominance of females were the Central area in the Phase 1 cold season, the Northern and Central areas in the Phase 1 warm season and the Southern area in the Phase 2 cold season. Predominance of males increased with depth, by stratum and over the entire area.

In the survey area order, the female maturity ratio was 6.7%, 9.9%, 44.9% and 3.3% respectively. The spent female ratio was 0% in the warm season, but approximately 3% in the cold season. The geographical or vertical difference in the female maturity ratio was observed. This trend was particularly clear in the Phase 2 cold season, in which the female maturity ratio at the 3-20 m stratum in the Northern and Southern areas was 90 %, 100% respectively. Such a concentration of the mature females in the coastal area strongly suggests a migration for reproductive purposes. From these results it is possible to infer that the European squid always spawns in the cold season (April-May), but also that there is another spawning period after the warm season (September-October). One could also presume that spawning in the coastal area is done by means of temporal displacements according to geographical location.

A certain size-dependent change of the sex ratio was observed in some survey seasons, but this change has two opposing forms. In classes between 50 and 260 mm, the sex ratio increased from 0 to 300% in the Phase 1 warm season and decreased from 300 to 0% in the Phase 2 cold season, with some intermediate fluctuations. For the individuals with the mantle length over 30cm, males were clearly in the majority and females appeared only rarely.

The mantle length at first maturity was, for both males and females, at the 14-15cm class in the cold season and at the 12-13cm class in the warm season. According to Dia *et* Inejih (1991), the mantle length at first reproduction would be approximately 13cm for males (at the age of 10 months) and about 16cm for females (at the age of 12 months). These authors report that the European squid has a lifespan of three years for males and two years for females. The results obtained – namely, of predominant males and rare females beyond 30cm, and of the mantle length at first maturity of 12–15cm for males and females, do not contradict those findings.

f) Feeding habits

Table 3.104 (page 3-321) presents the stomach condition and the stomach content composition of the European squid in each survey season. Figure 3.76 (page 3-322) presents the relationship between the mantle length and SSI and SCW.

The ratio of the empty stomach varied between 78 and 93%. The relationship between the mantle length and SSI and SCW showed that the largest individuals consume great quantities of food, while the small-size individuals are voracious eaters in relation to their body weight. However, the mantle length-SCW relationship shows that the ingested quantity increased up to about 200 mm, and then declined. At the moment it is not known whether this decrease in quantities ingested by the large-size individuals is related to reproduction.

The European squid mainly fed on fish (the European pilchard *Sardina pilchardas*, the red pandora *Pagellus bellottii*, the Lusitanian sole *Microchirus boscanion*, etc.), but also on mollusks (cuttlefish or squid) and crustaceans.

Table 3.101 Body length range and mean body length of European squid *Loligo vulgaris* : ML in mm.

(A) *Amrigue* survey area

Northern coastal area (Stratum: 3-20m)	Phase 1						Phase 2					
	Cold season			Warm season			Cold season			Warm season		
	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
Banc d'Arguin	1	460	460.0	0			0			5	22 ~ 168	61.8
Other	1	460	460.0	0			0			5	22 ~ 168	61.8
All area	0			0			0			0		

(B) *Al-Awam* survey area

Subarea	Stratum	Phase 1						Phase 2					
		Cold season			Warm season			Cold season			Warm season		
		Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
North	3-20m	-	-	-	-	-	-	28	25 ~ 474	237.0	2	150 ~ 172	161.0
	20-30m	90	47 ~ 404	103.6	58	32 ~ 450	122.7	80	40 ~ 396	106.9	20	72 ~ 137	105.0
	30-80m	131	45 ~ 435	120.5	60	28 ~ 460	165.7	99	31 ~ 500	154.3	100	41 ~ 342	98.0
	80-200m	0			0			0			8	128 ~ 152	141.1
	200-400m	0			0			-	-	-	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	221	45 ~ 435	113.6	118	28 ~ 460	144.6	207	25 ~ 500	147.2	130	41 ~ 342	102.7
Central	3-20m	-	-	-	0			114	50 ~ 540	206.5	0		
	20-30m	32	75 ~ 427	185.1	0			60	30 ~ 315	101.3	0		
	30-80m	1	250	250.0	134	28 ~ 325	138.8	0			67	67 ~ 308	146.9
	80-200m	0			100	70 ~ 252	129.8	0			49	84 ~ 200	118.8
	200-400m	0			0			0			0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	33	75 ~ 427	187.1	234	28 ~ 325	135.0	174	30 ~ 540	170.2	116	67 ~ 308	155.0
South	3-20m	-	-	-	0			12	180 ~ 450	299.6	0		
	20-30m	4	69 ~ 93	81.0	0			13	78 ~ 355	163.9	0		
	30-80m	2	119 ~ 159	139.0	100	65 ~ 365	135.7	0			51	79 ~ 452	156.8
	80-200m	0			108	70 ~ 257	122.3	0			20	56 ~ 202	127.6
	200-400m	0			0			0			0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	6	69 ~ 159	100.3	208	65 ~ 365	128.7	25	78 ~ 450	229.0	71	56 ~ 452	148.5

Remark. - : no trawl.

Figure3.73 (A) continued.

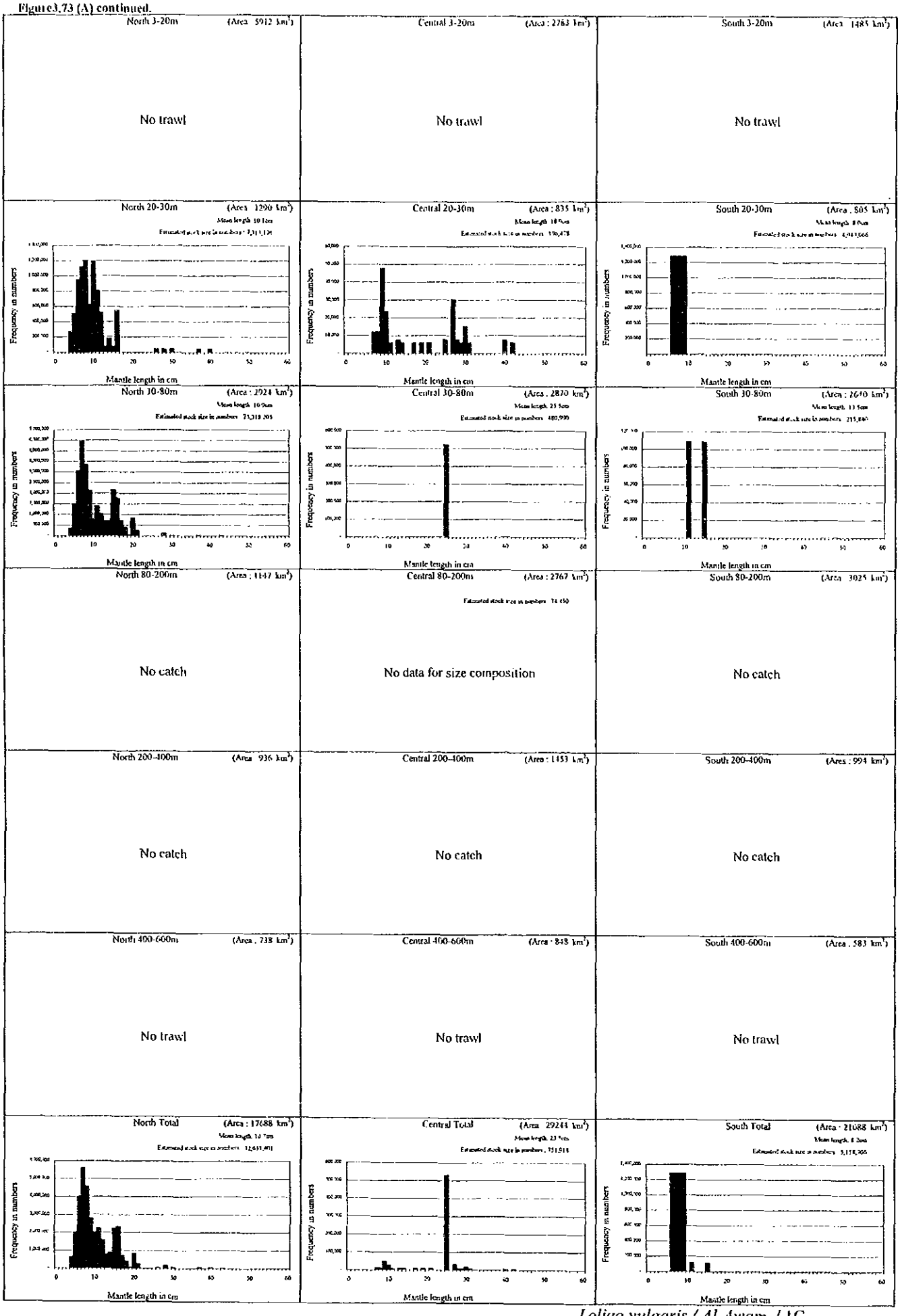


Figure3.73 (II) continued.

North 3-20m (Area 5912 km²)

No trawl

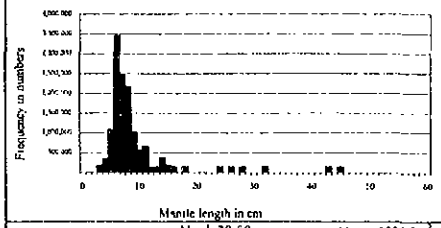
Central 3-20m (Area 2783 km²)

No catch

South 3-20m (Area 1865 km²)

No catch

North 20-30m (Area : 1290 km²)



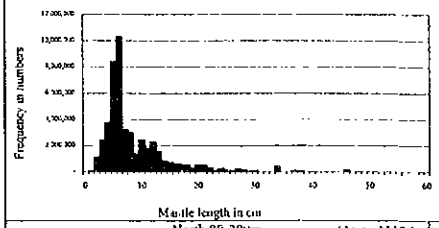
Central 20-30m (Area : 835 km²)

No data for size composition

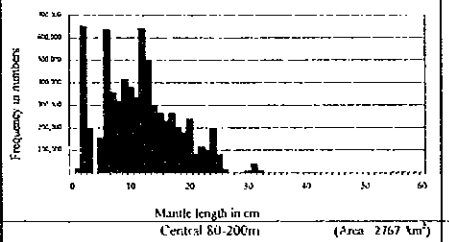
South 20-30m (Area 805 km²)

No catch

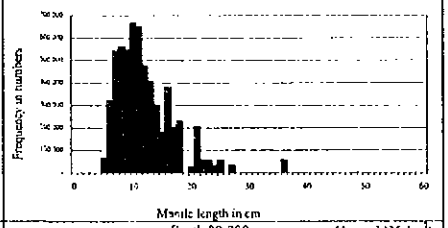
North 30-80m (Area 2921 km²)



Central 30-80m (Area : 2870 km²)



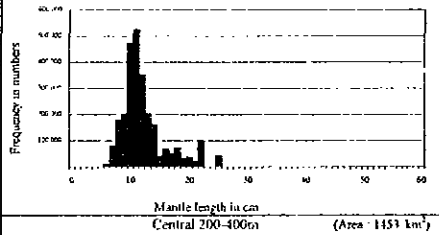
South 30-80m (Area 2640 km²)



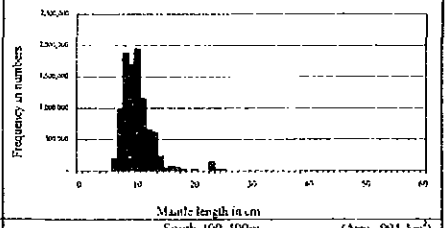
North 80-200m (Area 1147 km²)

No data for size composition

Central 80-200m (Area 2767 km²)



South 80-200m (Area : 3025 km²)



North 200-400m (Area : 936 km²)

No catch

Central 200-400m (Area : 1453 km²)

No catch

South 200-400m (Area . 994 km²)

No catch

North 400-600m (Area . 738 km²)

No trawl

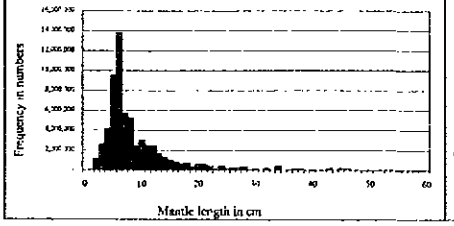
Central 400-600m (Area : 848 km²)

No catch

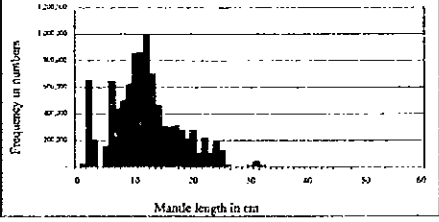
South 400-600m (Area 583 km²)

No trawl

North Total (Area : 17688 km²)



Central Total (Area : 29244 km²)



South Total (Area : 21088 km²)

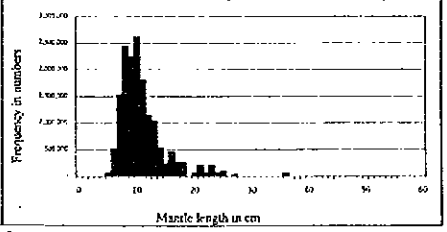


Figure3.73 (C) continued.

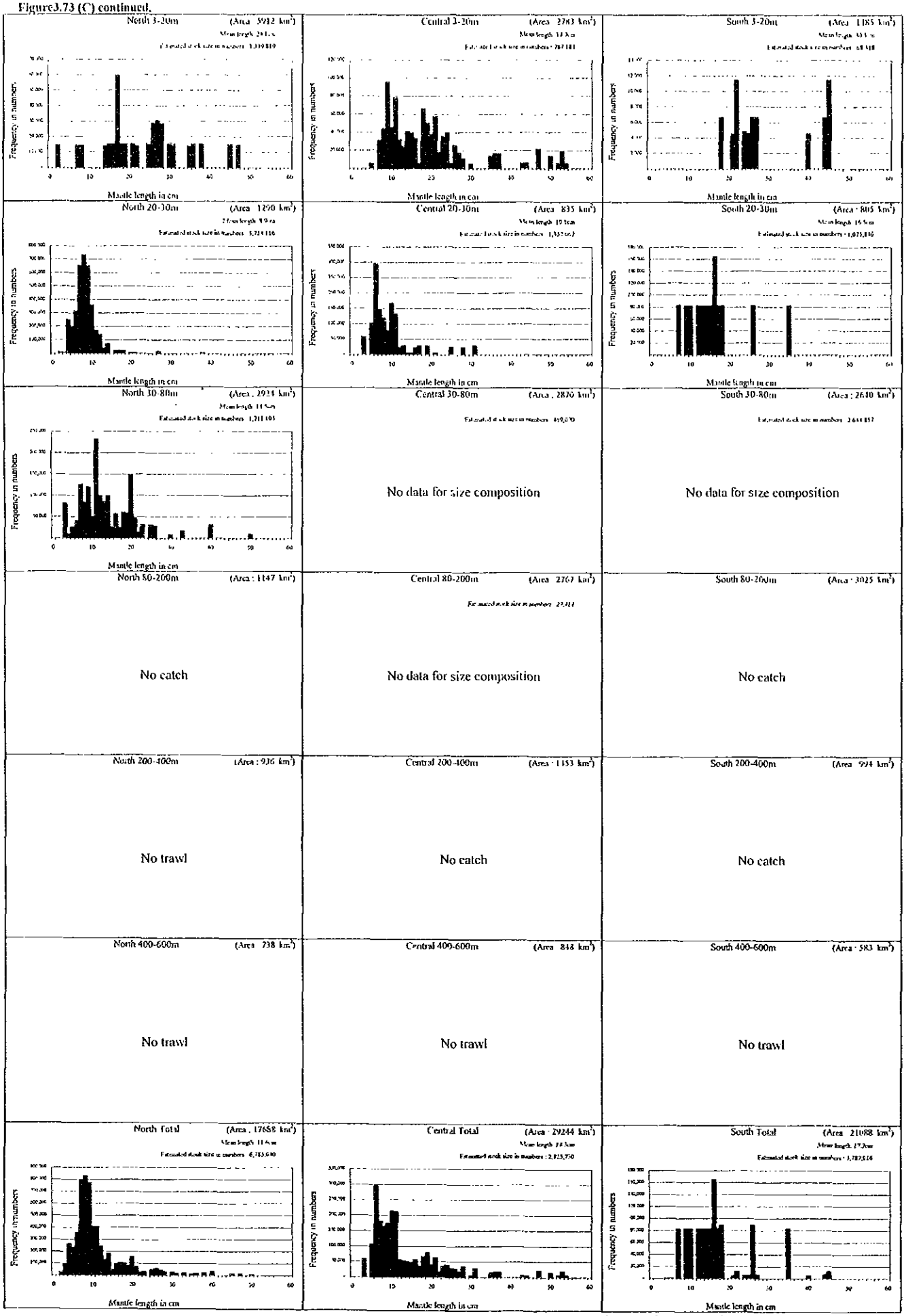


Figure3.73 (I) continued.

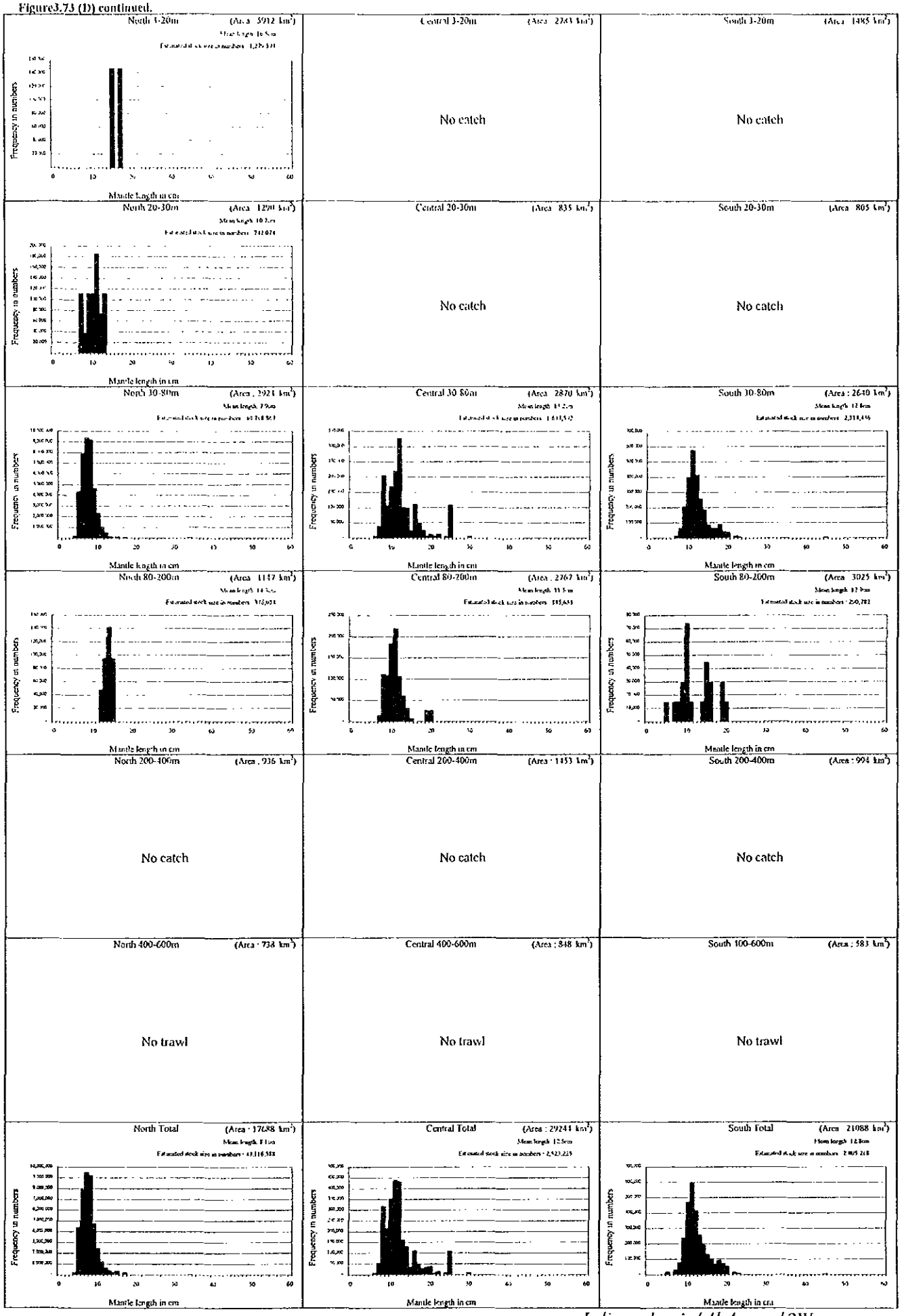


Table 3.102 Body length and weight by sex for European squid *Loligo vulgaris.*

(A) *Amrigue* survey area

Phase	Season	Sex	Individuals of specimens	Mantle length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	1	460	460.0	1,220.0	1,220.0
		Female	0				
		Indeterminate	0				
		Total	1	460	460.0	1,220.0	1,220.0
	Warm	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
2	Cold	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	0				
		Female	1	168	168.0	145.0	145.0
		Indeterminate	4	22 ~ 43	35.3	2.5 ~ 5.3	4.2
		Total	5	22 ~ 168	61.8	2.5 ~ 145.0	32.4

(B) *Al-Awam* survey area

Phase	Season	Sex	Individuals of specimens	Mantle length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	130	52 ~ 435	124.3	5.0 ~ 1,450.0	117.2
		Female	122	47 ~ 312	124.8	5.0 ~ 715.0	114.7
		Indeterminate	8	45 ~ 82	60.9	5.0 ~ 25.0	12.6
		Total	260	45 ~ 435	122.6	5.0 ~ 1,450.0	112.8
	Warm	Male	218	70 ~ 460	155.6	20.0 ~ 1,295.0	157.8
		Female	212	59 ~ 450	140.1	15.0 ~ 1,140.0	123.9
		Indeterminate	130	28 ~ 205	90.8	1.0 ~ 255.0	40.9
		Total	560	28 ~ 460	134.7	1.0 ~ 1,295.0	117.8
2	Cold	Male	141	70 ~ 530	225.4	14.0 ~ 1,900.0	385.9
		Female	90	70 ~ 540	197.9	15.0 ~ 2,100.0	275.8
		Indeterminate	175	25 ~ 205	92.7	2.3 ~ 252.0	41.6
		Total	406	25 ~ 540	162.1	2.3 ~ 2,100.0	213.1
	Warm	Male	174	51 ~ 452	132.2	5.0 ~ 1,160.0	100.6
		Female	98	65 ~ 243	129.4	13.0 ~ 340.0	91.8
		Indeterminate	45	41 ~ 120	86.0	3.7 ~ 69.0	33.1
		Total	317	41 ~ 452	124.8	3.7 ~ 1,160.0	88.3

Table 3.103 Sex ratio and female maturity stage for European squid *Loligo vulgaris*.

(A) *Amrigue* survey area

Northern coastal area (Stratum: 3-20m)	Phase 1 cold season							Phase 1 warm season							Phase 2 cold season							Phase 2 warm season						
	Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
Banc d'Arguin	0	0	E					0	0	E					0	0	E					0	0	E				
Other	0	1	E					0	0	E					0	0	E					1	0	0.00	0.0	0.0	100.0	0.0
All area	0	1	E					0	0	E					0	0	E					1	0	0.00	0.0	0.0	100.0	0.0

(B) *Al-Awam* survey area

Subarea	Stratum	Phase 1 cold season							Phase 1 warm season							Phase 2 cold season							Phase 2 warm season						
		Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
		♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
North	3-20m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	14	1.27	0.0	9.1	90.9	0.0	0	2	E				
	20-30m	49	36	0.73	91.8	2.0	6.1	0.0	34	14	0.41	58.8	32.4	8.8	0.0	9	7	0.78	44.4	22.2	33.3	0.0	6	12	2.00				
	30-80m	48	80	1.67	82.2	13.3	2.2	2.2	27	20	0.74	66.7	29.6	3.7	0.0	13	32	2.46	46.2	23.1	30.8	0.0	26	35	1.35	100.0	0.0	0.0	0.0
	80-200m	0	0	E					0	0	E					0	0	E					5	3	0.60	20.0	80.0	0.0	0.0
	200-400m	0	0	E					0	0	E					-	-	-	-	-	-	-	0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	97	116	1.20	87.2	7.4	4.3	1.1	61	34	0.56	62.3	31.1	6.6	0.0	33	53	1.61	30.3	18.2	51.5	0.0	37	52	1.41	87.1	12.9	0.0	0.0
Central	3-20m	-	-	-	-	-	-	-	0	0	E					40	60	1.50	28.2	25.6	38.5	7.7	0	0	E				
	20-30m	21	11	0.52	57.1	19.0	19.0	4.8	0	0	E					3	20	6.67	33.3	33.3	33.3	0.0	0	0	E				
	30-80m	1	0	0.00	0.0	0.0	0.0	100.0	47	38	0.81	48.9	29.8	21.3	0.0	0	0	E					21	45	2.14	61.9	19.0	14.3	0.0
	80-200m	0	0	E					49	27	0.55	71.4	26.5	2.0	0.0	0	0	E					10	38	3.80	70.0	30.0	0.0	0.0
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	22	11	0.50	54.5	18.2	18.2	9.1	96	65	0.68	60.4	28.1	11.5	0.0	43	80	1.86	28.6	26.2	38.1	7.1	31	83	2.68	64.5	22.6	9.7	0.0
South	3-20m	-	-	-	-	-	-	-	0	0	E					7	5	0.71	0.0	0.0	100.0	0.0	0	0	E				
	20-30m	1	3	3.00	100.0	0.0	0.0	0.0	0	0	E					7	3	0.43	85.7	14.3	0.0	0.0	0	0	E				
	30-80m	2	0	0.00	50.0	50.0	0.0	0.0	25	57	2.28	72.0	8.0	20.0	0.0	0	0	E					22	29	1.32	77.3	22.7	0.0	0.0
	80-200m	0	0	E					30	62	2.07	33.3	63.3	3.3	0.0	0	0	E					8	10	1.25	100.0	0.0	0.0	0.0
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	3	3	1.00	66.7	33.3	0.0	0.0	55	119	2.16	50.9	38.2	10.9	0.0	14	8	0.57	42.9	7.1	50.0	0.0	30	39	1.30	82.8	17.2	0.0	0.0
All	3-20m	-	-	-	-	-	-	-	0	0	E					58	79	1.36	19.3	19.3	56.1	5.3	0	2	E				
	20-30m	71	50	0.70	81.7	7.0	9.9	1.4	34	14	0.41	58.8	32.4	8.8	0.0	19	30	1.58	57.9	21.1	21.1	0.0	6	12	2.00				
	30-80m	51	80	1.57	79.2	14.6	2.1	4.2	99	115	1.16	59.6	24.2	16.2	0.0	13	32	2.46	46.2	23.1	30.8	0.0	69	109	1.58	81.2	13.0	4.3	0.0
	80-200m	0	0	E					79	89	1.13	57.0	40.5	2.5	0.0	0	0	E					23	51	2.22	68.2	31.8	0.0	0.0
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	122	130	1.07	80.7	10.1	6.7	2.5	212	218	1.03	58.5	31.6	9.9	0.0	90	141	1.57	31.5	20.2	44.9	3.4	98	174	1.78	78.0	17.6	3.3	0.0

Remarks. * I: Immature, II: Semi-mature, III: Mature, IV: Spent. -: no trawl. E: Error. blank: no data.

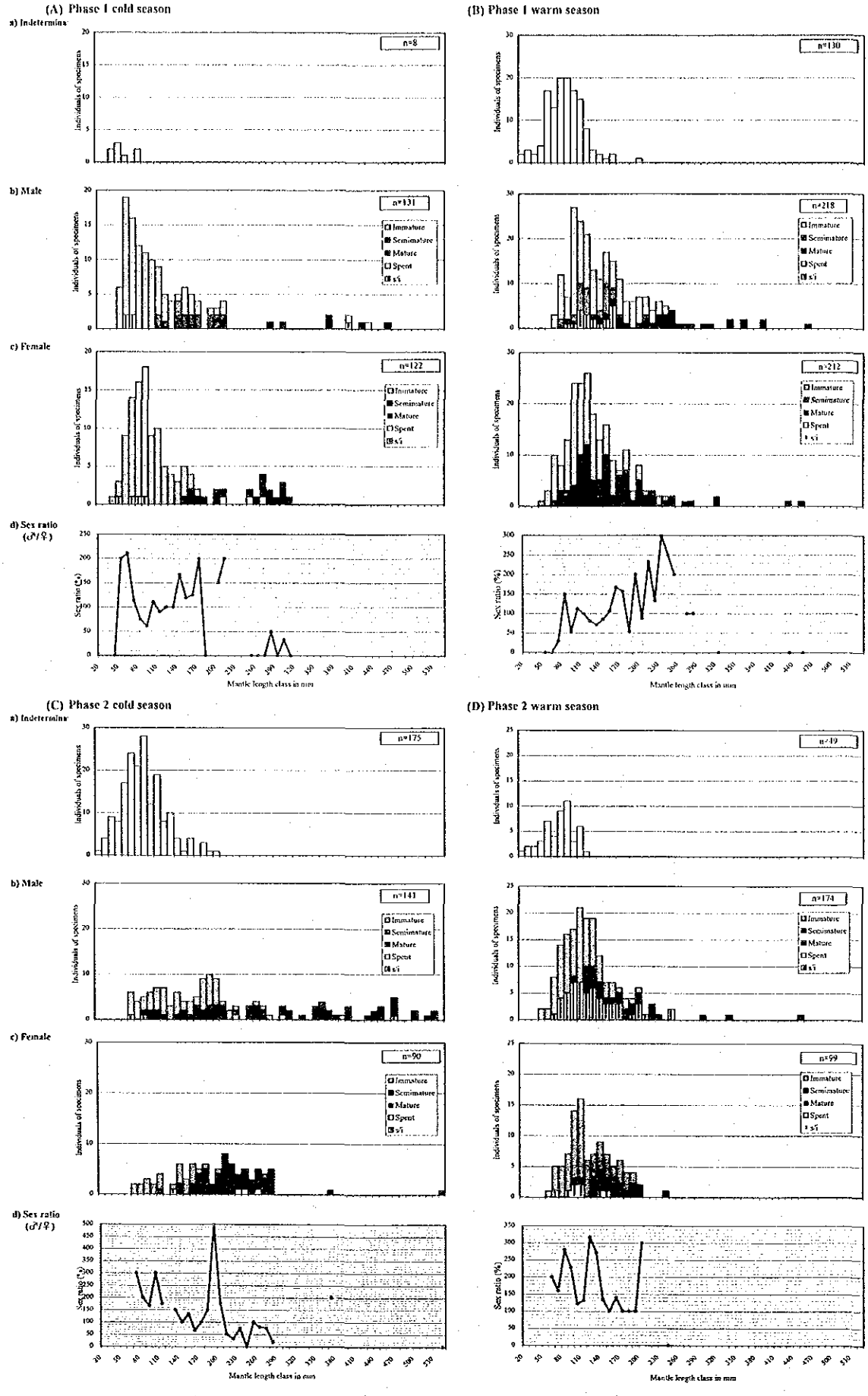


Figure 3.75 Sex ratio and female maturity stage by length class for European squid *Loligo vulgaris*.

Table 3.104 Stomach content analysis of European squid *Loligo vulgaris*.

(A) Stomach condition

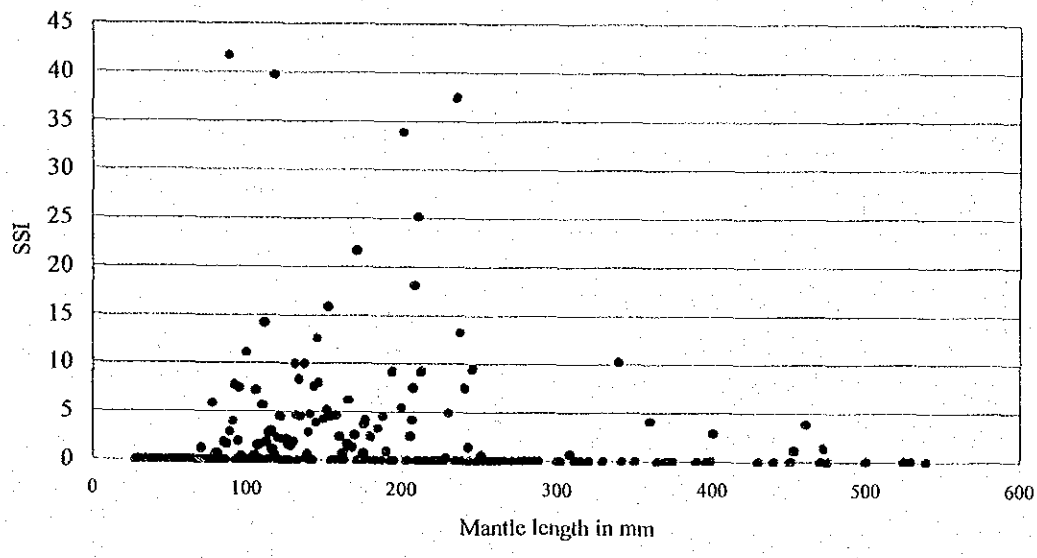
Phase	Season	Stomach condition			Stomach content Somatic Index (SSI)			
		n*	Empty (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	9	88.89	11.11	8	0.00	0.00	0.00
	Warm	398	77.89	22.11	394	0.00	125.00	3.82
2	Cold	288	93.06	6.94	268	0.00	183.33	2.78
	Warm	181	79.01	20.99	181	0.00	40.58	2.92

(B) Stomach contents

Phase	Season	n*	Mollusca	Crustacea	Fish				Unknown
			Decapoda		*Sardina pilchardus*	*Pagellus bellottii*	*Microchirus boscanion*	Other	
1	Cold	1	100.00						
	Warm	88	1.14	4.55				13.64	82.95
2	Cold	20			5.00	5.00	5.00	20.00	65.00
	Warm	37		18.92				45.95	35.14

Remark. * : Individuals of specimens.

(A) Relationship between mantle length and SSI



(B) Relationship between mantle length and SCW

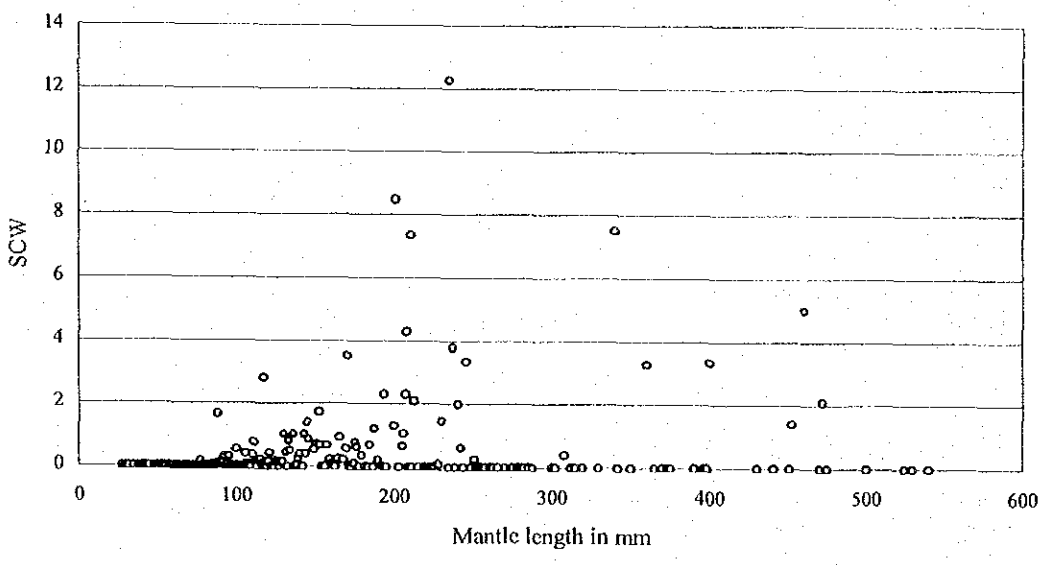


Figure 3.76 Relationship between body length and SSI (A) and SCW (B) for European squid *Loligo vulgaris*.

2) **Common cuttlefish *Sepia officinalis***

a) **Body length range and mean body length**

Table 3.105 (page 3-327) presents the minimum, maximum and mean mantle length obtained for the common cuttlefish.

In the *Amrigue* survey area, the mantle length varied between 30 and 285 mm. The mean mantle length was larger in the cold season than in the warm season and larger in other area than in the Banc d'Arguin.

In the *Al-Awam* survey area, the mantle length varied between 32 and 345 mm. The mean mantle length by area was larger in the Central and Southern areas in the cold season and in the Northern area in the warm season. The mean mantle length by stratum tended to be larger in shallow strata in the cold season and in deep strata in the warm season. Such a geographical and vertical variations of the mean size suggest seasonal movement in the north-south and inshore-offshore directions.

b) **Size composition**

Figure 3.77 (page 3-324, 3-328 to 3-331) shows the evaluation of size composition for the common cuttlefish stock. The mantle length class is indicated at intervals of 1cm. For convenience of considering the size composition, three groups were defined: (i) small-size (mantle length less than 10cm), (ii) medium-size (length between 10 and 20cm), (iii) large-size (length over 20cm).

The total stock size in number was mainly comprised, in the cold season, the medium-size group and the large-size group (number of samples in Phase 1 was low) and, in the warm season, the medium-size group. The small-size group appeared only in the warm season.

The size composition by stratum and by area revealed the distribution pattern of the three groups. The small-size group that only appeared in the warm season, was widespread at various strata from north to south, mainly in the Central and Southern areas. However, very young larvae with the mantle length smaller than 5cm, occurred only at the 30-80 m stratum in the Northern area. The medium-size group was widespread in all seasons from north to south, mainly in the Central area (no samples in the Phase 1 cold season). The large-size group was also widespread over the entire survey area. Particularly the large individuals of the 34-35cm class found only in the Phase 1 warm season, occurred solely at the 80-200 m stratum in the Southern area. In the Phase 2 cold season, the large-size group was concentrated at the 3-20 m stratum in each area. This result strongly suggests a migration along the coastline for reproductive purposes.

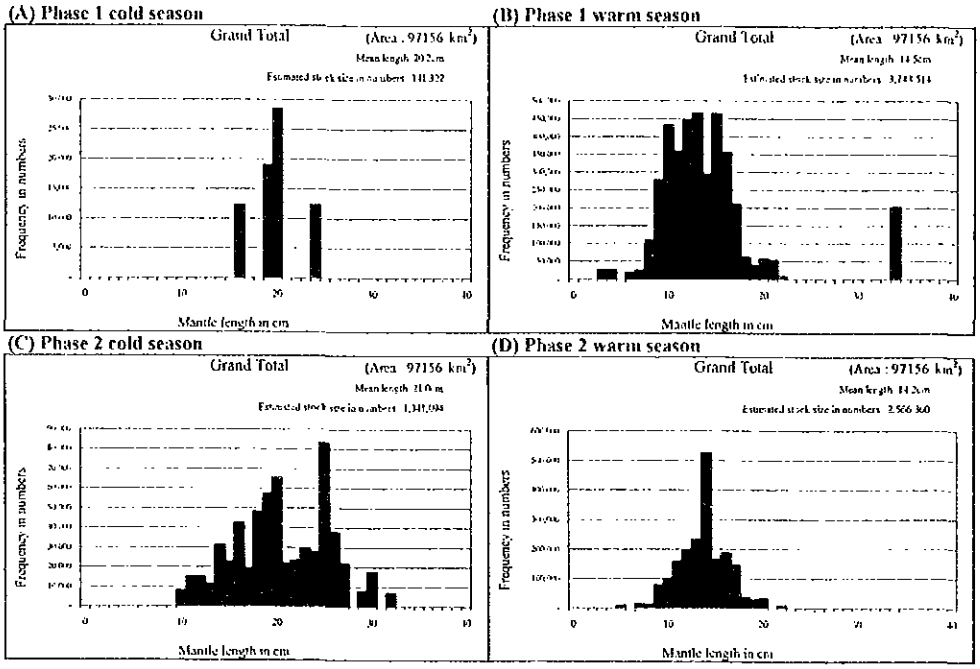


Figure 3.77 Size composition for common cuttlefish *Sepia officinalis*.

c) Length-weight relationship

Figure 3.78 (page 3-325) presents the relationship between the mantle length and weight for the common cuttlefish. The length-weight equations obtained were the following:

Phase 1 cold season	: $BW = 0.1799 \times ML^{2.786}$	(r=0.9834)
Phase 1 warm season	: $BW = 0.2159 \times ML^{2.783}$	(r=0.9712)
Phase 2 cold season	: $BW = 0.2841 \times ML^{2.640}$	(r=0.9808)
Phase 2 warm season	: $BW = 0.2998 \times ML^{2.637}$	(r=0.9733)

where, BW : body weight (g), ML : mantle length (cm) and r : the coefficient of correlation.

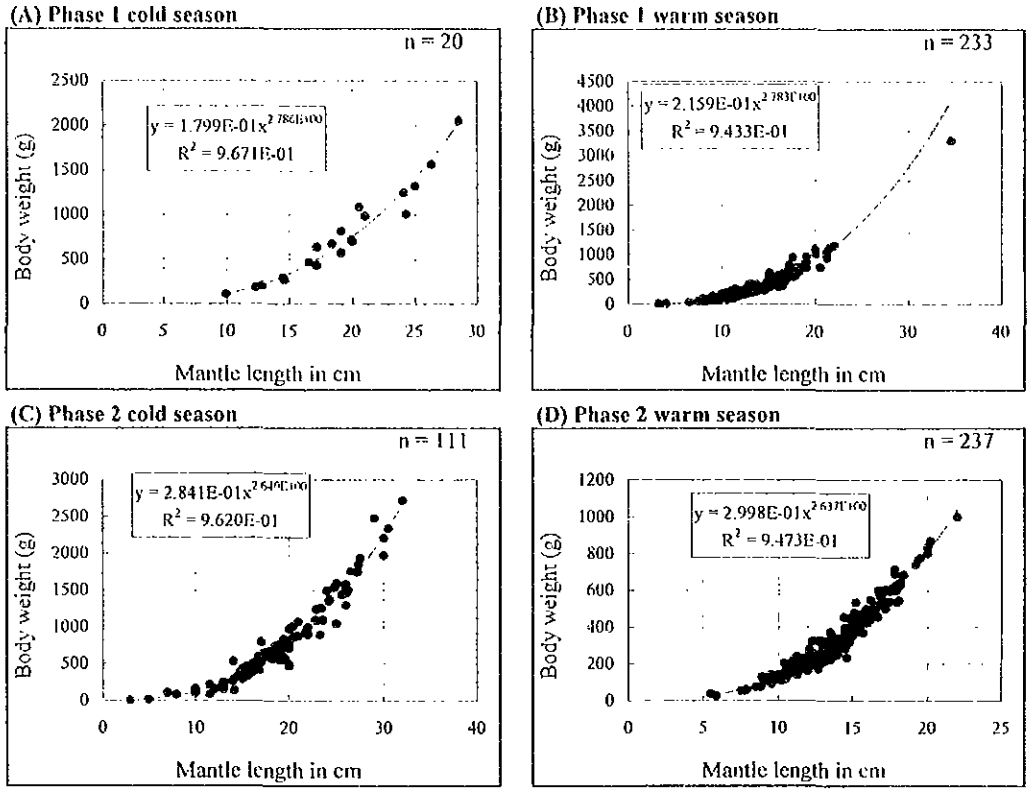


Figure 3.78 Length-weight relationship for common cuttlefish *Sepia officinalis*.

d) Length and weight by sex

Table 3.106 (page 3-332) presents the mantle length and body weight observed in each sex for the common cuttlefish.

In the *Amrigue* survey area, the mantle length of males varied between 50 and 210 mm and that of females between 70 and 285 mm. The mean mantle length and mean weight of males were larger than those of females. The mean size of both males and females was larger in the cold season than in the warm season. However, the mean mantle length and weight of males and females in the entire area declined along the study seasons.

In the *Al-Awam* survey area, the mantle length of males varied between 65 and 345 mm and that of females between 55 and 320 mm. The mean mantle length of males was larger than that of females in all seasons except the Phase 1 warm season. The mean mantle length and weight of males and females in the cold season was larger than that in the warm season, of 6–7cm and around 500 g. In the cold season, the mantle length of the smallest male with sufficiently developed gonads to be visually recognized as such was 10cm for the early individuals and 17cm for the late ones; for females, those values were respectively 12 and 19cm. In the warm season, those figures were 6–8cm for males and 7–10cm for females. It appears that gonadal development starts earlier in males than in females.

e) Sex ratio and female maturity stage

Table 3.107 (page 3-333) summarizes the sex ratio and the female maturity stage for the common

cuttlefish. Figure 3.79 (page 3-334) presents their distribution by length class. The maturation state of males is also indicated.

In the *Amrigue* survey area, the overall sex ratio was 1.00 in all seasons, except for the Phase 2 warm season in which it was 1.55. The female maturity ratio was high in the cold season (between 38 and 68%) and low in the warm season (9%).

In the *Al-Awam* survey area, the overall sex ratio was, in survey order, 1.00, 0.72, 1.16 and 1.39. The depth-dependent change of the sex ratio was not observed. On the other hand, the sex ratio by area was high in the Northern area in all seasons except in the Phase 2 warm season, and declined southwards.

The female maturity ratio in the entire area was, in survey order, 100% (only 2 individuals of specimens at the 30-80 m stratum in the Northern area), 9%, 67% and 7%. The spent female ratio was 33% at the 30-80 m stratum in the Northern area in the Phase 1 warm season. In the Phase 2 cold season, from north to south, it was respectively 100%, 6% and 25% at the 3-20 m strata in the three areas.

These results suggest that ①the common cuttlefish spawns from the cold season to the warm season, with temporal displacements according to its geographical position, ②the main spawning period is in the cold season and ③the spawning site is in the coastal zone (inshore-ward migration for reproduction). According to Dah *et* Inejih (1991), the spawning period would be long (from November to August), and the spawning peak of females over the continental shelf of the IRM would be between March and May. The present results confirm those findings and add more detail to them.

There was no clear size-dependent change of the sex ratio. However, in the Phase 1 warm season and in the Phase 2 cold season, the sex ratio declined from approximately 200% to 0% within classes between 10 and 210cm, with some intermediate fluctuation.

The mantle length at first maturity was, for males, at the 14-15cm class both in the cold and warm seasons, and, for females, at the 11-12cm class in the cold season and at the 15-16cm class in the warm season. According to Inejih (1990), the mantle length at first maturity for female would be 13.8cm. That figure is close to the mean value of the lengths obtained from the cold and warm seasons in the present survey.

f) Feeding habits

Table 3.108 (page 3-335) presents the stomach condition and the stomach content composition of the common cuttlefish in each survey season. Figure 3.80 (page 3-336) presents the relationship between the mantle length and SSI and SCW.

The ratio of the empty stomach varied between 31 and 74%. The relationship between the mantle length and SSI and SCW showed that, except for a single individual of approximately 29cm in the mantle length, the largest individuals consume great quantities of food (despite a SCW climax at about 50 g for individuals over 250 mm) while the small-size individuals are voracious eaters in relation to their body weight (despite the fact the difference between SSIs corresponding to the mantle length of 100 and 350 mm was small, about 20).

The common cuttlefish fed on fish, crustaceans (crabs, shrimp, etc.) and mollusks (bivalves, and cuttlefish *Sepia* sp. or squid).

Table 3.105 Body length range and mean body length for common cuttlefish *Sepia officinalis* : ML in mm.

(A) *Amrigue* survey area

Northern coastal area (Stratum: 3-20m)	Phase 1						Phase 2					
	Cold season			Warm season			Cold season			Warm season		
	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
Banc d'Arguin	6	99 ~ 250	163.8	0			13	30 ~ 200	131.5	24	78 ~ 157	120.1
Other	10	145 ~ 285	202.7	0			14	50 ~ 250	141.8	7	59 ~ 155	120.4
All area	16	99 ~ 285	188.1	0			27	30 ~ 250	136.9	31	59 ~ 157	120.2

(B) *Al-Awam* survey area

Subarea	Stratum	Phase 1						Phase 2					
		Cold season			Warm season			Cold season			Warm season		
		Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
North	3-20m	-	-	-	-	-	-	4	200 ~ 256	231.5	2	145 ~ 146	145.5
	20-30m	1	191	191.0	4	145 ~ 178	159.0	4	100 ~ 260	161.3	30	99 ~ 194	145.5
	30-80m	1	205	205.0	14	32 ~ 190	138.8	0			15	55 ~ 192	140.4
	80-200m	0			0			0			0		
	200-400m	0			0			-	-	-	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	2	191 ~ 205	198.0	18	32 ~ 190	143.3	8	100 ~ 260	196.4	47	55 ~ 194	143.9
Central	3-20m	-	-	-	44	75 ~ 200	131.6	38	115 ~ 320	207.7	40	89 ~ 165	136.7
	20-30m	0			5	120 ~ 175	151.4	2	120 ~ 130	125.0	38	79 ~ 182	139.6
	30-80m	0			53	80 ~ 220	151.2	0			36	75 ~ 220	138.7
	80-200m	0			16	88 ~ 150	112.4	0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	0			118	75 ~ 220	138.7	40	115 ~ 320	203.6	114	75 ~ 220	138.3
South	3-20m	-	-	-	38	65 ~ 148	111.7	30	150 ~ 300	209.3	28	100 ~ 180	132.8
	20-30m	2	166 ~ 241	203.5	42	90 ~ 212	130.2	6	145 ~ 190	173.3	13	90 ~ 167	126.6
	30-80m	0			16	98 ~ 212	144.6	0			4	150 ~ 165	158.5
	80-200m	0			1	345	345.0	0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	2	166 ~ 241	203.5	97	65 ~ 345	127.6	36	145 ~ 300	203.3	45	90 ~ 180	133.3

Remark. - : no trawl.

Figure3.77 (A) continued.

North 3-20m (Area : 5912 km²)

No trawl

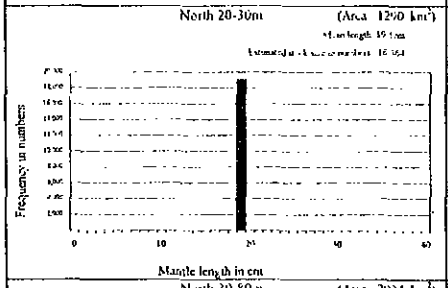
Central 3-20m (Area : 2783 km²)

No trawl

South 3-20m (Area : 1485 km²)

No trawl

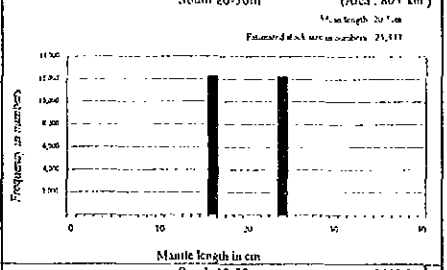
North 20-30m (Area : 1290 km²)



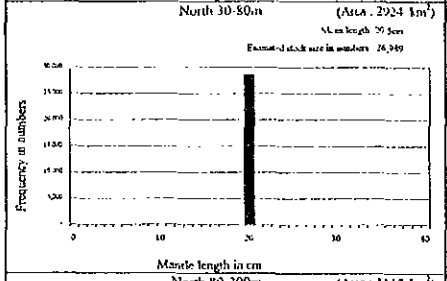
Central 20-30m (Area : 835 km²)

No catch

South 20-30m (Area : 805 km²)



North 30-80m (Area : 2924 km²)



Central 30-80m (Area : 2870 km²)

No catch

South 30-80m (Area : 2640 km²)

No data for size composition

North 80-200m (Area : 1137 km²)

No catch

Central 80-200m (Area : 2767 km²)

No catch

South 80-200m (Area : 3025 km²)

No catch

North 200-400m (Area : 936 km²)

No catch

Central 200-400m (Area : 1453 km²)

No catch

South 200-400m (Area : 994 km²)

No catch

North 400-600m (Area : 738 km²)

No trawl

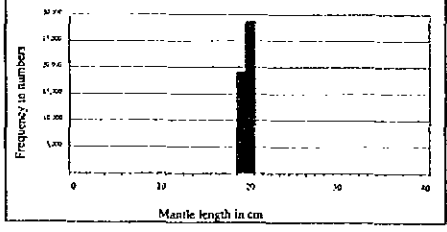
Central 400-600m (Area : 848 km²)

No trawl

South 400-600m (Area : 583 km²)

No trawl

North Total (Area : 17688 km²)



Central Total (Area : 29244 km²)

No catch

South Total (Area : 21088 km²)

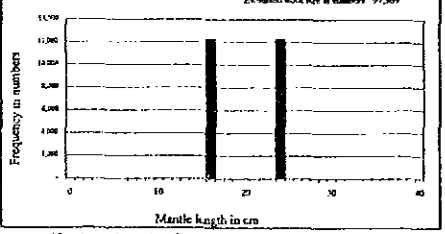


Figure3.77 (B) continued.

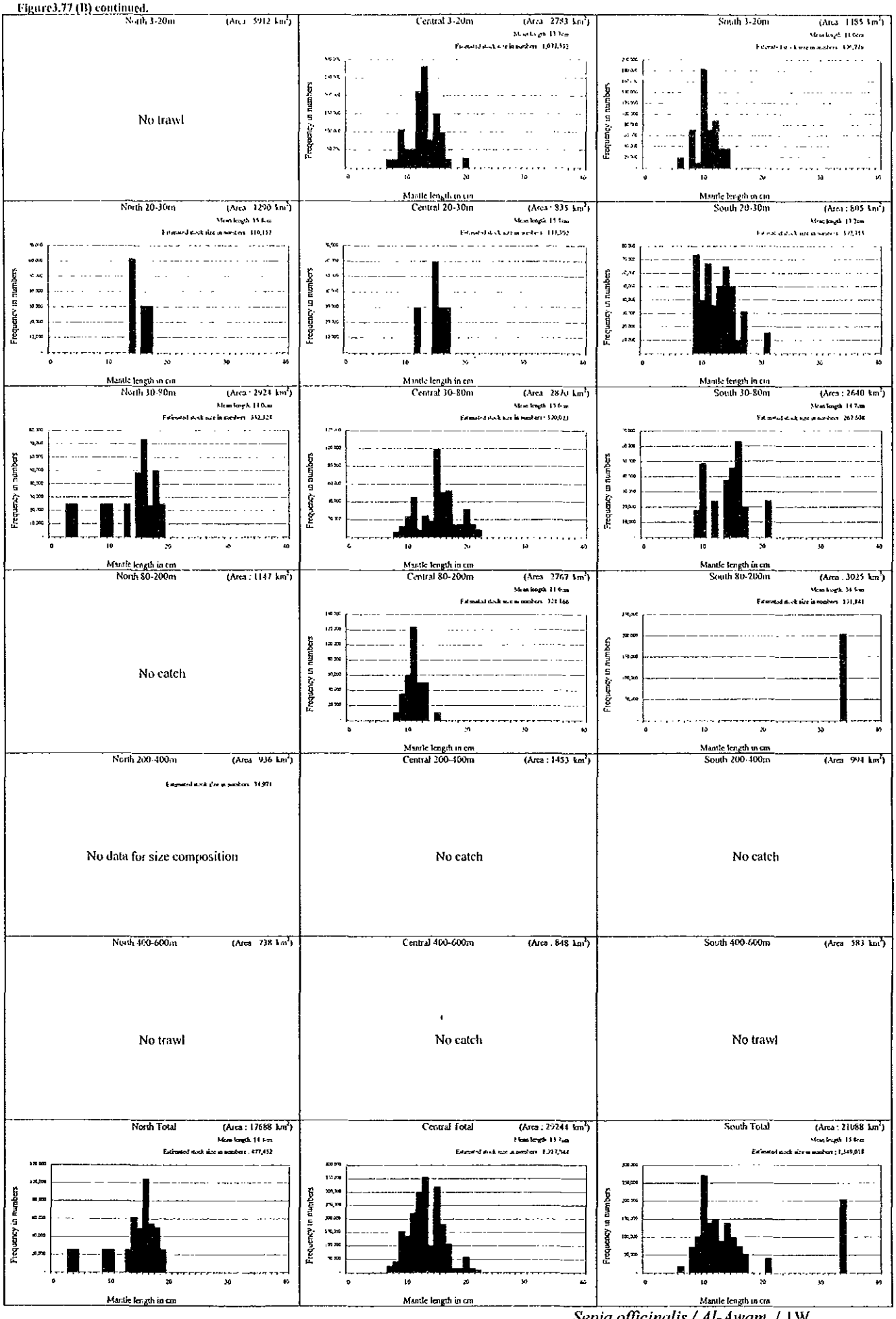
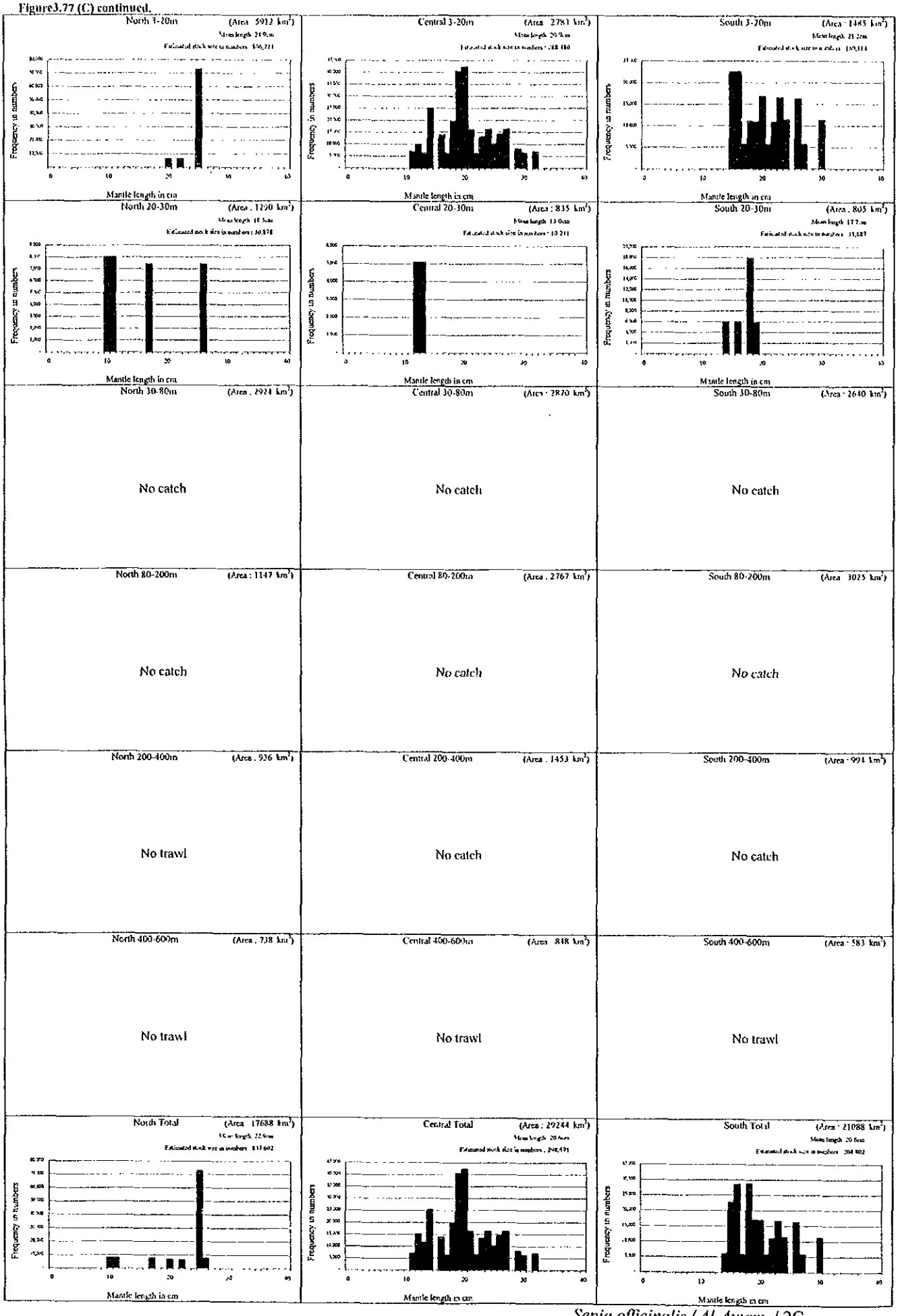


Figure3.77 (C) continued.



Sepia officinalis / Al-Awam / 2C

Figure3.77 (D) continued.

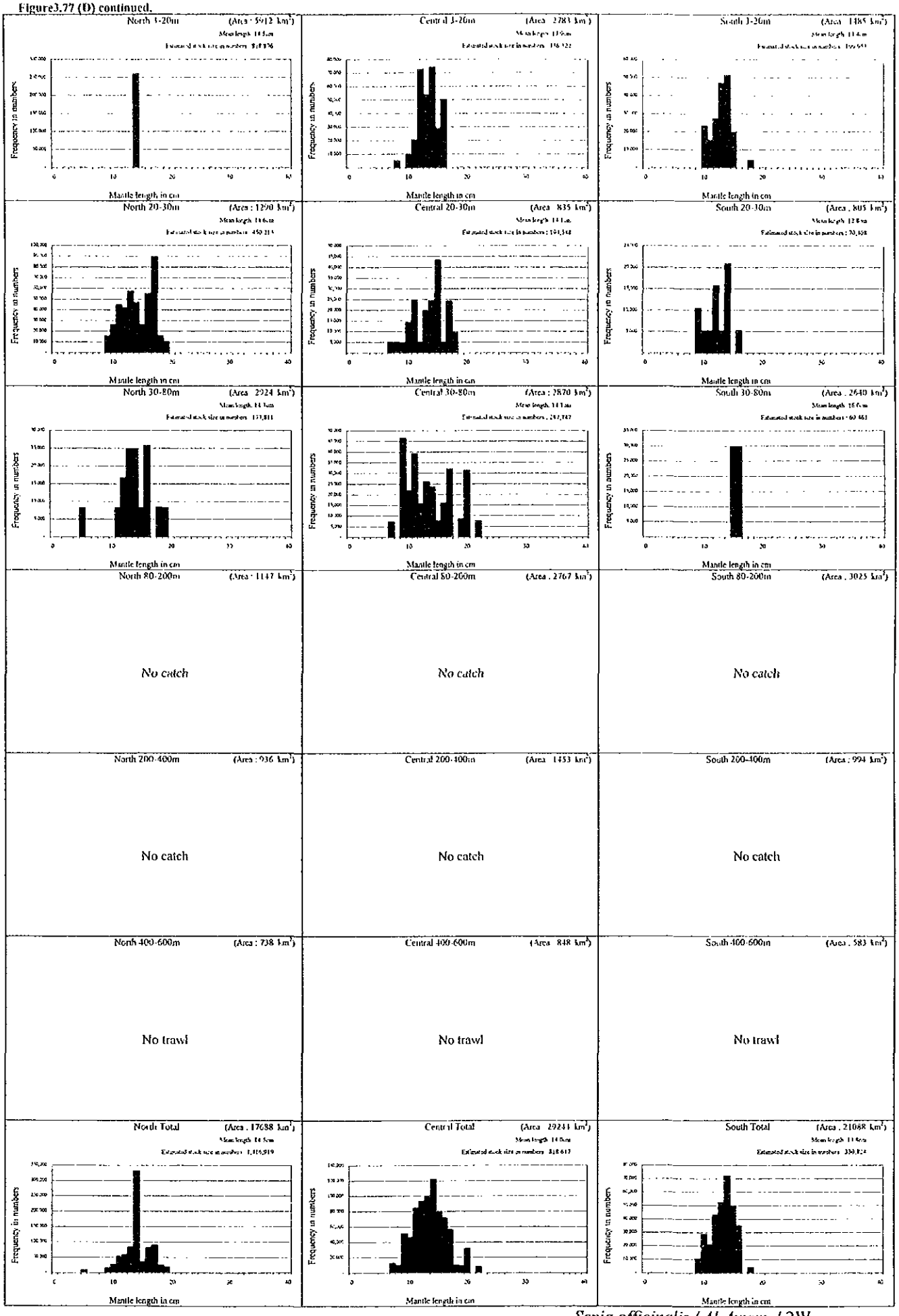


Table 3.106 Body length and weight by sex for common cuttlefish *Sepia officinalis*.

(A) *Amrigue* survey area

Phase	Season	Sex	Individuals of specimens	Mantle length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	8	99 ~ 285	202.8	110.0 ~ 2,062.0	902.5
		Female	8	123 ~ 210	173.5	185.0 ~ 988.0	569.5
		Indeterminate	0				
		Total	16	99 ~ 285	188.1	110.0 ~ 2,062.0	736.0
	Warm	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
2	Cold	Male	12	70 ~ 250	154.2	80.0 ~ 1,580.0	518.3
		Female	12	50 ~ 200	142.9	20.0 ~ 980.0	401.8
		Indeterminate	3	30 ~ 50	43.3	5.0 ~ 20.0	13.3
		Total	27	30 ~ 250	136.9	5.0 ~ 1,580.0	410.4
	Warm	Male	17	97 ~ 155	128.9	110.0 ~ 375.0	229.2
		Female	11	90 ~ 157	119.0	90.0 ~ 370.0	198.4
		Indeterminate	3	59 ~ 88	75.0	28.0 ~ 75.0	52.3
		Total	31	59 ~ 157	120.2	28.0 ~ 375.0	201.2

(B) *Al-Awam* survey area

Phase	Season	Sex	Individuals of specimens	Mantle length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	2	166 ~ 241	203.5	470.0 ~ 1,250.0	860.0
		Female	2	191 ~ 205	198.0	820.0 ~ 1,090.0	955.0
		Indeterminate	0				
		Total	4	166 ~ 241	200.8	470.0 ~ 1,250.0	907.5
	Warm	Male	87	75 ~ 212	132.9	60.0 ~ 1,060.0	332.0
		Female	121	65 ~ 345	140.9	41.0 ~ 3,300.0	399.0
		Indeterminate	25	32 ~ 158	108.2	5.0 ~ 630.0	213.2
		Total	233	32 ~ 345	134.4	5.0 ~ 3,300.0	354.1
2	Cold	Male	44	100 ~ 320	211.7	90.0 ~ 2,720.0	1,017.1
		Female	38	115 ~ 273	195.4	190.0 ~ 1,860.0	807.0
		Indeterminate	1	129	129.0	220.0	220.0
		Total	83	100 ~ 320	203.2	90.0 ~ 2,720.0	911.3
	Warm	Male	111	55 ~ 220	141.4	40.0 ~ 1,000.0	352.3
		Female	80	95 ~ 200	138.8	115.0 ~ 835.0	345.4
		Indeterminate	15	79 ~ 165	115.7	60.0 ~ 520.0	204.7
		Total	206	55 ~ 220	138.5	40.0 ~ 1,000.0	338.9

Table 3.107 Sex ratio and female maturity stage for common cuttlefish *Sepia officinalis*.

(A) *Amrigue* survey area

Northern coastal area	Phase 1 cold season							Phase 1 warm season							Phase 2 cold season							Phase 2 warm season						
	Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
(Stratum: 3-20m)	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
Blanc d'Arguin	4	1	0.25	75.0	0.0	25.0	0.0	0	0	E					5	5	1.20	20.0	0.0	80.0	0.0	8	14	1.75	100.0	0.0	0.0	0.0
Other	4	7	1.75	25.0	25.0	50.0	0.0	0	0	E					7	6	0.86	14.3	28.6	57.1	0.0	3	3	1.00	66.7	33.3	0.0	0.0
All area	8	8	1.00	50.0	12.5	37.5	0.0	0	0	E					12	12	1.00	16.7	16.7	66.7	0.0	11	17	1.55	90.9	9.1	0.0	0.0

(B) *Al-Awam* survey area

Subarea	Stratum	Phase 1 cold season							Phase 1 warm season							Phase 2 cold season							Phase 2 warm season						
		Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
		♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
North	3-20m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	3.00	0.0	0.0	0.0	100.0	1	1	1.00				
	20-30m	1	0	0.00					3	1	0.33	0.0	66.7	33.3	0.0	2	2	1.00	0.0	0.0	100.0	0.0	11	19	1.73	54.5	45.5	0.0	0.0
	30-80m	1	0	0.00	0.0	0.0	100.0	0.0	3	7	2.33	66.7	0.0	0.0	33.3	0	0	E					9	6	0.67	55.6	44.4	0.0	0.0
	80-200m	0	0	E					0	0	E					0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E					-	-	-	-	-	-	-	0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	2	0	0.00	0.0	0.0	100.0	0.0	6	8	1.33	33.3	33.3	16.7	16.7	3	5	1.67	0.0	0.0	66.7	33.3	21	26	1.24	55.0	45.0	0.0	0.0
Central	3-20m	-	-	-	-	-	-	-	21	16	0.76	81.0	14.3	4.8	0.0	18	19	1.06	11.8	0.0	82.4	5.9	13	22	1.69	40.0	50.0	10.0	0.0
	20-30m	0	0	E					2	2	1.00	0.0	100.0	0.0	0.0	0	2	E					12	21	1.75	58.3	16.7	25.0	0.0
	30-80m	0	0	E					26	18	0.69	38.5	26.9	34.6	0.0	0	0	E					16	20	1.25	46.2	46.2	7.7	0.0
	80-200m	0	0	E					8	6	0.75	62.5	37.5	0.0	0.0	0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	0	0	E					57	42	0.74	56.1	26.3	17.5	0.0	18	21	1.17	11.8	0.0	82.4	5.9	41	63	1.54	48.6	37.1	14.3	0.0
South	3-20m	-	-	-	-	-	-	-	15	21	1.40	100.0	0.0	0.0	0.0	13	16	1.23	16.7	8.3	50.0	25.0	15	15	1.15	46.2	53.8	0.0	0.0
	20-30m	0	2	E					34	8	0.24	100.0	0.0	0.0	0.0	4	2	0.50	0.0	50.0	50.0	0.0	4	4	1.00	75.0	25.0	0.0	0.0
	30-80m	0	0	E					8	8	1.00	50.0	50.0	0.0	0.0	0	0	E					1	3	3.00	0.0	100.0	0.0	0.0
	80-200m	0	0	E					1	0	0.00	0.0	100.0	0.0	0.0	0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	0	2	E					58	37	0.64	91.4	8.6	0.0	0.0	17	18	1.06	12.5	18.8	50.0	18.8	18	22	1.22	50.0	50.0	0.0	0.0
All	3-20m	-	-	-	-	-	-	-	36	37	1.03	88.9	8.3	2.8	0.0	32	38	1.19	13.3	3.3	66.7	16.7	27	38	1.41	43.5	52.2	4.3	0.0
	20-30m	1	2	2.00					39	11	0.28	87.2	10.3	2.6	0.0	6	6	1.00	0.0	33.3	66.7	0.0	27	44	1.63	59.3	29.6	11.1	0.0
	30-80m	1	0	0.00	0.0	0.0	100.0	0.0	37	33	0.89	43.2	29.7	24.3	2.7	0	0	E					26	29	1.12	47.8	47.8	4.3	0.0
	80-200m	0	0	E					9	6	0.67	55.6	44.4	0.0	0.0	0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	2	2	1.00	0.0	0.0	100.0	0.0	121	87	0.72	71.9	18.2	9.1	0.8	38	44	1.16	11.1	8.3	66.7	13.9	80	111	1.39	50.7	42.5	6.8	0.0

Remarks. * *I: Immature, II: Semi-mature, III: Mature, IV: Spent.* -: *no trawl.* E: *Error.* blank: *no data.*

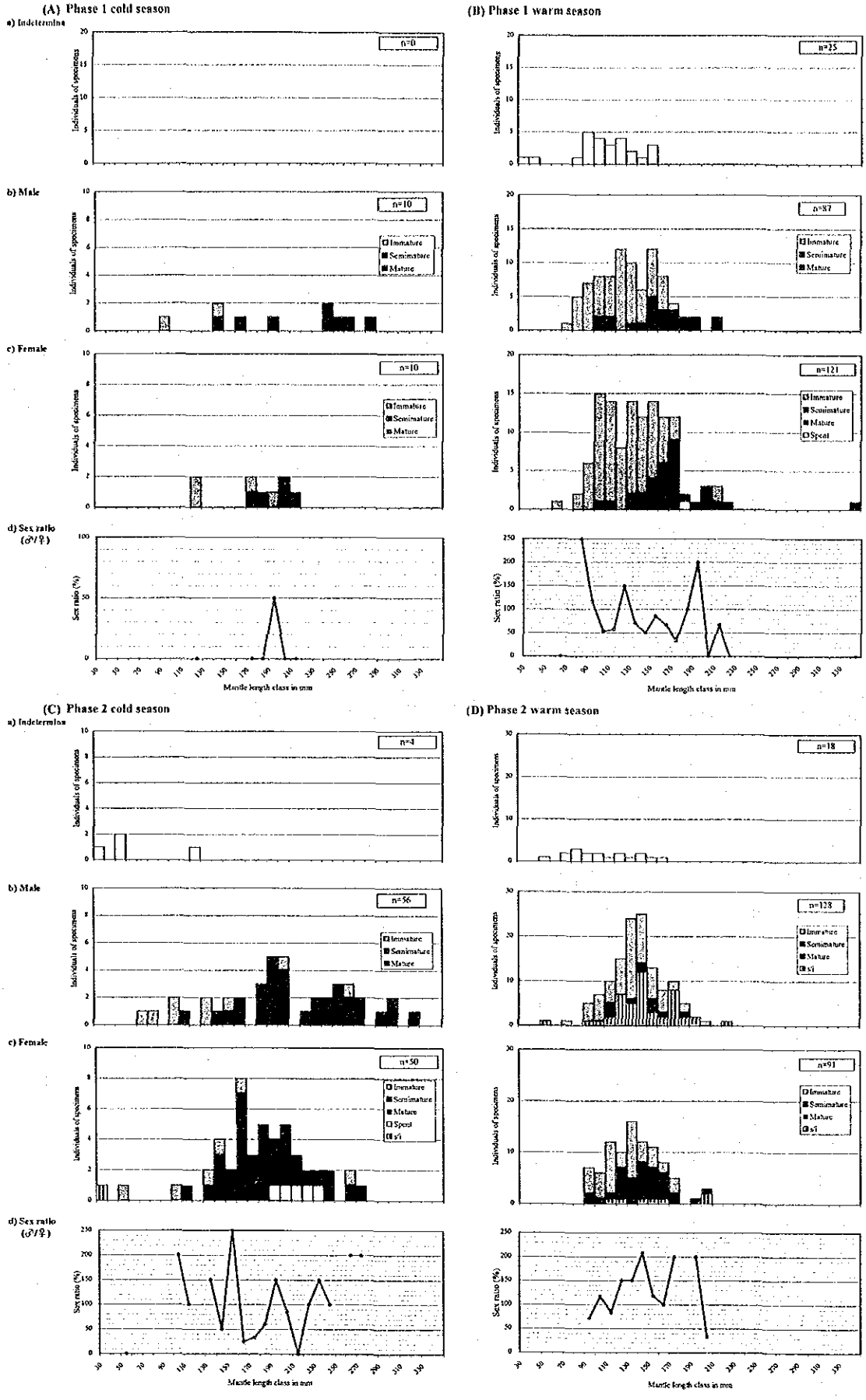


Figure 3.79 Sex ratio and female maturity stage by length class for common cuttlefish *Sepia officinalis*.

Table 3.108 Stomach content analysis of common cuttlefish *Sepia officinalis*.

(A) Stomach condition

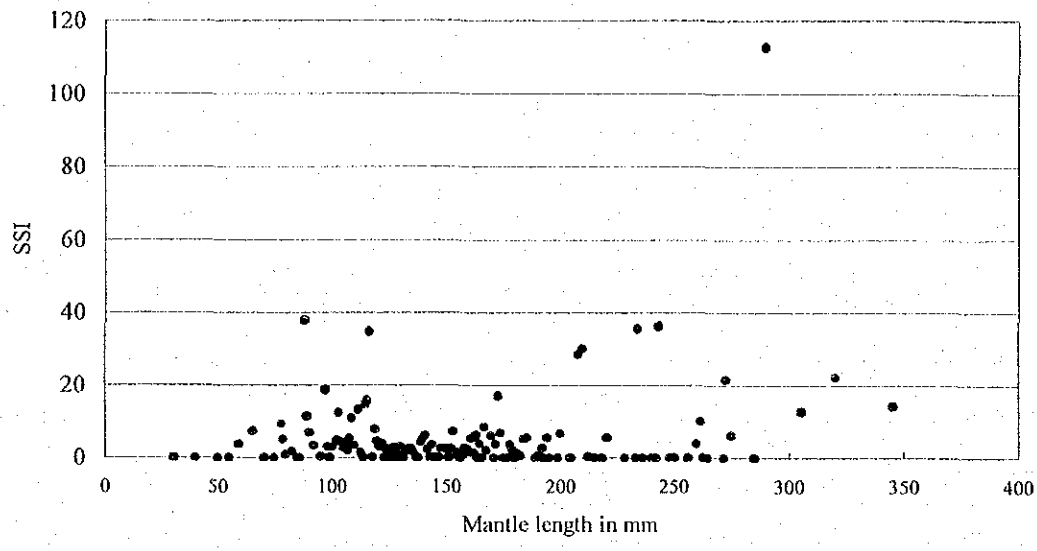
Phase	Season	Stomach condition			Stomach content Somatic Index (SSI)			
		n*	Empty (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	16	31.25	68.75	5	0.00	0.00	0.00
	Warm	182	62.09	37.91	182	0.00	37.89	3.16
2	Cold	76	73.68	26.32	76	0.00	112.90	6.80
	Warm	150	42.67	57.33	146	0.00	67.39	4.26

(B) Stomach contents

Phase	Season	n*	Mollusca			Crustacea			Fish	Unknown
			Bivalvia	*Sepia* sp.	Decapoda	Crab	Shrimp	Other		
1	Cold	11			5.10	9.09	45.45	18.18	63.64	
	Warm	69			4.17			11.59	10.14	78.26
2	Cold	20				10.00			35.00	55.00
	Warm	84	25.00	1.19		4.76		32.14	25.00	22.62

Remark. * : Individuals of specimens.

(A) Relationship between mantle length and SSI



(B) Relationship between mantle length and SCW

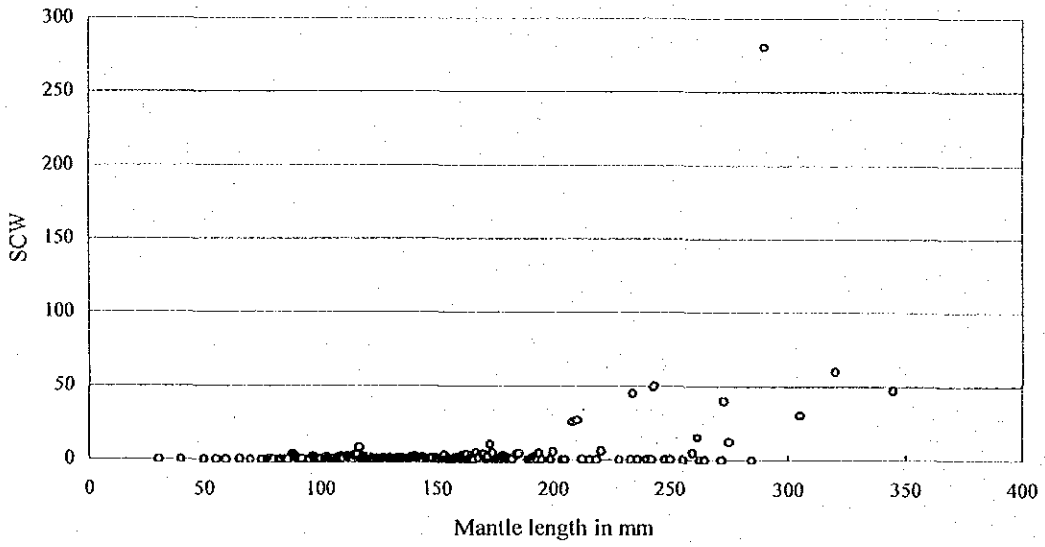


Figure 3.80 Relationship between body length and SSI (A) and SCW (B) for common cuttlefish *Sepia officinalis*.

3) Common octopus *Octopus vulgaris*

a) Body length range and mean body length

Table 3.109 (page 3-341) presents the minimum, maximum and mean mantle length obtained for the common octopus.

In the *Amrigue* survey area, six individuals were subjected to the multi-iem biological measurement in the cold season and five in the Phase 2 warm season. The mantle length of this species varied between 20 and 120 mm. The mean mantle length was 55 mm in the cold season and 82 mm in the warm season. Those mean values were lower than those obtained in each area of the *Al-Awam* survey area in the same periods.

In the *Al-Awam* survey area, the mantle length varied between 25 and 250 mm throughout the survey. The mean mantle length by area was higher in the Southern area throughout; in all seasons except in the Phase 2 warm season, it decreased from the south northwards. The mean mantle length in each area were higher in Phase 2 than in Phase 1.

b) Size composition

Figure 3.81 (page 3-338, 3-342 to 3-345) shows the evaluation of size composition for the common octopus stock. The mantle length class is indicated at intervals of 1cm. For convenience of considering the size composition, three groups were defined: (i) small-size (mantle length less than 10cm), (ii) medium-size (length between 10 and 20cm), (iii) large-size (length over 20cm).

For all seasons, the total stock size in number essentially comprised the small- and medium-size groups, and also a few large-size individuals. The predominant mode of the small-size group was distributed within the three classes between 7 and 10cm. As no difference between predominant mode classes of the small-size group in the cold and warm seasons was observed, it is conceivable that spawning would occur in two periods a year. According to Hatanaka (1979), octopus stock would indeed have two spawning periods in the territorial waters of the IRM: in the spring (March-June) and in the fall (September-October). Eggs laid in the spring would hatch in July and newly hatched youngs would reach a total length of about 40cm within about four months; after two years, they reaching a total length of about 80cm would then spawn in the spring. Conversely, the eggs laid in the fall would hatch in November and hatched youngs would reach a total length of about 40cm between April and June of the following year; again, two years after incubation, they reaching a total length of about 75cm would spawn in the fall. It could be said that the mode of the small-size group observed in the cold season (hereinafter referred to the mode as Sc) would doubtlessly correspond to the young octopus that hatched in early winter of the previous year, and that the mode of the small-size group observed in the warm season (Sw) would correspond to the newly hatched youngs in early summer of the same year. The medium-size group displayed two modes (but only one in the Phase 1 cold season). One is a predominant mode within two classes between 10 and 12cm (the mode in the cold season is here called Msc and the mode in the warm season Msw), and the other a mode within two classes between 14 and 16cm (respectively Mlc and Mlw for the modes in the cold and warm seasons). Although the modes of the large-size group were not very clear, one of them could be observed at the 20-21cm class in the warm season – except in the Phase 2 cold season in which it was at the 23-24cm class (those cold and warm season modes are respectively named Lc and Lw).

The size composition by stratum and area was utilized to verify the distribution of these groups.

①The small-size groups (the Sc and Sw groups) were distributed over the entire survey area and at various strata, mainly in the Central area (however, in the Phase 2 warm season, the estimated number of individuals was more significant in the Northern area). ②The Msc and Msw groups in the medium-size group were distributed over the entire survey area and at various strata, mainly in the North and Central areas (as well as in the Southern area in the Phase 2 warm season). ③The Mlc and Mlw groups in the medium-size group (Mlc was not observed in the Phase 1 cold season, so that it was not considered) were distributed over the entire survey area, mainly in the Southern area or in the Northern area. ④The large-size groups (the Lc and Lw groups) were distributed over all areas, but with a lower frequency of occurrence than that of the groups above.

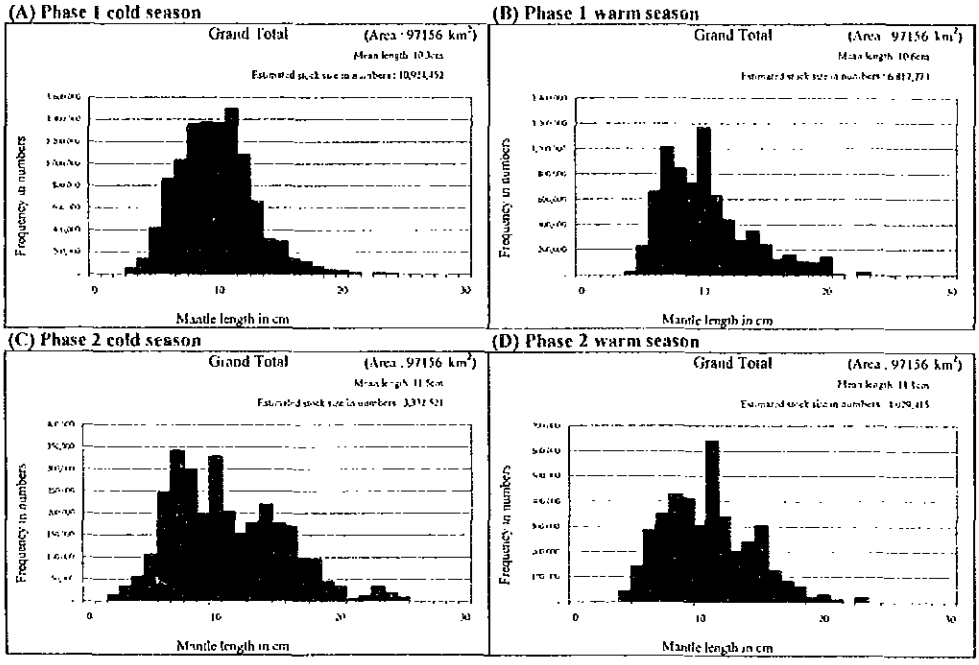


Figure 3.81 Size composition for common octopus *Octopus vulgaris*.

c) Length-weight relationship

Figure 3.82 presents the relationship between the mantle length and weight for the common octopus. The length-weight equations obtained from all samples were the following:

Phase 1 cold season	: $BW = 1.516 \times ML^{2.614}$	(r=0.9241)
Phase 1 warm season	: $BW = 8.169 \times ML^{1.936}$	(r=0.8240)
Phase 2 cold season	: $BW = 3.083 \times ML^{2.270}$	(r=0.9399)
Phase 2 warm season	: $BW = 2.946 \times ML^{2.294}$	(r=0.8762)

where, BW : body weight (g), ML : mantle length (cm) and r : the coefficient of correlation.

The coefficients of correlation for the length-weight relationship in this species are low for a cephalopod. Presumably this is due to the significance of fluctuations of actual values measured from live specimens.

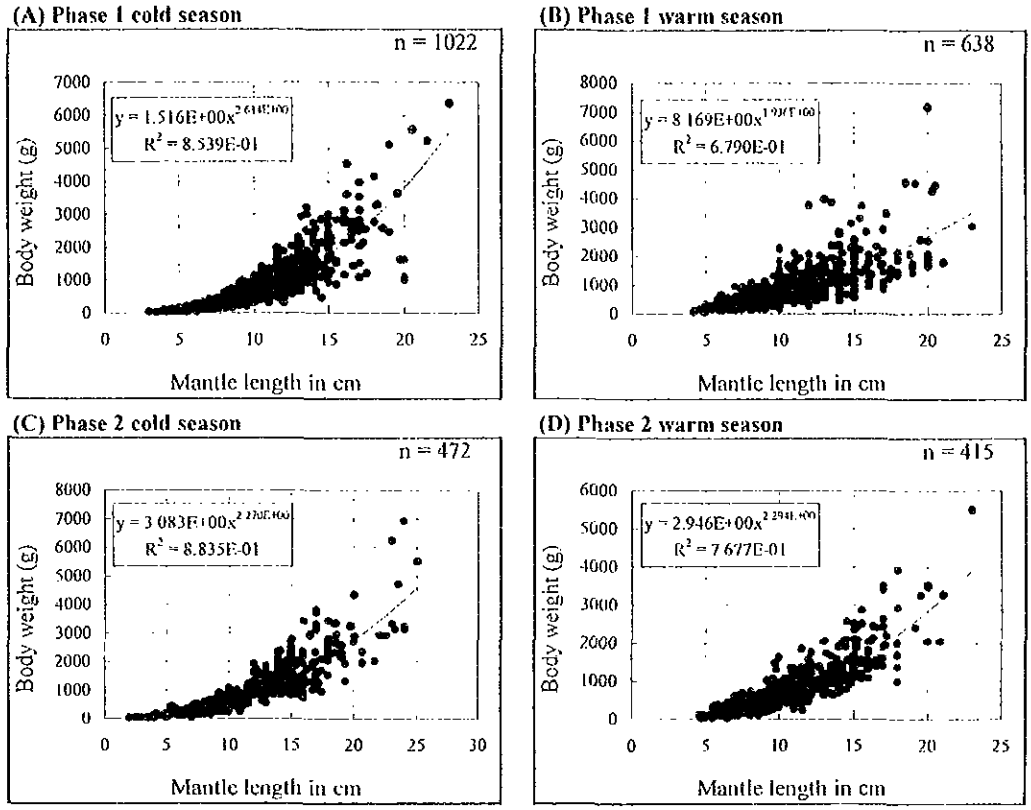


Figure 3.82 Length-weight relationship for common octopus *Octopus vulgaris*.

d) Length and weight by sex

Table 3.110 (page 3-346) shows the mantle length and body weight observed in each sex for the common octopus.

In the *Amrigue* survey area, the data obtained in Phase 2 refer to only two females and nine males. The mantle length and weight of females were 50 mm and 125 g in the cold season and 120 mm and 1,350 g in the warm season. The mantle length and weight of males varied between 20 and 95 mm and between 30 and 440 g respectively. Males were larger (in both mean mantle length and weight) in the warm season than in the cold season.

In the *Al-Awam* survey area, the mantle length varied between 25 and 250 mm for males and between 36 and 240 mm for females. The weight varied between 15 and 7,200 g for males and between 30 and 4,535 g for females. In Phase 1, the mean mantle length of males was near that of females, but in Phase 2 the mean length of males was larger. The mean weight of males was higher than that of females in Phase 2 surely, but also in Phase 1.

The mantle length of individuals with enough developed gonads to allow sex determination by visual inspection was in the order of 3 to 5cm in the mantle length for both males and females.

e) Sex ratio and female maturity stage

Table 3.111 (page 3-347) summarizes the sex ratio and the female maturity stage for the common octopus. Figure 3.83 (page 3-348) presents their distribution by length class. The maturation state of males is also indicated.

In the *Amrigue* survey area, two females and nine males were sampled. The females in the warm season were all mature.

In the *Al-Awam* survey area, the overall sex ratio varied between 0.84 and 0.98, showing that the state of male/female equilibrium was more or less maintained. The sex ratio by area and by stratum indicated the same trend.

The female maturity ratio in the entire area was low in the cold season (4 and 11%) and high in the warm season (30 and 32%). Throughout the survey there were females exhibiting an ovulation after spawning, and females protecting their eggs inside a pot trap or a tire, in a percentage varying between 0.4 and 1.9%. There was a geographic-dependent change of the female maturity ratio by area: the ratio was high in the Southern area in the three seasons up to the Phase 2 cold season, but in this latter it was high in the Northern area. No depth-dependent change of the ratio by stratum was observed. Therefore, it appears that the survey period (April-May for the cold season and September-October for the warm season) corresponded indeed to the spawning periods (particularly the warm season, which was the main spawning period), and that there are geographical variations at the spawning level.

The sex ratio did not present a sharp size-dependent change. In all classes (except those where the number of samples was too low, not considered here), the state of male/female equilibrium was more or less maintained.

In the cold season, the mantle length at first maturity was observed at the 6-7cm class for males and at the 8-9cm class for females. In the warm season, the length class at first maturity was of 7-8cm for males and 6-7cm for females. Those length class is roughly equal to the mode classes of the small-size group, the above Sc and Sw, which are estimated to correspond to the age group of half a year old. This result suggested that precocious individuals in the youngs start to spawn at half a year old. At this stage, it is unknown whether prematurity of young octopus means a biological compensation to decrease in the octopus stock.

f) Feeding habits

Table 3.112 (page 3-349) presents the stomach condition and the stomach content composition of the common octopus in each survey season. Figure 3.84 (page 3-350) presents the relationship between the mantle length and SSI and SCW.

The ratio of the empty stomach varied between 55 and 97%. The relationship between the mantle length and SSI and SCW showed that the largest individuals consume great quantities of food, while the small-size individuals are voracious eaters for their body weight.

The common octopus feeds on mollusks (bivalves, cuttlefish or squid), crustaceans and fish (the red pandora *Pagellus bellottii*, etc.).

Table 3.109 Body length range and mean body length for common octopus *Octopus vulgaris* : ML in mm.

(A) *Amrigue* survey area

Northern coastal area (Stratum: 3-20m)	Phase 1						Phase 2					
	Cold season			Warm season			Cold season			Warm season		
	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
Banc d'Arguin	0			0			0			1	65	65.0
Other	0			0			6	20 ~ 80	55.0	4	65 ~ 120	86.3
All area	0			0			6	20 ~ 80	55.0	5	65 ~ 120	82.0

(B) *Al-Awam* survey area

Subarea	Stratum	Phase 1						Phase 2					
		Cold season			Warm season			Cold season			Warm season		
		Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean	Specimens	Range	Mean
North	3-20m	-	-	-	-	-	-	3	70 ~ 186	112.0	1	160	160.0
	20-30m	34	50 ~ 230	96.0	3	98 ~ 192	131.3	0			10	55 ~ 180	121.5
	30-80m	69	45 ~ 205	95.1	84	54 ~ 200	95.2	34	40 ~ 250	100.5	65	65 ~ 230	125.9
	80-200m	49	55 ~ 135	102.2	53	50 ~ 150	83.5	24	30 ~ 185	99.2	52	47 ~ 155	89.1
	200-400m	0			0			-	-	-	2	110 ~ 168	139.0
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	152	45 ~ 230	97.6	140	50 ~ 200	91.5	61	30 ~ 250	100.5	130	47 ~ 230	111.3
Central	3-20m	-	-	-	43	50 ~ 175	88.3	75	25 ~ 150	79.3	45	60 ~ 208	98.5
	20-30m	90	30 ~ 165	71.2	71	58 ~ 135	89.4	5	61 ~ 154	93.0	36	50 ~ 152	93.3
	30-80m	228	60 ~ 200	117.6	163	46 ~ 200	108.6	83	40 ~ 240	133.4	50	55 ~ 195	102.7
	80-200m	252	39 ~ 173	92.6	58	50 ~ 174	97.5	119	35 ~ 240	112.1	43	65 ~ 180	116.1
	200-400m	0			0			1	95	95.0	0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	570	30 ~ 200	99.3	335	46 ~ 200	100.0	283	25 ~ 240	109.3	174	50 ~ 208	103.0
South	3-20m	-	-	-	0			0			0		
	20-30m	2	100 ~ 125	112.5	36	60 ~ 160	110.9	0			2	112 ~ 122	117.0
	30-80m	170	35 ~ 215	104.1	88	62 ~ 230	130.2	34	110 ~ 233	159.4	75	46 ~ 200	131.4
	80-200m	128	52 ~ 190	102.4	39	42 ~ 210	105.2	88	28 ~ 225	113.0	29	48 ~ 170	108.8
	200-400m	0			0			0			0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	300	35 ~ 215	103.4	163	42 ~ 230	119.9	122	28 ~ 233	125.9	106	46 ~ 200	125.0

Remark. - : no trawl.

Figure3.81 (A) continued.

North 3-20m (Area : 3912 km²)

No trawl

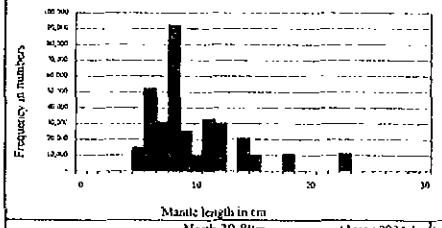
Central 3-20m (Area : 2783 km²)

No trawl

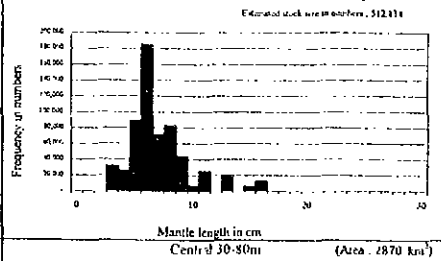
South 3-20m (Area : 1485 km²)

No trawl

North 20-30m (Area : 1250 km²)



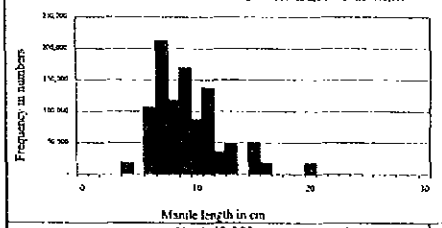
Central 20-30m (Area : 835 km²)



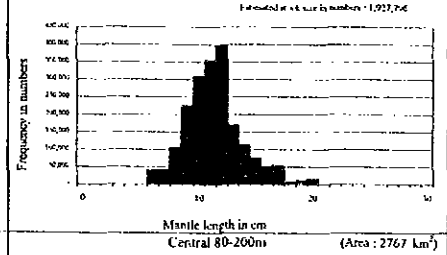
South 20-30m (Area : 805 km²)

No data for size composition

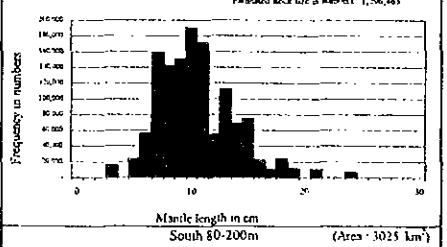
North 30-80m (Area : 2924 km²)



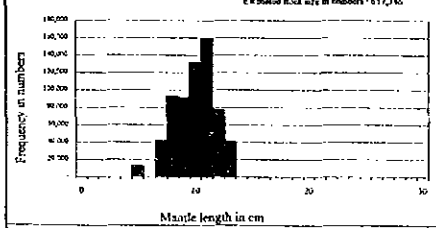
Central 30-80m (Area : 2870 km²)



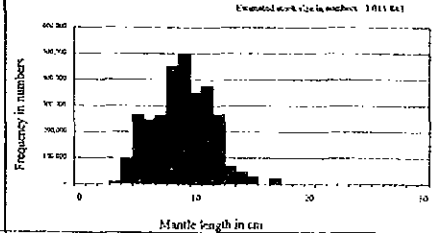
South 30-80m (Area : 2640 km²)



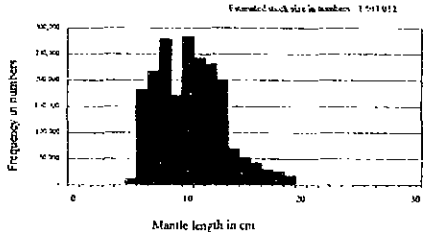
North 80-200m (Area : 1147 km²)



Central 80-200m (Area : 2767 km²)



South 80-200m (Area : 3025 km²)



North 200-400m (Area : 936 km²)

No data for size composition

Central 200-400m (Area : 1453 km²)

No data for size composition

South 200-400m (Area : 994 km²)

No data for size composition

North 400-600m (Area : 738 km²)

No trawl

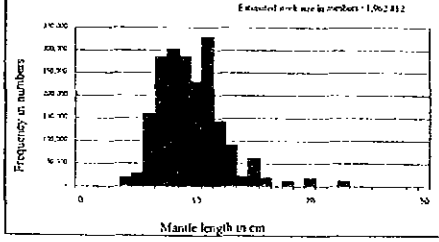
Central 400-600m (Area : 848 km²)

No trawl

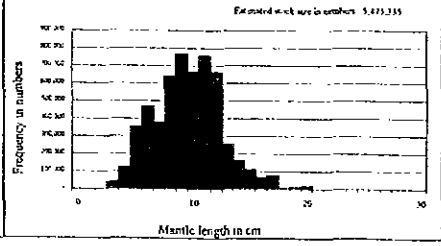
South 400-600m (Area : 583 km²)

No trawl

North Total (Area : 17698 km²)



Central Total (Area : 29244 km²)



South Total (Area : 21058 km²)

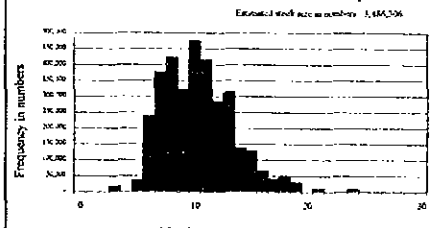


Figure3.81 (B) continued.

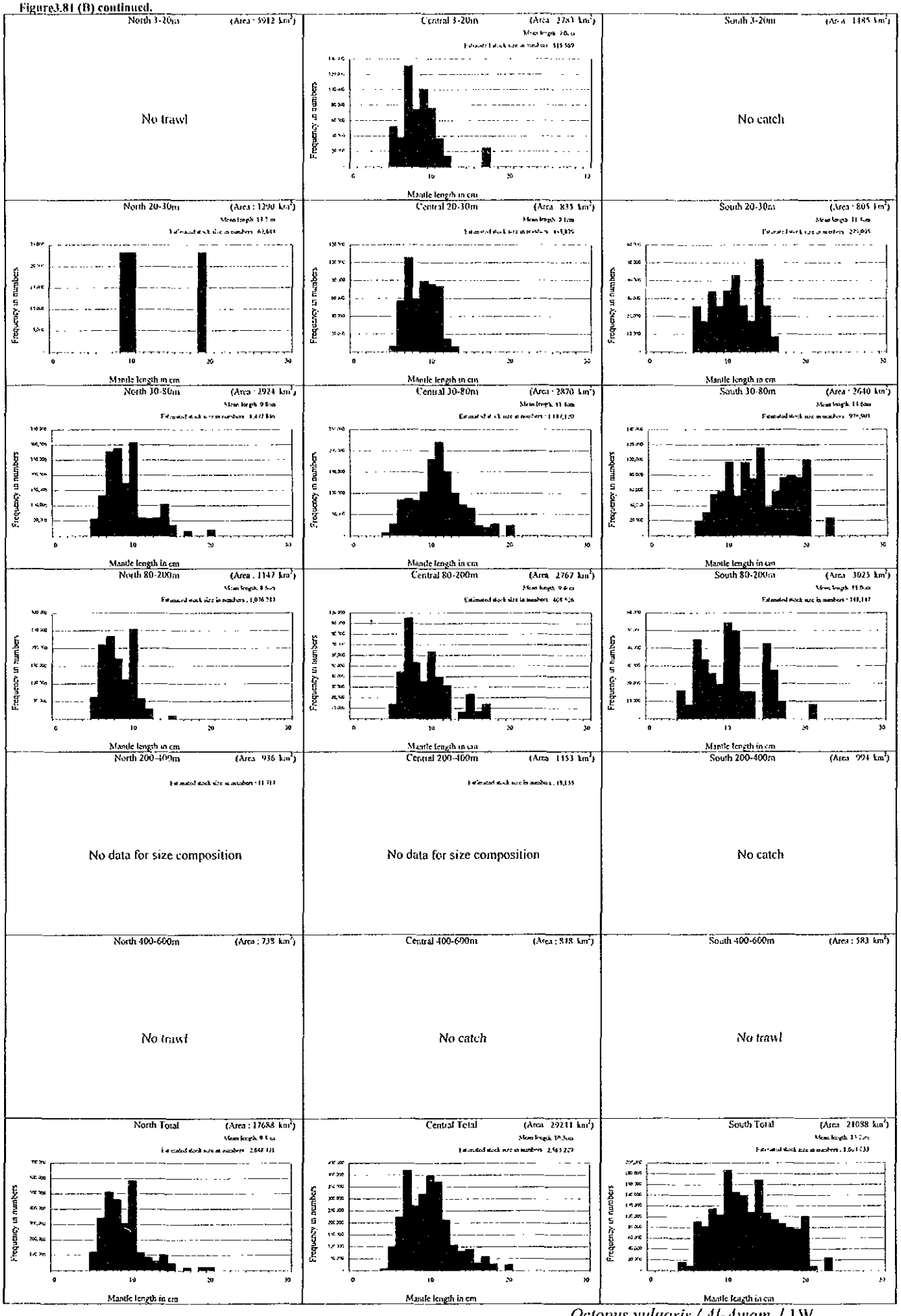


Figure3.81 (C) continued.

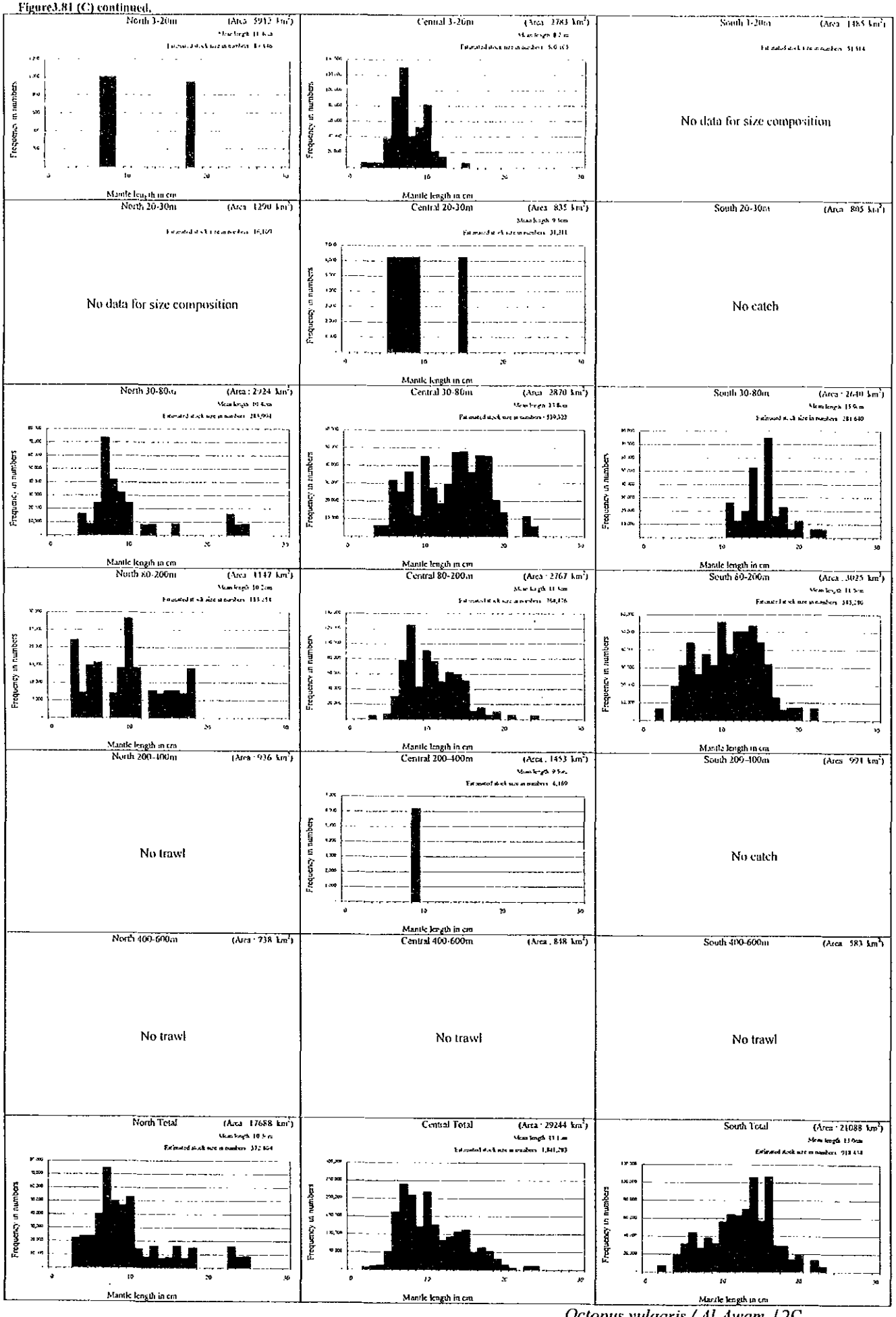


Figure3.81 (I) continued.

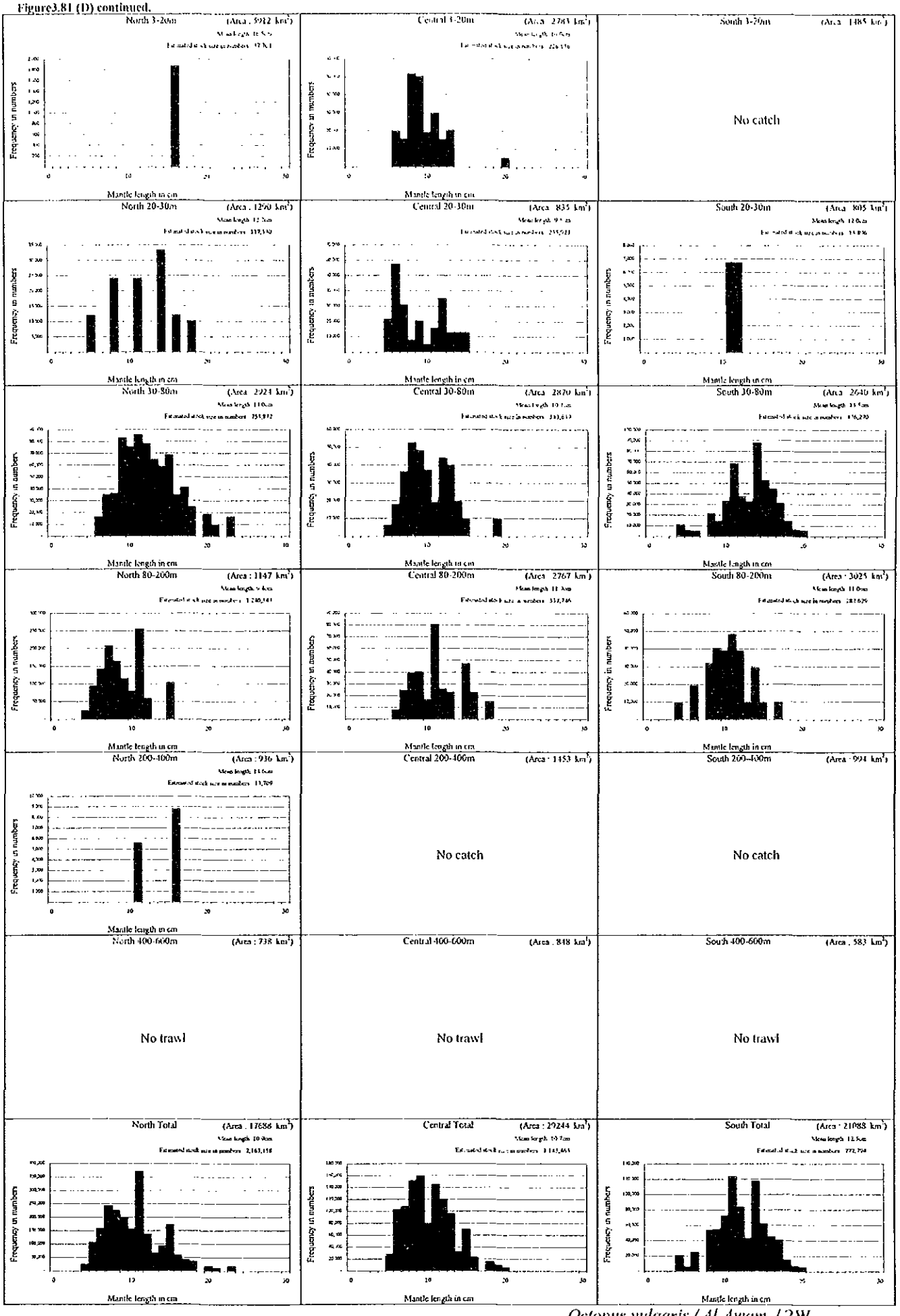


Table 3.110 Body length and weight by sex for common octopus *Octopus vulgaris*.

(A) *Amrigue* survey area

Phase	Season	Sex	Individuals of specimens	Mantle length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
2	Cold	Male	5	20 ~ 80	56.0	30.0 ~ 380.0	172.0
		Female	1	50	50.0	125.0	125.0
		Indeterminate	0				
		Total	6	20 ~ 80	55.0	30.0 ~ 380.0	164.2
	Warm	Male	4	65 ~ 95	72.5	205.0 ~ 440.0	325.0
		Female	1	120	120.0	1,350.0	1,350.0
		Indeterminate	0				
		Total	5	65 ~ 120	82.0	205.0 ~ 1,350.0	530.0

(B) *Al-Awam* survey area

Phase	Season	Sex	Individuals of specimens	Mantle length in mm		Body weight in g	
				Range	Mean	Range	Mean
1	Cold	Male	504	35 ~ 230	100.4	15.0 ~ 6,380.0	853.5
		Female	515	36 ~ 200	100.5	30.0 ~ 4,157.0	729.1
		Indeterminate	3	30 ~ 35	31.7	35.0 ~ 55.0	46.7
		Total	1022	30 ~ 230	100.2	15.0 ~ 6,380.0	788.4
	Warm	Male	292	42 ~ 205	103.5	90.0 ~ 7,200.0	937.7
		Female	325	46 ~ 230	105.3	85.0 ~ 4,535.0	892.2
		Indeterminate	21	50 ~ 110	67.1	140.0 ~ 490.0	271.1
		Total	638	42 ~ 230	103.2	85.0 ~ 7,200.0	892.6
2	Cold	Male	206	25 ~ 250	118.1	30.0 ~ 6,920.0	1,151.7
		Female	246	40 ~ 240	110.5	50.0 ~ 4,350.0	861.2
		Indeterminate	12	30 ~ 110	56.8	14.0 ~ 695.0	207.0
		Total	464	25 ~ 250	112.5	14.0 ~ 6,920.0	973.2
	Warm	Male	196	49 ~ 230	116.3	50.0 ~ 5,510.0	1,078.0
		Female	214	46 ~ 180	106.7	40.0 ~ 2,515.0	740.0
		Indeterminate	0				
		Total	410	46 ~ 230	111.3	40.0 ~ 5,510.0	901.6

Table 3.111 Sex ratio and female maturity stage for common octopus *Octopus vulgaris*.

(A) *Amrigue* survey area

Northern coastal area	Phase 1 cold season							Phase 1 warm season						
	Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
(Stratum: 3-20m)	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
Banc d'Arguin	0	0	E					0	0	E				
Other	0	0	E					0	0	E				
All area	0	0	E					0	0	E				

Northern coastal area	Phase 2 cold season							Phase 2 warm season						
	Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
(Stratum: 3-20m)	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
Banc d'Arguin	0	0	E					0	1	E				
Other	1	5	5.00	100.0	0.0	0.0	0.0	1	3	3.00	0.0	0.0	100.0	0.0
All area	1	5	5.00	100.0	0.0	0.0	0.0	1	4	4.00	0.0	0.0	100.0	0.0

(B) *Al-Awam* survey area

Subarea	Stratum	Phase 1 cold season							Phase 1 warm season						
		Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
		♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
North	3-20m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	20-30m	17	17	1.00	64.7	29.4	5.9	0.0	3	0	0.00	66.7	0.0	0.0	33.3
	30-80m	28	41	1.46	92.9	7.1	0.0	0.0	43	41	0.95	55.8	0.0	41.9	2.3
	80-200m	32	17	0.53	53.1	37.5	9.4	0.0	28	25	0.89	89.3	7.1	3.6	0.0
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	77	75	0.97	70.1	24.7	5.2	0.0	74	66	0.89	68.9	2.7	25.7	2.7
Central	3-20m	-	-	-	-	-	-	-	19	23	1.21	57.9	42.1	0.0	0.0
	20-30m	31	56	1.81	93.5	6.5	0.0	0.0	42	25	0.60	34.1	36.6	29.3	0.0
	30-80m	115	115	1.02	67.3	27.4	4.4	0.9	77	72	0.94	26.0	41.6	32.5	0.0
	80-200m	150	102	0.68	84.7	15.3	0.0	0.0	25	35	1.32	20.0	32.0	44.0	4.0
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E				
	All stratum	294	273	0.93	78.9	19.0	1.7	0.3	163	153	0.94	30.9	38.9	29.6	0.6
South	3-20m	-	-	-	-	-	-	-	0	0	E				
	20-30m	0	2	E					20	15	0.75	60.0	5.0	35.0	0.0
	30-80m	51	59	1.16	70.6	21.6	7.8	0.0	44	43	0.98	25.0	40.9	34.1	0.0
	80-200m	93	95	1.02	75.0	15.2	8.7	1.1	24	15	0.63	45.8	20.8	33.3	0.0
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	144	156	1.08	73.4	17.5	8.4	0.7	88	75	0.83	38.6	27.3	34.1	0.0
All	3-20m	-	-	-	-	-	-	-	19	23	1.21	57.9	42.1	0.0	0.0
	20-30m	48	75	1.56	83.3	14.6	2.1	0.0	65	40	0.62	43.8	25.0	29.7	1.6
	30-80m	192	215	1.12	71.9	22.9	4.7	0.5	164	156	0.95	33.5	30.5	35.4	0.6
	80-200m	275	214	0.78	77.7	17.9	4.0	0.4	77	73	0.95	53.2	19.5	26.0	1.3
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E				
	All stratum	515	504	0.98	76.1	19.5	4.1	0.4	325	292	0.90	41.7	27.5	29.9	0.9

Subarea	Stratum	Phase 2 cold season							Phase 2 warm season						
		Specimens		Sex ratio	♀ : maturity stage* (%)				Specimens		Sex ratio	♀ : maturity stage* (%)			
		♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
North	3-20m	2	1	0.50	0.0	50.0	50.0	0.0	0	1	E				
	20-30m	0	0	E					5	5	1.00	60.0	20.0	20.0	0.0
	30-80m	17	17	1.00	94.1	5.9	0.0	0.0	36	29	0.81	22.2	13.9	61.1	2.8
	80-200m	13	7	0.54	76.9	15.4	7.7	0.0	24	28	1.17	41.7	20.8	37.5	0.0
	200-400m	-	-	-	-	-	-	-	2	0	0.00	50.0	0.0	50.0	0.0
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	32	25	0.78	81.3	12.5	6.3	0.0	67	63	0.94	32.8	16.4	49.3	1.5
Central	3-20m	41	31	0.76	92.7	7.3	0.0	0.0	20	25	1.25	84.2	15.8	0.0	0.0
	20-30m	3	2	0.67	100.0	0.0	0.0	0.0	15	21	1.40	60.0	20.0	20.0	0.0
	30-80m	41	39	0.95	41.5	29.3	26.8	2.4	36	14	0.39	30.6	33.3	36.1	0.0
	80-200m	63	54	0.86	74.2	21.0	4.8	0.0	20	23	1.15	45.0	10.0	30.0	15.0
	200-400m	1	0	0.00	0.0	100.0	0.0	0.0	0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	149	126	0.85	70.3	19.6	9.5	0.7	91	83	0.91	50.0	22.2	24.4	3.3
South	3-20m	0	0	E					0	0	E				
	20-30m	0	0	E					2	0	0.00	50.0	50.0	0.0	0.0
	30-80m	15	19	1.27	33.3	13.3	53.3	0.0	35	40	1.14	40.0	31.4	28.6	0.0
	80-200m	50	36	0.72	64.0	30.0	6.0	0.0	19	10	0.53	42.1	36.8	21.1	0.0
	200-400m	0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	65	55	0.85	56.9	26.2	16.9	0.0	56	50	0.89	41.1	33.9	25.0	0.0
All	3-20m	43	32	0.74	88.4	9.3	2.3	0.0	20	26	1.30	84.2	15.8	0.0	0.0
	20-30m	3	2	0.67	100.0	0.0	0.0	0.0	22	26	1.18	59.1	22.7	18.2	0.0
	30-80m	73	75	1.03	52.1	20.5	26.0	1.4	107	83	0.78	30.8	26.2	42.1	0.9
	80-200m	126	97	0.77	70.4	24.0	5.6	0.0	63	61	0.97	42.9	22.2	30.2	4.8
	200-400m	1	0	0.00	0.0	100.0	0.0	0.0	2	0	0.00	50.0	0.0	50.0	0.0
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	246	206	0.84	68.2	20.4	11.0	0.4	214	196	0.92	42.3	23.5	32.4	1.9

Remarks. * I: Immature, II: Semi-mature, III: Mature, IV: Spent. -: no trawl. E: Error blank: no data.

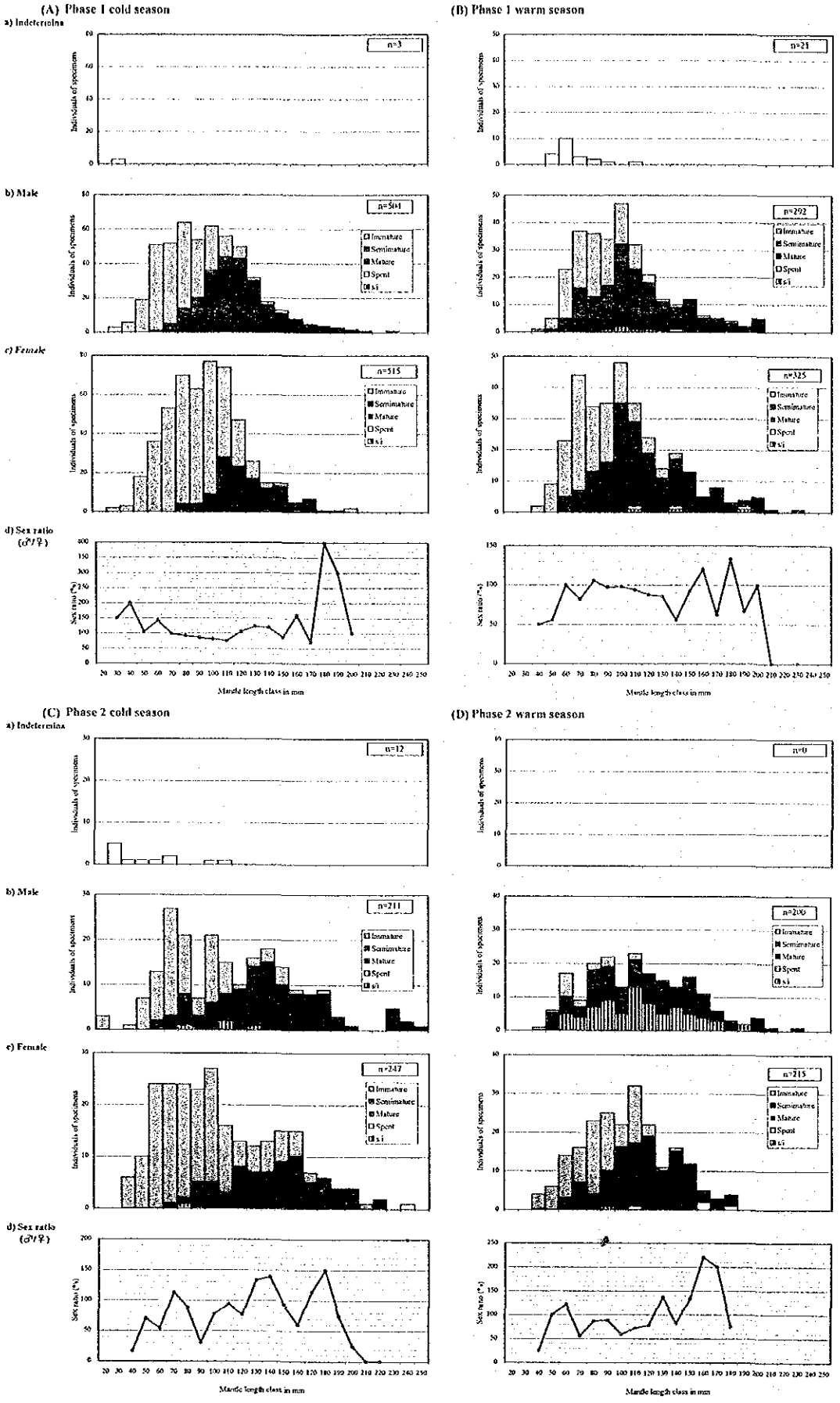


Figure 3.83 Sex ratio and female maturity stage by length class for common octopus *Octopus vulgaris*.

Table 3.112 Stomach content analysis of common octopus *Octopus vulgaris*.

(A) Stomach condition

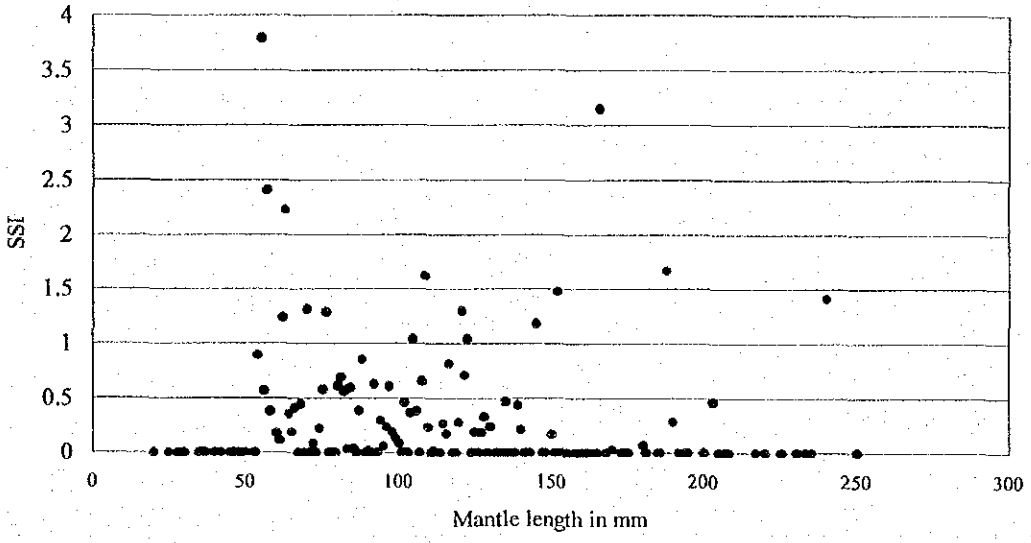
Phase	Season	Stomach condition			Stomach content Somatic Index (SSI)			
		n*	Empty (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	217	54.84	45.16	137	0.00	5.97	0.27
	Warm	402	88.06	11.94	399	0.00	9.42	0.22
2	Cold	344	97.09	2.91	344	0.00	37.22	0.27
	Warm	163	57.67	42.33	134	0.00	18.52	1.19

(B) Stomach contents

Phase	Season	n*	Mollusca		Crustacea	Fish		Unknown
			Bivalvia	Decapoda		*Pagellus bellottii*	Other	
1	Cold	98	12.24	5.10	8.16		1.02	74.49
	Warm	48		4.17	14.58		2.08	79.17
2	Cold	10				10.00	20.00	70.00
	Warm	58	27.59	1.72	3.45			67.24

Remark. * : Individuals of specimens.

(A) Relationship between mantle length and SSI



(B) Relationship between mantle length and SCW

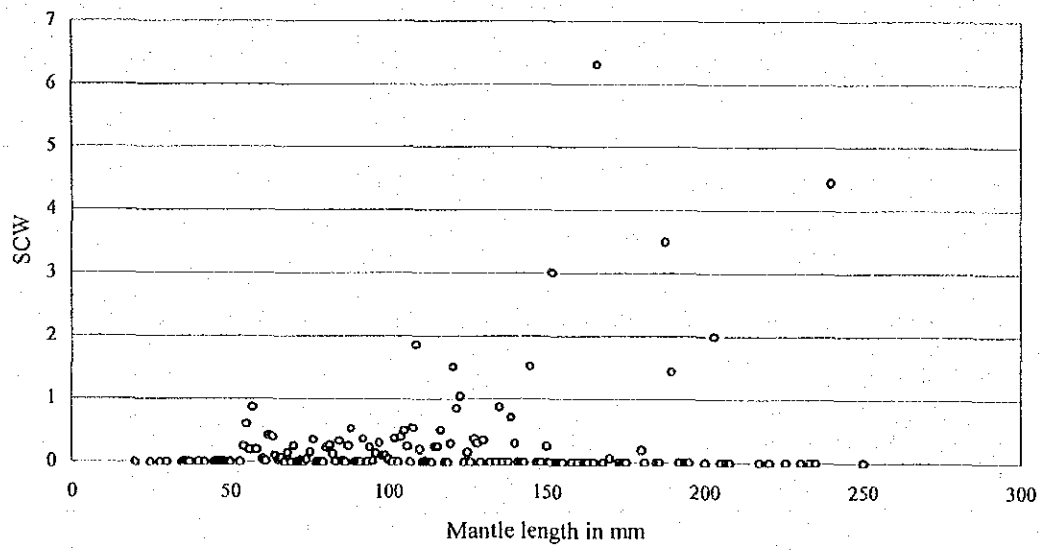


Figure 3.84 Relationship between body length and SSI (A) and SCW (B) for common octopus *Octopus vulgaris*.