4) White grouper *Epinephelus aeneus*

a) Body length range and mean body length

Table 3.65 (page 3-188) presents the minimum, maximum and mean total lengths obtained for the white grouper in each survey season and at each stratum in each area.

The number of samples of this species collected in the areas surveyed by the *Amrigue* and the *Al-Awam* were respectively 10 and 110 individuals. The total length was between 55 and 313 mm for the area surveyed by the *Amrigue* and between 42 and 960 mm for that surveyed by the *Al-Awam*.

In the latter case, the mean total length by area was high in the Northern area in the warm season and in the Central and Southern areas in the cold season. The mean total length by stratum in each area was higher in deep strata than in shallow strata.

b) Size composition

Figure 3.37 (page 3-185, 3-189 to 3-192) shows the evaluation of the size composition for the white grouper stock. The total length class is indicated at intervals of 5 cm. For convenience three groups were defined: (i) small-size (total length less than 30 cm), (ii) medium-size (length between 30 and 60 cm), (iii) large-size (length over 60 cm).

The total stock size in number for the white grouper essentially comprised the small and/or medium-size groups. Frequency of occurrence of the large-size group was low (none in the Phase 2), except in the Phase 1 cold season where instances were numerous enough to be studied. The size composition at each stratum in each area shows that, regardless of season, the small-size group was distributed only at strata less than 30 m depth in the Southern area (and in part of the Central area). Also, large-size group occurred in the Central area and/or in the Southern area. In the Northern area, the white grouper stock comprised the medium-size group in all seasons. According to Dah *et al.* (1991), juveniles (less than 25 cm) would be concentrated south of 18° N. The finding that the small-size group only occur in the coastal zone is compatible with those observations.

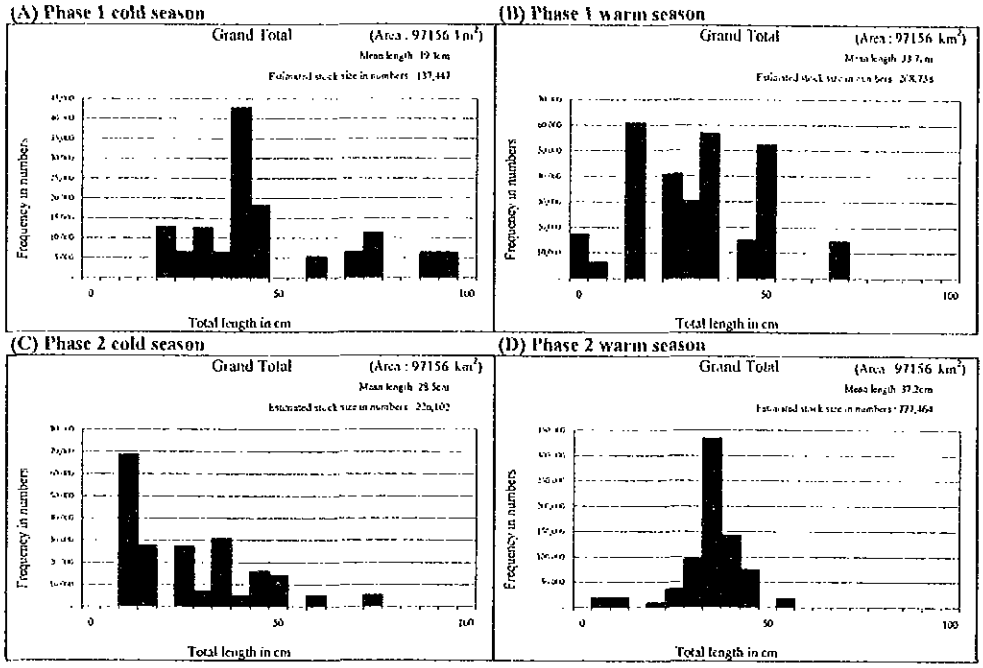


Figure 3.37 Size composition for white grouper *Epinephelus aeneus*.

c) Length-weight relationship

Figure 3.38 presents the length-weight relationship for the white grouper. The length-weight equations obtained from all samples (areas surveyed by the *Amrigue* and the *Al-Awam*) were the following:

Phase 1 cold season	: BW=	$6.595\times10^{-3}\times TL^{3.186}$	(r=0.9982)
Phase 1 warm season	: BW=	$3.000\times10^{-2}\times TL^{2.760}$	(r=0.9811)
Phase 2 cold season	: BW=	$5.959\times10^{-3}\times TL^{3.217}$	(r=0.9971)
Phase 2 warm season	: BW=	$1.300\times10^{-2}\times TL^{2.999}$	(r=0.9979)

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

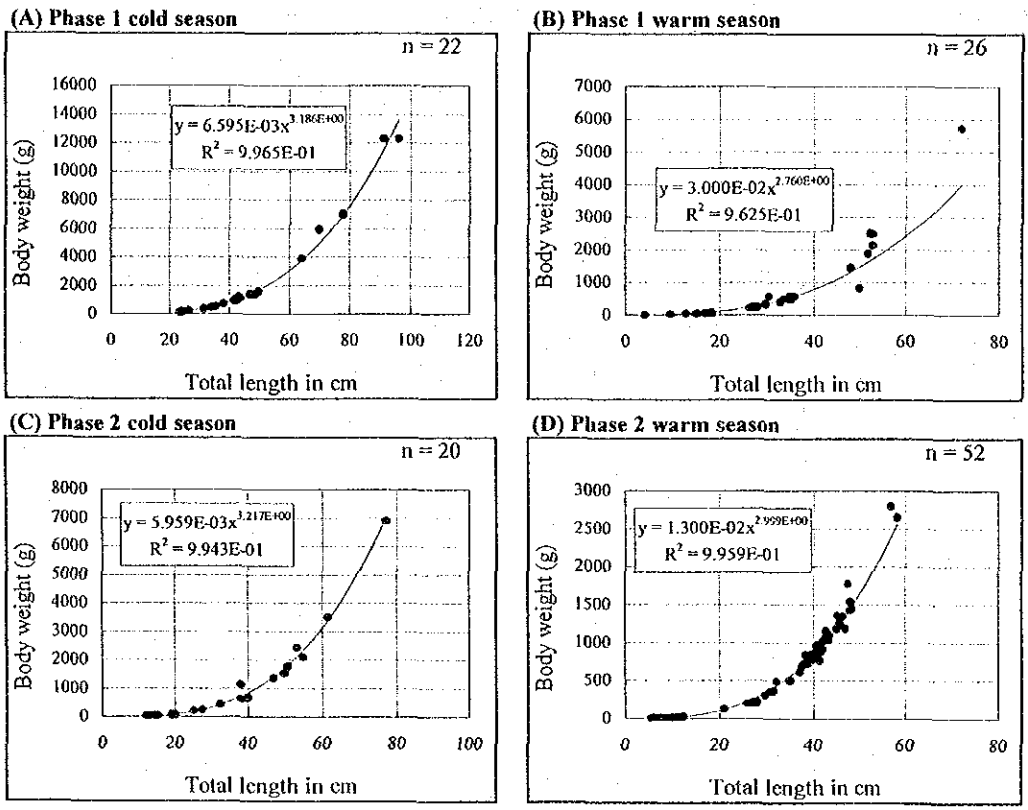


Figure 3.38 Length-weight relationship for white grouper *Epinephelus aeneus*.

d) Length and weight by sex

Table 3.66 (page 3-193) summarizes the total length and body weight observed in each sex for the white grouper.

In the area surveyed by the *Amrigue*, only one female and one male were measured by sex for sampling. Their total length and weight were respectively 313 mm and 390 g for the female, and 190 mm and 175 g for the male.

In the area surveyed by the *Al-Awam*, the total length varied between 250 and 960 mm for males and between 233 and 910 mm for females. In the cold season, the mean total length of males was larger than that

of females, while in the warm season it was the other way round. In males and females, individuals size enough for sex determination by visual inspection were a total length of 25 and 23 cm for the early ones, of 40 and 50 cm for the late ones respectively.

According to Fish Base, the white grouper is a protogynous hermaphrodite species. The result that male individuals with developed gonads were smaller than females with those in simultaneously obtained samples is likely to be an error in sex determination.

e) Sex ratio and female maturity stage

Table 3.67 (page 3-194) presents the sex ratio and the female maturity stage for the white grouper. Figure 3.39 (page 3-195) presents their distribution by length class.

In survey order, the overall sex ratio of this species was successively 0.31, 3.00, 1.17 and 0.62. Available samples were too few and no definitive conclusions could be drawn on its variation and seasonal, geographical or vertical distribution characteristics.

In the Phase 1 cold season, a single mature female was observed. This specimen was 910 mm in total length, and was caught at the 30-80 m stratum in the Central area. Again, the small size of the sample precludes any definitive conclusions on the size-dependent of the sex ratio.

f) Feeding habits

Table 3.68 (page 3-196) presents the stomach condition and the stomach content composition of the white grouper in each survey season. Figure 3.40 (page 3-197) presents the relationship between body length and SSI and SCW.

The ratio of the empty stomachs varied between 60 and 74%. The relationship between body 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 white grouper mainly feeds on fish (carangids, sparids, pandora, etc.) as well as on crustaceans (crabs, shrimp). Polychaetes (Phase 1 cold season) and gastropods (Phase 2 cold season) were also found in its stomach.

Table 3.65 Body length range and mean body length for white grouper *Epinephelus aeneus* : 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	0			2	130 ~ 153	141.5	2	150 ~ 190	170.0	5	55 ~ 102	75.6
Other	1	313	313.0	0			0			0		
All area	1	313	313.0	2	130 ~ 153	141.5	2	150 ~ 190	170.0	5	55 ~ 102	75.6

(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	-	-	-	-	-	-	1	323	323.0	5	310 ~ 415	348.0
	20-30m	3	417 ~ 435	428.0	1	530	530.0	2	380 ~ 470	425.0	8	372 ~ 470	399.5
	30-80m	0			0			0			19	321 ~ 570	434.6
	80-200m	0			0			0			0		
	200-400m	0			0			-	-	-	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	3	417 ~ 435	428.0	1	530	530.0	3	323 ~ 470	391.0	32	310 ~ 570	412.3
Central	3-20m	-	-	-	5	360 ~ 721	516.2	3	496 ~ 770	626.7	5	380 ~ 480	441.2
	20-30m	6	430 ~ 776	541.0	0			0			1	92	92.0
	30-80m	3	775 ~ 960	881.7	0			0			0		
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	9	430 ~ 960	654.6	5	360 ~ 721	516.2	3	496 ~ 770	626.7	6	92 ~ 480	383.0
South	3-20m	-	-	-	16	42 ~ 530	264.5	12	120 ~ 549	302.8	8	112 ~ 583	266.6
	20-30m	9	233 ~ 700	378.6	1	297	297.0	0			1	307	307.0
	30-80m	0			1	305	305.0	0			0		
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	9	233 ~ 700	378.6	18	42 ~ 530	268.6	12	120 ~ 549	302.8	9	112 ~ 583	271.1

Remark. - : no trawl.

Figure3.37 (A) continued.

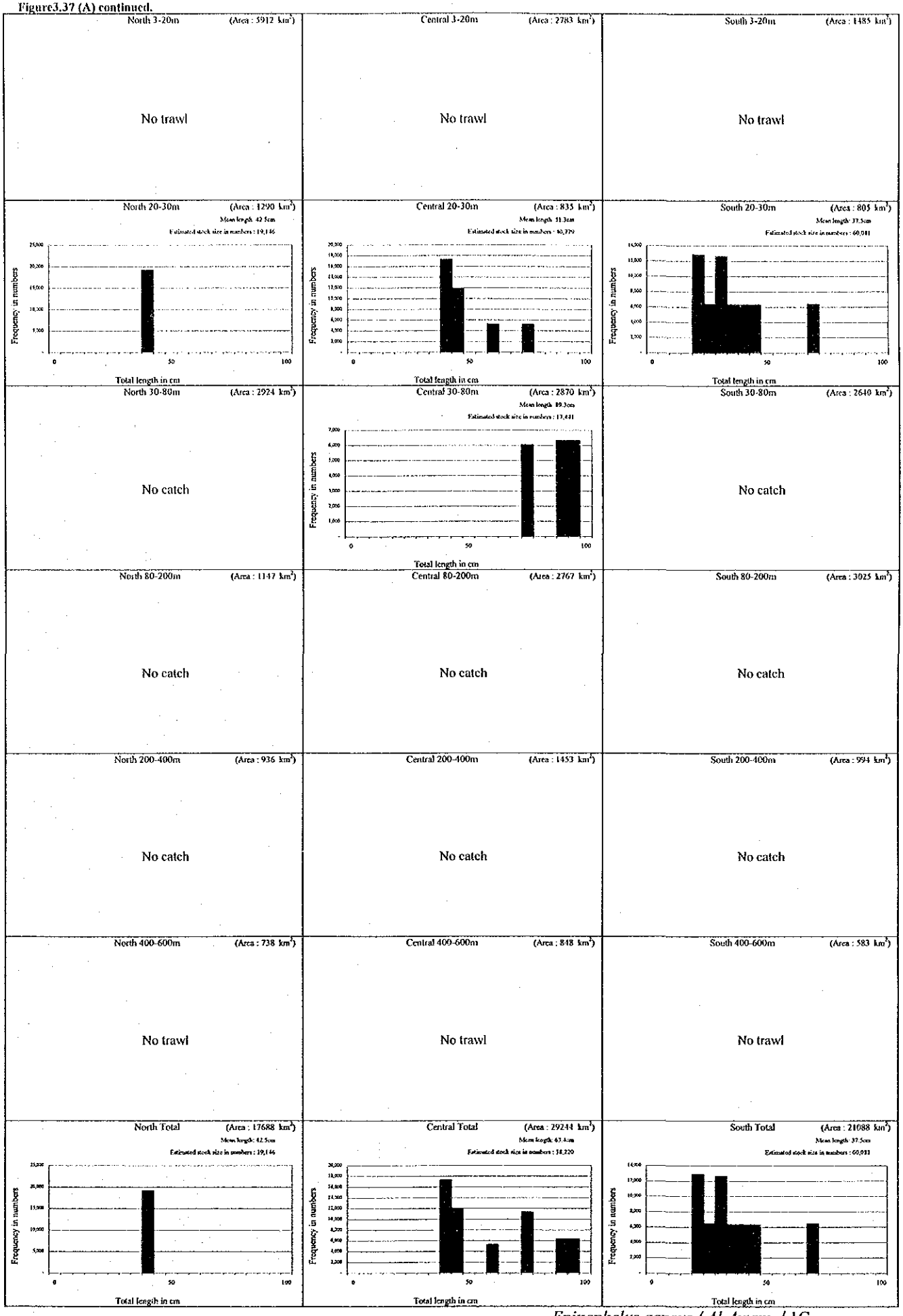


Figure3.37 (B) continued.

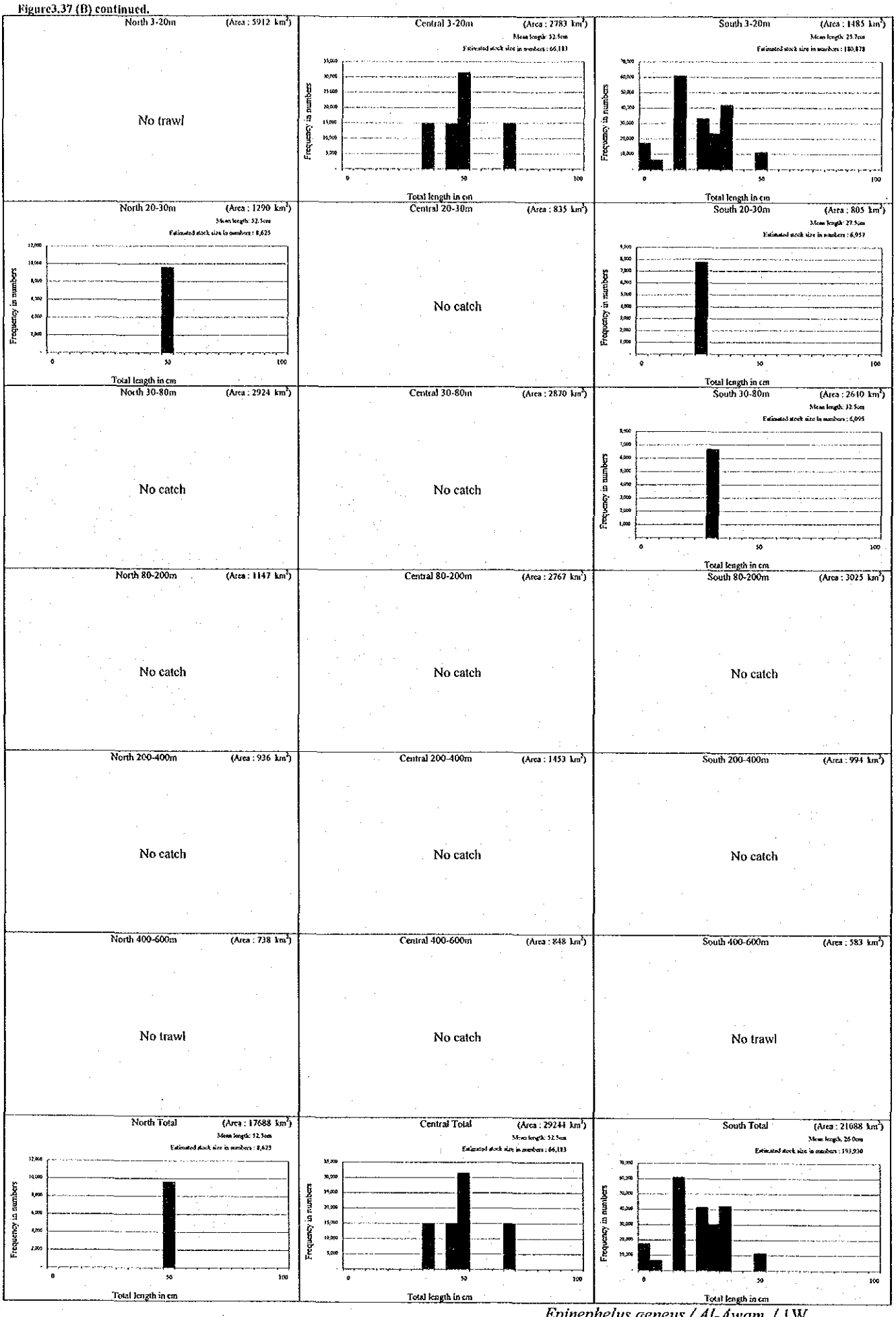


Figure3.37 (C) continued.

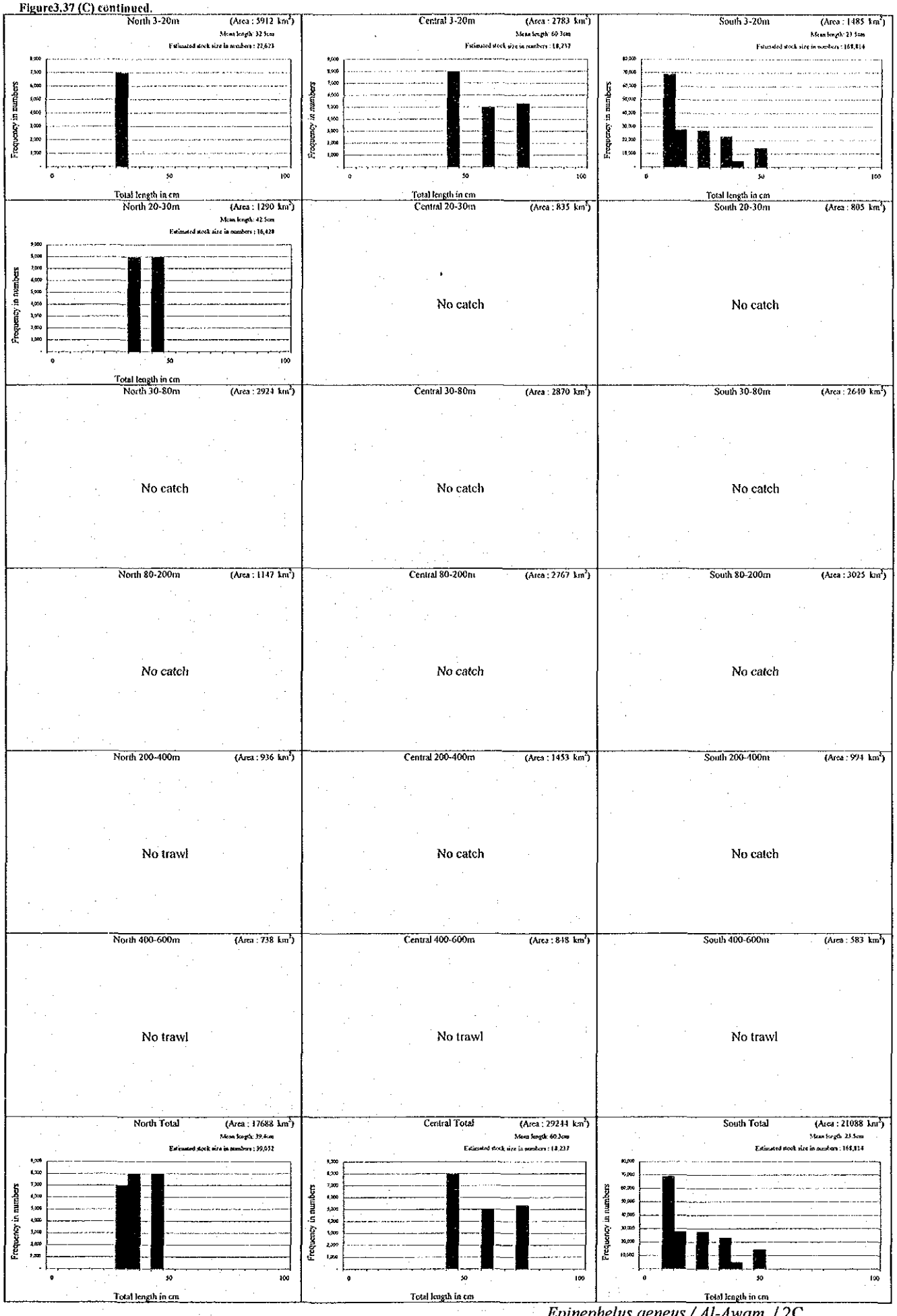


Figure3.37 (D) continued.

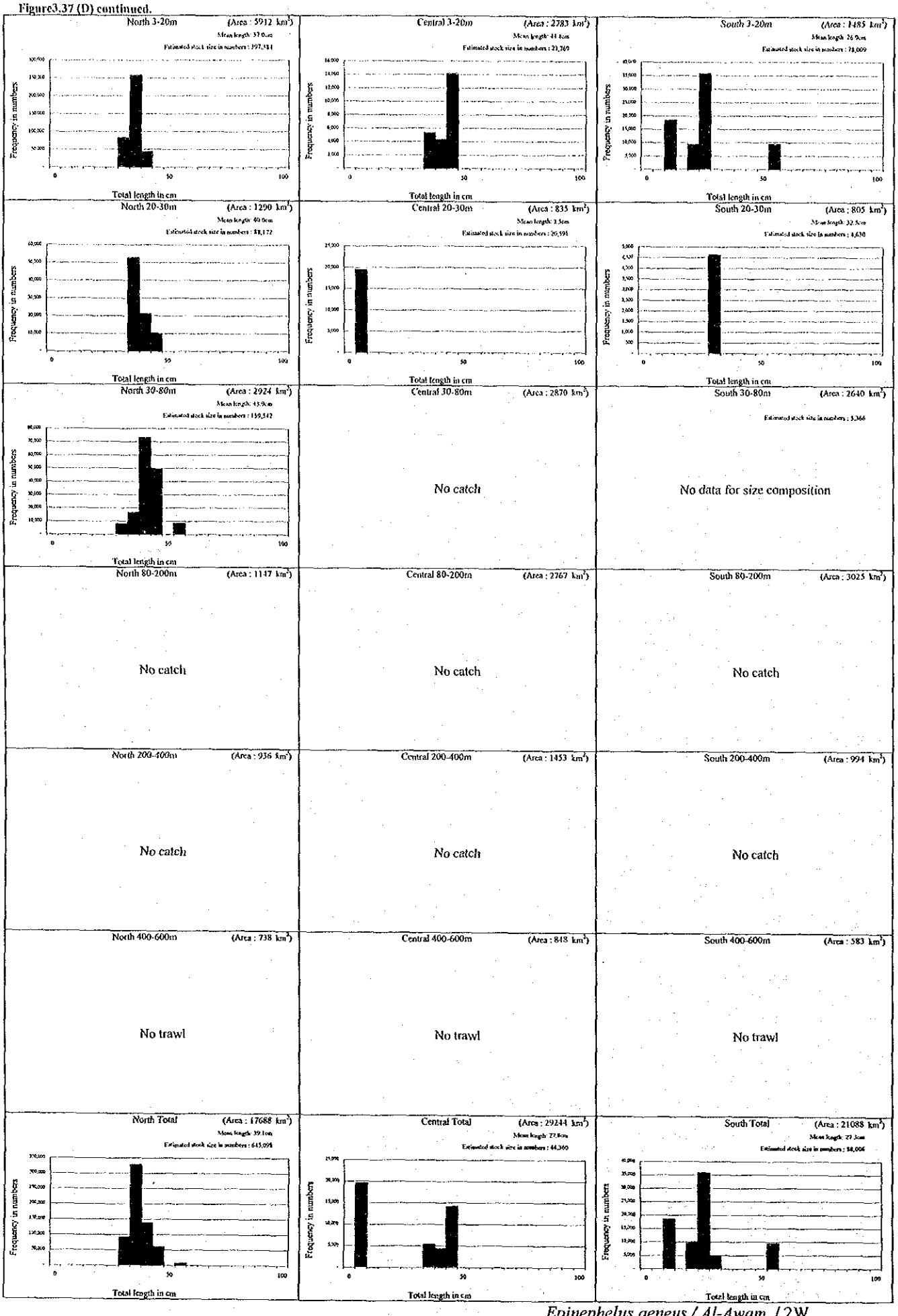


Table 3.66 Body length and weight by sex for white grouper *Epinephelus aeneus*.

(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	1	313	313.0	390.0	390.0
		Indeterminate	0				
		Total	1	313	313.0	390.0	390.0
	Warm	Male	0				
		Female	0				
		Indeterminate	2	130 ~ 153	141.5	27.0 ~ 42.0	34.5
		Total	2	130 ~ 153	141.5	27.0 ~ 42.0	34.5
2	Cold	Male	1	190	190.0	75.0	75.0
		Female	0				
		Indeterminate	1	150	150.0	35.0	35.0
		Total	2	150 ~ 190	170.0	35.0 ~ 75.0	55.0
	Warm	Male	0				
		Female	0				
		Indeterminate	5	55 ~ 102	75.6	2.8 ~ 12.0	6.3
		Total	5	55 ~ 102	75.6	2.8 ~ 12.0	6.3

(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	5	432 ~ 960	716.6	1,165.0 ~ 12,300.0	6,273.0
		Female	16	233 ~ 910	437.4	160.0 ~ 12,300.0	1,868.8
		Indeterminate	0				
		Total	21	233 ~ 960	503.9	160.0 ~ 12,300.0	2,917.4
	Warm	Male	6	297 ~ 530	444.5	350.0 ~ 2,525.0	1,592.5
		Female	2	500 ~ 520	510.0	840.0 ~ 1,900.0	1,370.0
		Indeterminate	16	42 ~ 721	266.1	5.0 ~ 5,725.0	581.9
		Total	24	42 ~ 721	331.0	5.0 ~ 5,725.0	900.2
2	Cold	Male	7	250 ~ 770	480.4	210.0 ~ 6,900.0	2,205.7
		Female	6	323 ~ 530	429.8	425.0 ~ 2,445.0	1,253.3
		Indeterminate	5	120 ~ 199	148.8	20.0 ~ 85.0	39.0
		Total	18	120 ~ 770	371.4	20.0 ~ 6,900.0	1,286.4
	Warm	Male	16	270 ~ 477	390.1	215.0 ~ 1,775.0	832.2
		Female	26	257 ~ 583	416.9	195.0 ~ 2,805.0	1,064.8
		Indeterminate	5	92 ~ 310	169.8	10.0 ~ 355.0	105.0
		Total	47	92 ~ 583	381.5	10.0 ~ 2,805.0	883.5

Table 3.67 Sex ratio and female maturity stage for white grouper *Epinephelus aeneus*.

(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	1	E					0	0	E				
Other	1	0	0.00	100.0	0.0	0.0	0.0	0	0	E					0	0	E					0	0	E				
All area	1	0	0.00	100.0	0.0	0.0	0.0	0	0	E					0	1	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	0.00	100.0	0.0	0.0	0.0	3	1	0.33	100.0	0.0	0.0	0.0
	20-30m	2	1	0.50	100.0	0.0	0.0	0.0	0	1	E					2	0	0.00	100.0	0.0	0.0	0.0	2	6	3.00	100.0	0.0	0.0	0.0
	30-80m	0	0	E					0	0	E					0	0	E					14	5	0.36	78.6	21.4	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	1	0.50	100.0	0.0	0.0	0.0	0	1	E					3	0	0.00	100.0	0.0	0.0	0.0	19	12	0.63	84.2	15.8	0.0	0.0
Central	3-20m	-	-	-	-	-	-	-	2	1	0.50	100.0	0.0	0.0	0.0	1	2	2.00	100.0	0.0	0.0	0.0	3	2	0.67	100.0	0.0	0.0	0.0
	20-30m	4	2	0.50	100.0	0.0	0.0	0.0	0	0	E					0	0	E					0	0	E				
	30-80m	1	2	2.00	0.0	0.0	100.0	0.0	0	0	E					0	0	E					0	0	E				
	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	5	4	0.80	80.0	0.0	20.0	0.0	2	1	0.50	100.0	0.0	0.0	0.0	1	2	2.00	100.0	0.0	0.0	0.0	3	2	0.67	100.0	0.0	0.0	0.0
South	3-20m	-	-	-	-	-	-	-	0	2	E					2	5	2.50	100.0	0.0	0.0	0.0	4	1	0.25	100.0	0.0	0.0	0.0
	20-30m	9	0	0.00	88.9	11.1	0.0	0.0	0	1	E					0	0	E					0	1	E				
	30-80m	0	0	E					0	1	E					0	0	E					0	0	E				
	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	9	0	0.00	88.9	11.1	0.0	0.0	0	4	E					2	5	2.50	100.0	0.0	0.0	0.0	4	2	0.50	100.0	0.0	0.0	0.0
All	3-20m	-	-	-	-	-	-	-	2	3	1.50	100.0	0.0	0.0	0.0	4	7	1.75	100.0	0.0	0.0	0.0	10	4	0.40	100.0	0.0	0.0	0.0
	20-30m	15	3	0.20	93.3	6.7	0.0	0.0	0	2	E					2	0	0.00	100.0	0.0	0.0	0.0	2	7	3.50	100.0	0.0	0.0	0.0
	30-80m	1	2	2.00	0.0	0.0	100.0	0.0	0	1	E					0	0	E					14	5	0.36	78.6	21.4	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					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	16	5	0.31	87.5	6.3	6.3	0.0	2	6	3.00	100.0	0.0	0.0	0.0	6	7	1.17	100.0	0.0	0.0	0.0	26	16	0.62	88.5	11.5	0.0	0.0

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

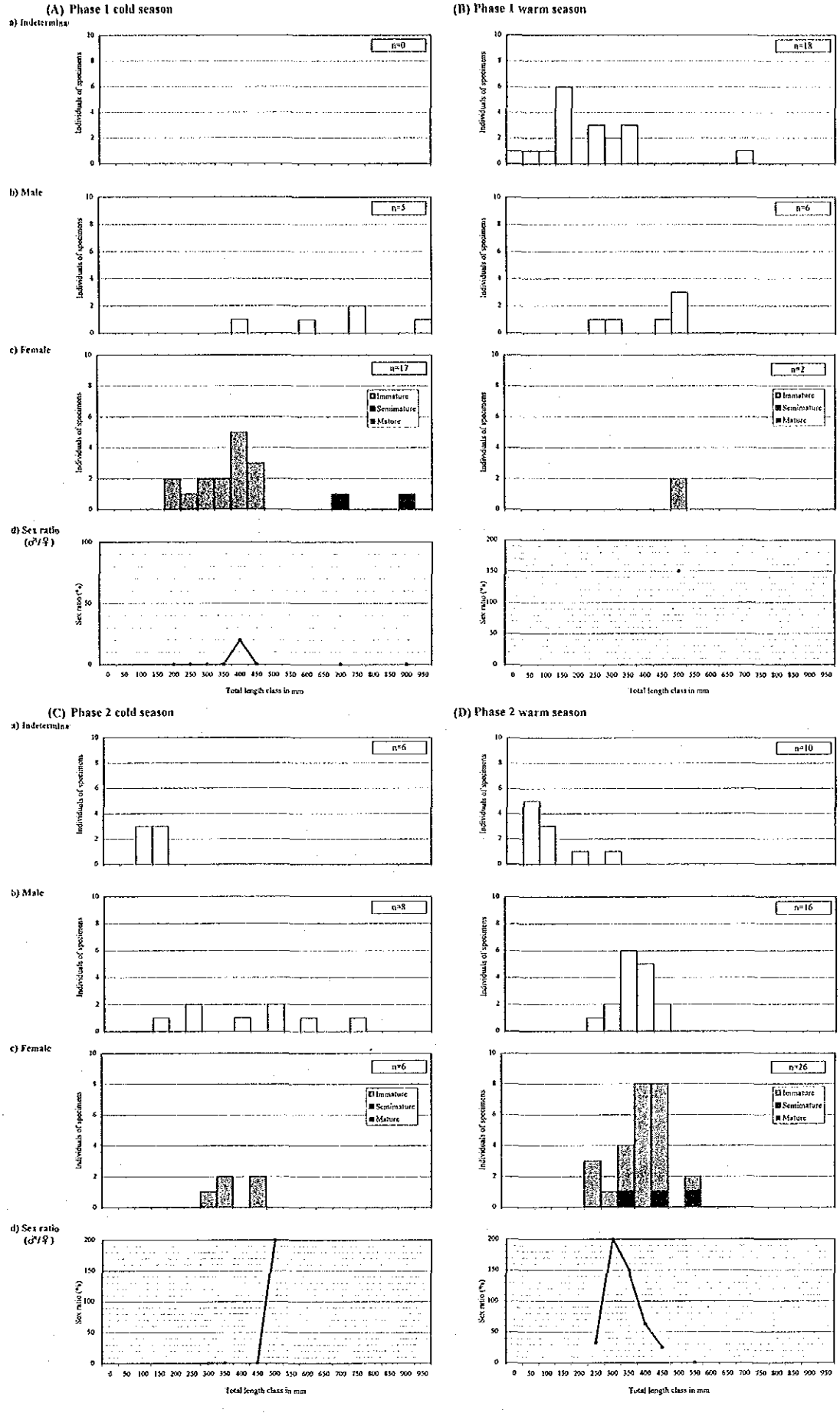


Figure 3.39 Sex ratio and female maturity stage by length class for white grouper *Epinephelus aeneus*.

Table 3.68 Stomach content analysis of white grouper *Epinephelus aeneus*.

(A) Stomach condition

Phase	Season	Stomach condition				Stomach content Somatic Index (SSI)			
		n*	Empty (%)	Evert (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	22	63.64	4.55	31.82	21	0.00	41.03	5.54
	Warm	23	73.91	0.00	26.09	23	0.00	16.30	1.78
2	Cold	12	66.67	0.00	33.33	12	0.00	24.76	5.41
	Warm	50	60.00	0.00	40.00	50	0.00	142.86	11.70

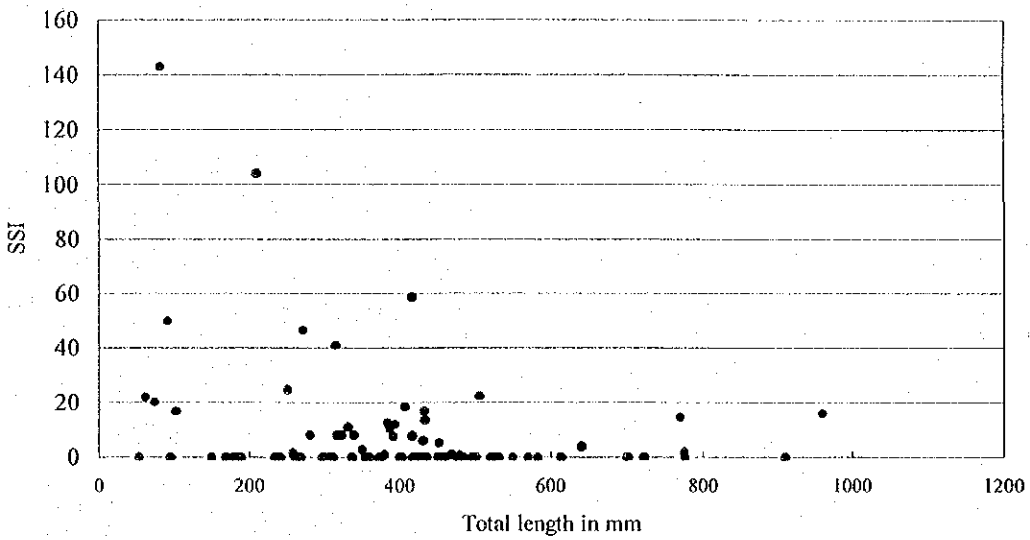
(B) Stomach contents

Phase	Season	n*	Mollusca	Polychaeta	Crustacea			
			Gastropoda		*Penaeus kerathurus*	Shrimp	Crab	Other
1	Cold	188		14.29			28.57	
	Warm	91					16.67	16.67
2	Cold	175	25.00					
	Warm	110			5.00	5.00		

Phase	Season	Fish				Unknown
		Carangidae sp.	*Pagellus* sp.	Sparidae sp.	Other	
1	Cold			14.29	28.57	14.29
	Warm				33.33	33.33
2	Cold				75.00	25.00
	Warm	5.00	5.00		20.00	60.00

Remark. * : Individuals of specimens.

(A) Relationship between total length and SSI



(B) Relationship between total length and SCW

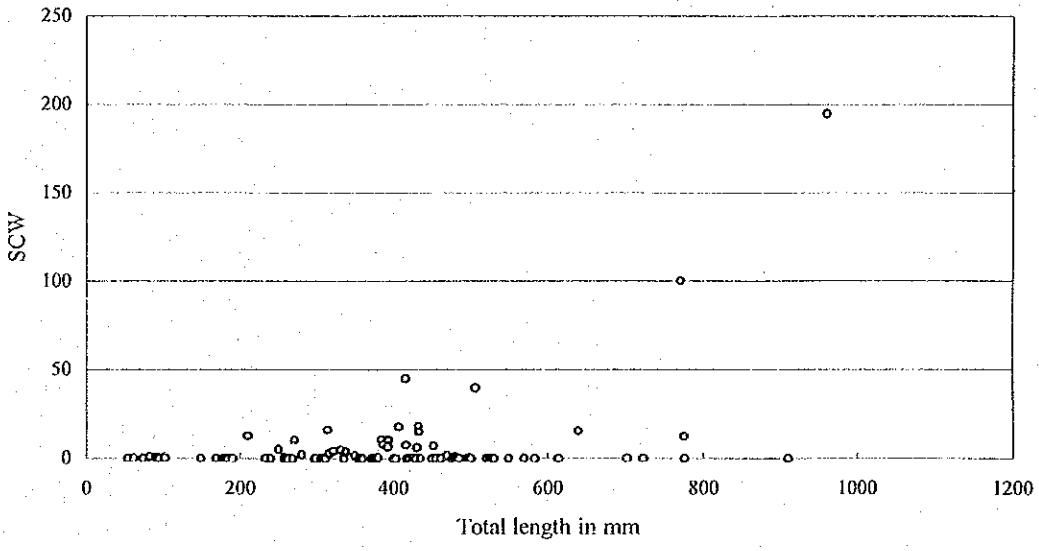


Figure 3.40 Relationship between body length and SSI (A) and SCW (B) for white grouper *Epinephelus aeneus*.

5) Cunene horse mackerel *Trachurus trecae*

At first, the Cunene horse mackerel was not a target species. But the results of the Phase 1 cold season demonstrated that it comprised the most stock size of all (however its stock size was not shown in Table 3.20, about 40% of the total stock size), and considering its economical value, it was indeed targeted only for the biological survey since the following warm season in Phase 1. This explains why there are no biological data for this species in the Phase 1 cold season.

a) Body length range and mean body length

Table 3.69 (page 3-203) presents the minimum, maximum and mean fork lengths obtained for the Cunene horse mackerel in each survey season at each stratum in each area. The considerations below are mainly based on the results of Phase 2.

The fork length of this species varied between 63 and 440 mm. According to Chevance *et al.* (1991), maximum fork length of the Cunene horse mackerel found in the territorial waters of the IRM would be 43 cm, a value practically identical to the one found in the present survey.

The mean fork length by area was higher in the Northern area in the warm season and in the other two areas in the cold season. Also, in the cold season, the mean fork length was high in the Southern area and declined northwards.

The mean fork length by stratum exhibited a depth-dependent change. In the cold season, the geographical difference in the depth-dependent change of the mean fork length was observed: in the Northern area, the mean fork length was large in shallow strata and decreased with depth, while in the Central and Southern areas, it was the other way round. In the warm season, the mean fork length by stratum was high in deep strata and low in shallow strata (although the reverse happened in the Northern and Southern areas in Phase 1).

b) Size composition

Figure 3.41 (page 3-200, 3-204 to 3-206) illustrates the evaluation of the size composition for the Cunene horse mackerel stock. The fork length class is indicated at intervals of 1 cm. For convenience, three groups were defined: (i) small-size (fork length less than 15 cm), (ii) medium-size (length between 15 and 30 cm), (iii) large-size (length over 30 cm).

The size composition of the total stock size in number showed a bi-modal distribution in the Phase 1 warm season and in the Phase 2 cold season, and a mono-modal distribution in the Phase 2 warm season. The bi-modal distribution had one dominant mode at classes around 10 cm and another mode at classes around 20 cm, while the dominant mode in the mono-modal distribution occurred at the 10-11 cm class. Both in the cold and in the warm seasons, the total stock size in number for the Cunene horse mackerel was composed mainly of the small-size group with mode class at around 10 cm. In both seasons except the last warm season, it also included the medium-size group (with mode classes of around 20 cm).

According to FAO (1989), the Cunene horse mackerel found in the territorial waters of the IRM spawns in September-October and in March-April. Also, results of age determination from otoliths obtained by Ba *et al.* (1990) indicated that at one year of age, fork length would be 17.4 cm; at two years, 22.48 cm; at three years, 26.34 cm; at four years, 29.5 cm; at five years, 32.05 cm; at six years, 34.14 cm; at seven years,

35.85 cm; at eight years, 37.24 cm; at nine years, 38.37 cm; and at ten years, 39.3 cm. From those data, it is conceivable that the small-size group observed in the cold season (survey period: April-May) originated from spawn in September-October of the previous year, and that seen in the warm season (survey period: September-October) did from spawn in March-April of the same year. The medium-size group also suggests growth and survival of the small-size group during the transitional periods -- namely, the three months between the cold and the warm seasons and the six months between the warm and cold seasons of the following year. (A survival rate of about 17% was calculated from the number of the small-size individuals at a modal class in the Phase 1 warm season and that of the medium-size individuals with a modal class in the Phase 2 cold season.) However, it is not known whether the absence of a clear mode indicating a group of the medium-size individuals in the Phase 2 warm season is due to either (i) the total mortality of the small-size individuals in the cold season of the same phase during the transitional period, (ii) to a displacement outward the survey area, or (iii) to an integration to the group of the small-size individuals following poor growth caused by environmental conditions (a low peak mode was observed at the 13–14 cm class).

The distribution of the three size groups was studied from their size composition at each stratum in each area. The small-size group was distributed at various strata in each area regardless of season, but the stock number was much higher in the Central area, particularly at the 30-80 m stratum in the cold season and at the 80-200 m stratum in the warm season. In the cold season, the medium-size group was concentrated in the Central and Southern areas, particularly in the 30-80 m stratum in the Southern area, while in the warm season it concentrated in the Northern area, particularly in the 30-80 m stratum. In the cold season, the large-size group lumped together at the strata deeper than 80 m in the Central and Southern areas, while in the warm season it was only found at the 80-200 m stratum in the Northern area. These results indicate that, if the small-size group is widely distributed during all seasons in coastal areas of the IRM, the medium- and large-size groups are concentrated in different areas according to the season: in the Central and Southern areas in the cold season and in the Northern area in the warm season.

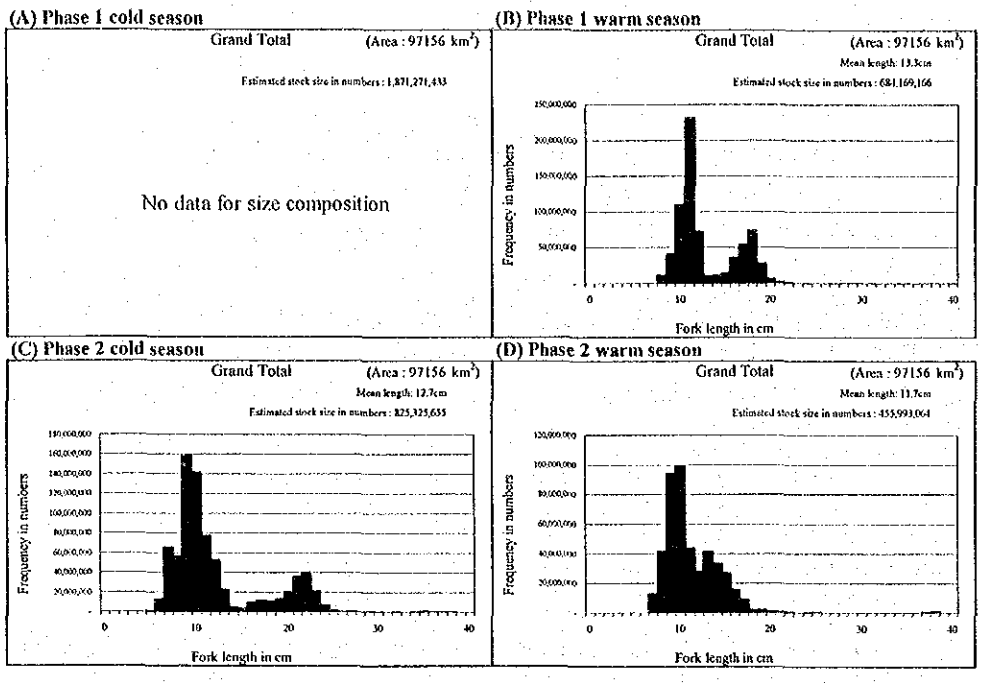


Figure 3.41 Size composition for Cunene horse mackerel *Trachurus trecae.*

c) *Length-weight relationship*

Figure 3.42 (page 3-201) presents the relationship between fork length and weight for the Cunene horse mackerel. The length-weight equations obtained from all samples were the following:

Phase 1 warm season	: BW=	$1.550\times10^{-2}\times FL^{2.918}$	(r=0.9818)
Phase 2 cold season	: BW=	$1.143\times10^{-2}\times FL^{3.035}$	(r=0.9931)
Phase 2 warm season	: BW=	$1.224\times10^{-2}\times FL^{3.011}$	(r=0.9941)

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

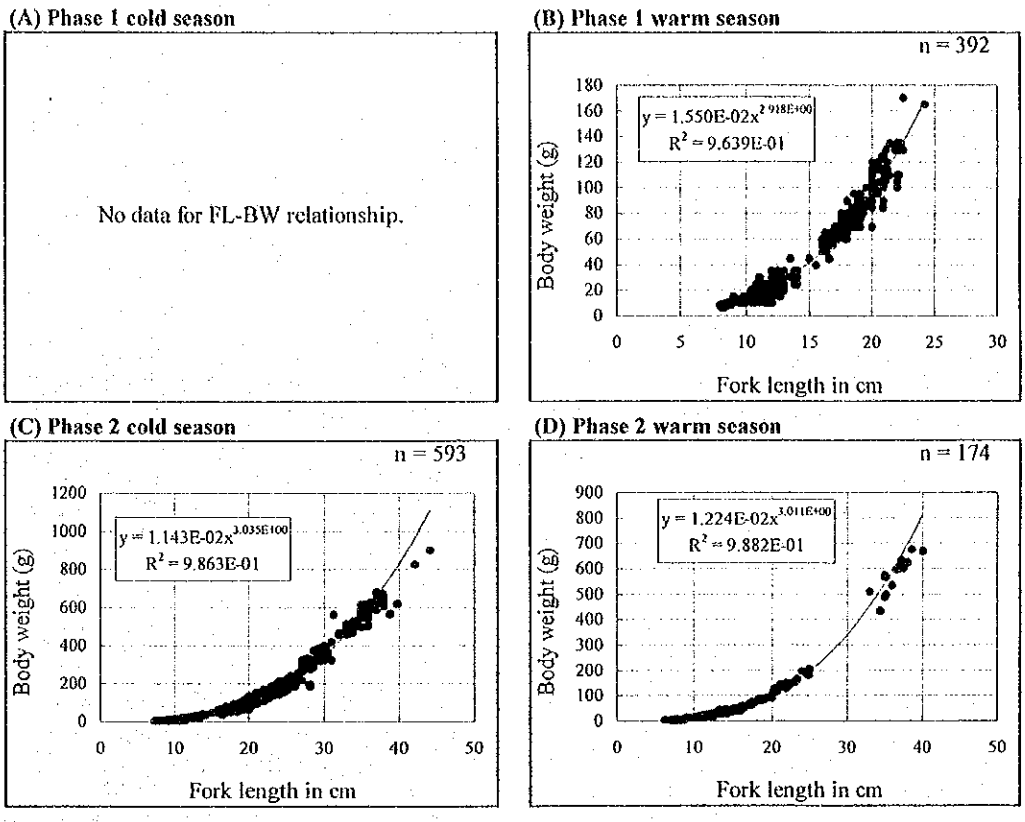


Figure 3.42 Length-weight relationship for Cunene horse mackerel *Trachurus trecae.*

d) Length and weight by sex

Table 3.70 (page 3-207) summarizes the fork length and body weight observed in each sex for the Cunene horse mackerel.

The relative size of males and females varied in each season: in survey order, larger females, males and females of about the same size and larger males. In both males and females, gonads were recognizable from a fork length of approximately 10 cm onwards. However, considering that the fork length of individuals of indetermined sex often surpassed 20 cm, it is conceivable that individual differences in gonadal development were significant.

e) Sex ratio and female maturity stage

Table 3.71 (page 3-208) summarizes the sex ratio and the female maturity stage for the Cunene horse mackerel. Figure 3.43 (page 3-209) presents their distribution by length class.

In the warm season, females were dominant (overall sex ratio of 0.52 in Phase 1 and of 0.60 in Phase 2), while males were dominant in the cold season (overall sex ratio of 1.54). In the warm season, the overall sex ratio indicated a predominance of females, but the sex ratio in the Southern area was 1.71 in Phase 2.

In Phase 2, the female maturity ratio over the entire area was 16% in the cold season and 18% in the warm season. The female maturity ratio by area was 0%, 8% and 41% from north to south in the cold season and 31%, 4% and 0% in the warm season. By stratum, the female maturity ratio over the entire area was

respectively 23% and 33% at the 80-200 m and 200-400 m strata in the cold season, and 16% and 30% at the 30-80 m and 80-200 m strata in the warm season.

Those results suggest the Cunene horse mackerel spawns mainly in the Southern area in the cold season and in the Northern area in the warm season, and at strata deeper in the cold than in the warm season. According to Josse *et al.* (1990), the Cape Blanc region is the main spawning area of the Cunene horse mackerel in the cold season. Those observations are different from the conclusions suggested by the obtained results, but it is not known whether that is due to a displacement from the main spawning site.

As for the sex ratio by length class, the size-dependent was not clearly observed. In the cold season, males were predominant in most length classes. In the warm season, females were majoritary in classes below 17 cm fork length, minoritary in classes between 17 and 25 cm, and predominant again in classes beyond 33 cm fork length.

The fork length at first maturity was at the 22-23 cm class, which corresponds more or less to the sexual maturation length for females previously recorded for the territorial waters of the IRM (over 24 cm according to Chavance *et al.*, 1991).

f) Feeding habits

Table 3.72 (page 3-210) presents the stomach condition and the stomach content composition of the Cunene horse mackerel in each survey season. Figure 3.44 (page 3-211) presents the relationship between fork length and SSI and SCW.

The ratio of the empty stomachs varied between 52 and 99%. The relationship between fork length and SSI observed for the four other species above, namely a SSI higher in smaller individuals, was not clearly observed. On the other hand, the relationship between fork length and SCW is similar, namely an ingested quantity that increased with body size.

Information on feeding habits of the Cunene horse mackerel was based on data from the Phase 2 warm season, where the ratio of the empty stomachs in the stomach condition and of unknown in the stomach content were lower. The Cunene horse mackerel feeds mainly on crustaceans (mysidacans, shrimp, etc.), but also on fish, mollusks (squid) and polychaetes.

Table 3.69 Body length range and mean body length for Cunene horse mackerel *Trachurus trecae* : 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	0			0			0			0		
Other	0			0			0			0		
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	-	-	-	-	-	-	20	100 ~ 223	185.7	0		
	20-30m	0			40	165 ~ 220	191.0	20	95 ~ 220	167.9	0		
	30-80m	0			80	105 ~ 212	165.6	60	112 ~ 244	165.4	80	63 ~ 372	170.9
	80-200m	0			40	107 ~ 180	141.3	60	100 ~ 214	151.4	3	375 ~ 385	380.0
	200-400m	0			0			-	-	-	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	0			160	105 ~ 220	165.9	160	95 ~ 244	163.0	83	63 ~ 385	178.4
Central	3-20m	-	-	-	0			0			0		
	20-30m	0			0			40	75 ~ 230	151.7	0		
	30-80m	0			20	105 ~ 175	116.6	80	85 ~ 371	188.9	40	92 ~ 233	147.8
	80-200m	0			80	98 ~ 242	138.4	119	165 ~ 440	250.9	11	92 ~ 400	174.5
	200-400m	0			0			0			0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	0			100	98 ~ 242	134.0	239	75 ~ 440	213.5	51	92 ~ 400	153.6
South	3-20m	-	-	-	0			0			0		
	20-30m	0			0			0			0		
	30-80m	0			92	80 ~ 225	140.6	60	73 ~ 350	227.0	40	85 ~ 250	163.1
	80-200m	0			40	97 ~ 140	111.1	120	200 ~ 388	274.9	0		
	200-400m	0			0			14	215 ~ 350	293.9	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	0			132	80 ~ 225	131.7	194	73 ~ 388	261.5	40	85 ~ 230	163.1

Remark. - : no trawl.

Figure3.41 (B) continued.

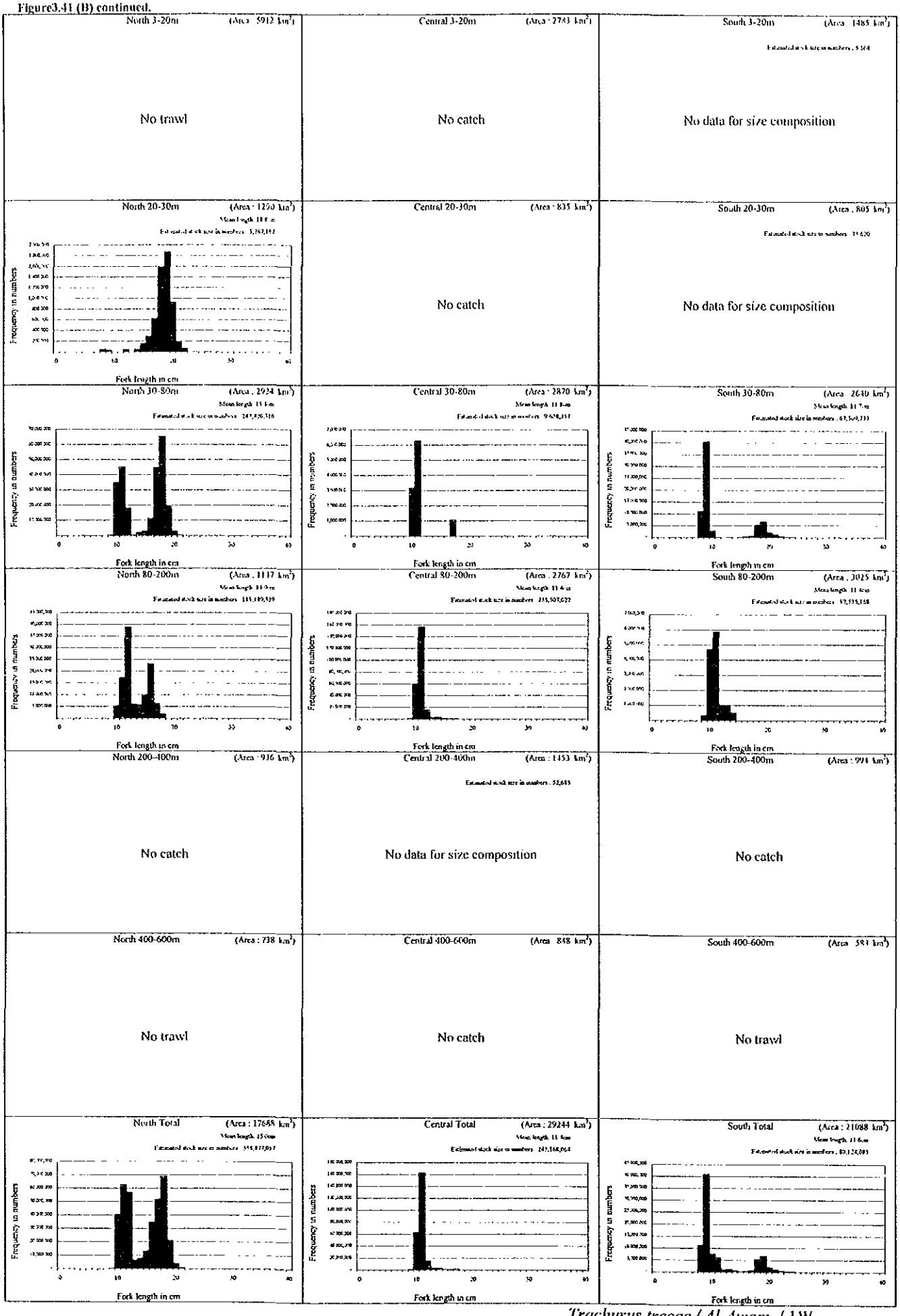


Figure3.41 (C) continued.

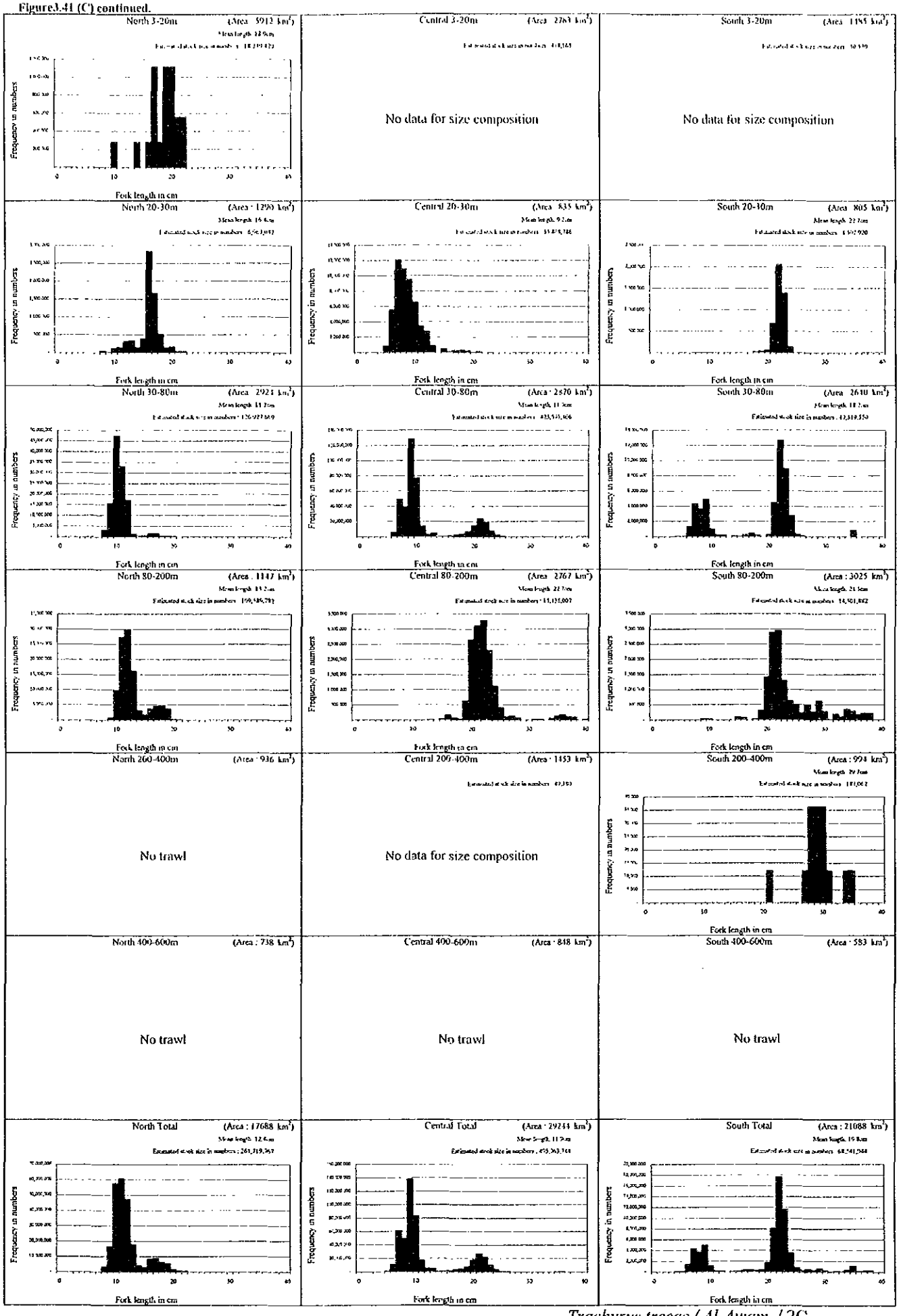


Figure3.41 (D) continued.

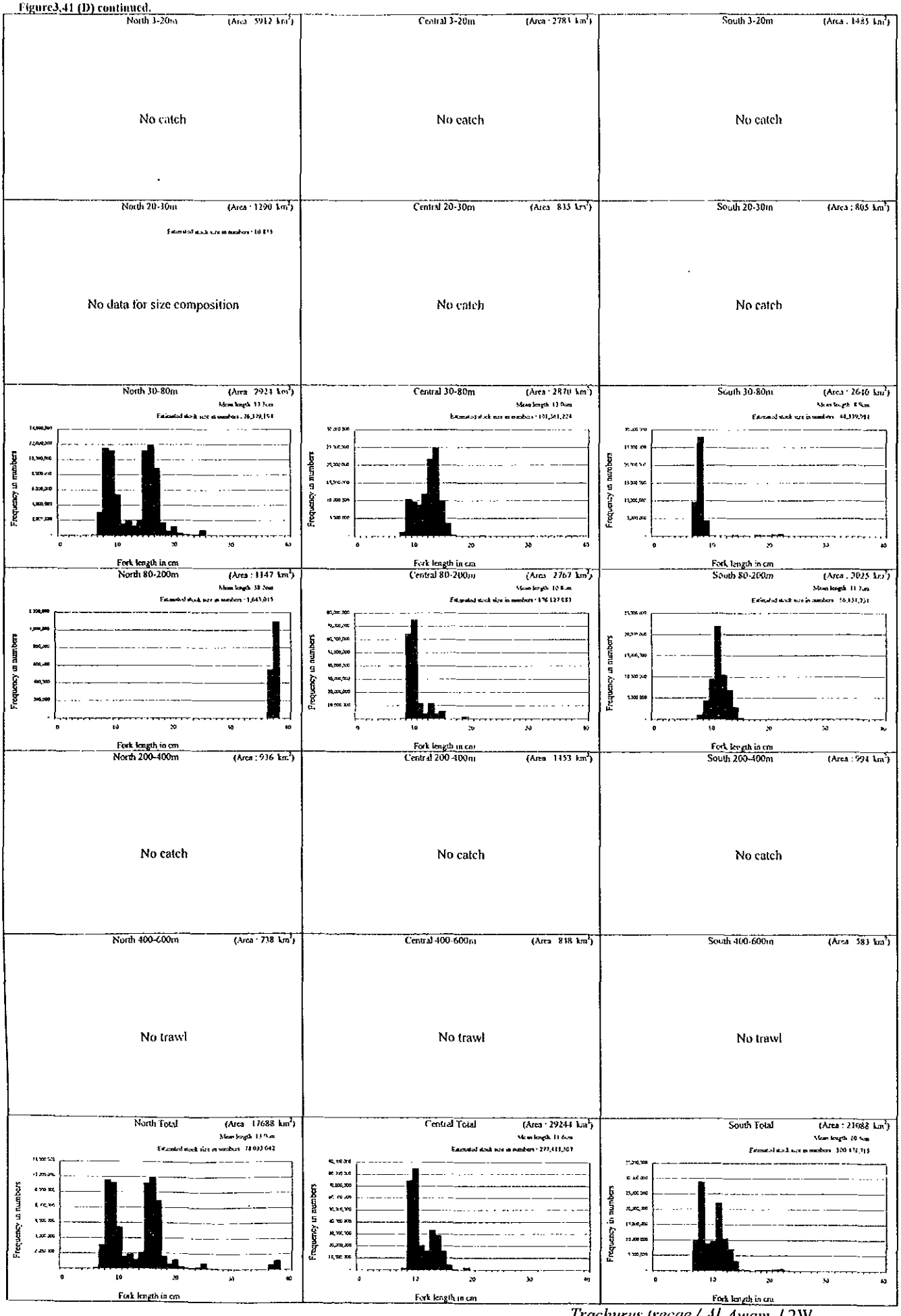


Table 3.70 Body length and weight by sex for Cunene horse mackerel *Trachurus trecae*.

(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	0				
		Female	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
2	Cold	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	0				
		Female	0				
		Indeterminate	0				
		Total	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	0				
		Female	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	32	102 ~ 221	179.6	15.0 ~ 115.0	76.7
		Female	61	110 ~ 242	194.3	20.0 ~ 165.0	94.0
		Indeterminate	299	80 ~ 225	132.8	7.0 ~ 170.0	36.9
		Total	392	80 ~ 242	146.2	7.0 ~ 170.0	49.0
2	Cold	Male	211	130 ~ 440	241.9	22.0 ~ 900.0	218.0
		Female	137	115 ~ 397	244.0	20.0 ~ 680.0	220.7
		Indeterminate	245	73 ~ 370	177.1	5.0 ~ 640.0	90.2
		Total	593	73 ~ 440	215.6	5.0 ~ 900.0	165.8
	Warm	Male	41	121 ~ 375	211.0	25.0 ~ 605.0	162.7
		Female	68	92 ~ 400	188.9	10.0 ~ 675.0	141.3
		Indeterminate	65	63 ~ 227	118.1	4.0 ~ 150.0	26.2
		Total	174	63 ~ 400	167.6	4.0 ~ 675.0	103.3

Table 3.71 Sex ratio and maturity stage for Cunene horse mackerel *Trachurus trecae.*

(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			E					0	0	E					0	1	E					0	0	E				
Other			E					0	0	E					0	0	E					0	0	E				
All area			E					0	0	E					0	1	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	7	1.40	100.0	0.0	0.0	0.0	0	0	E				
	20-30m			E					12	9	0.75	58.3	41.7	0.0	0.0	5	5	1.00	100.0	0.0	0.0	0.0	0	0	E				
	30-80m			E					9	10	1.11	100.0	0.0	0.0	0.0	6	27	4.50	100.0	0.0	0.0	0.0	33	19	0.58	66.7	6.1	27.3	0.0
	80-200m			E					8	6	0.75	37.5	62.5	0.0	0.0	10	14	1.40	100.0	0.0	0.0	0.0	2	1	0.50	0.0	0.0	100.0	0.0
	200-400m			E					0	0	E					-	-	-	-	-	-	-	0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum			E					29	25	0.86	65.5	34.5	0.0	0.0	26	53	2.04	100.0	0.0	0.0	0.0	35	20	0.57	62.9	5.7	31.4	0.0
Central	3-20m	-	-	-	-	-	-	-	0	0	E					0	0	E					0	0	E				
	20-30m			E					0	0	E					3	5	1.67	100.0	0.0	0.0	0.0	0	0	E				
	30-80m			E					0	0	E					19	28	1.47	94.7	5.3	0.0	0.0	18	8	0.44	94.4	5.6	0.0	0.0
	80-200m			E					18	1	0.06	66.7	33.3	0.0	0.0	50	38	0.76	74.0	14.0	12.0	0.0	8	1	0.13	87.5	0.0	12.5	0.0
	200-400m			E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum			E					18	1	0.06	66.7	33.3	0.0	0.0	72	71	0.99	80.6	11.1	8.3	0.0	26	9	0.35	92.3	3.8	3.8	0.0
South	3-20m	-	-	-	-	-	-	-	0	0	E					0	0	E					0	0	E				
	20-30m			E					0	0	E					0	0	E					0	0	E				
	30-80m			E					14	3	0.21	100.0	0.0	0.0	0.0	6	16	2.67	16.7	83.3	0.0	0.0	7	12	1.71	85.7	14.3	0.0	0.0
	80-200m			E					0	3	E					30	62	2.07	26.7	23.3	50.0	0.0	0	0	E				
	200-400m			E					0	0	E					3	9	3.00	33.3	33.3	33.3	0.0	0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum			E					14	6	0.43	100.0	0.0	0.0	0.0	39	87	2.23	25.6	33.3	41.0	0.0	7	12	1.71	85.7	14.3	0.0	0.0
All	3-20m	-	-	-	-	-	-	-	0	0	E					5	7	1.40	100.0	0.0	0.0	0.0	0	0	E				
	20-30m			E					12	9	0.75	58.3	41.7	0.0	0.0	8	10	1.25	100.0	0.0	0.0	0.0	0	0	E				
	30-80m			E					23	13	0.57	100.0	0.0	0.0	0.0	31	71	2.29	80.6	19.4	0.0	0.0	58	39	0.67	77.6	6.9	15.5	0.0
	80-200m			E					26	10	0.38	57.7	42.3	0.0	0.0	90	114	1.27	61.1	15.6	23.3	0.0	10	2	0.20	70.0	0.0	30.0	0.0
	200-400m			E					0	0	E					3	9	3.00	33.3	33.3	33.3	0.0	0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum			E					61	32	0.52	73.8	26.2	0.0	0.0	137	211	1.54	68.6	15.3	16.1	0.0	68	41	0.60	76.5	5.9	17.6	0.0

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

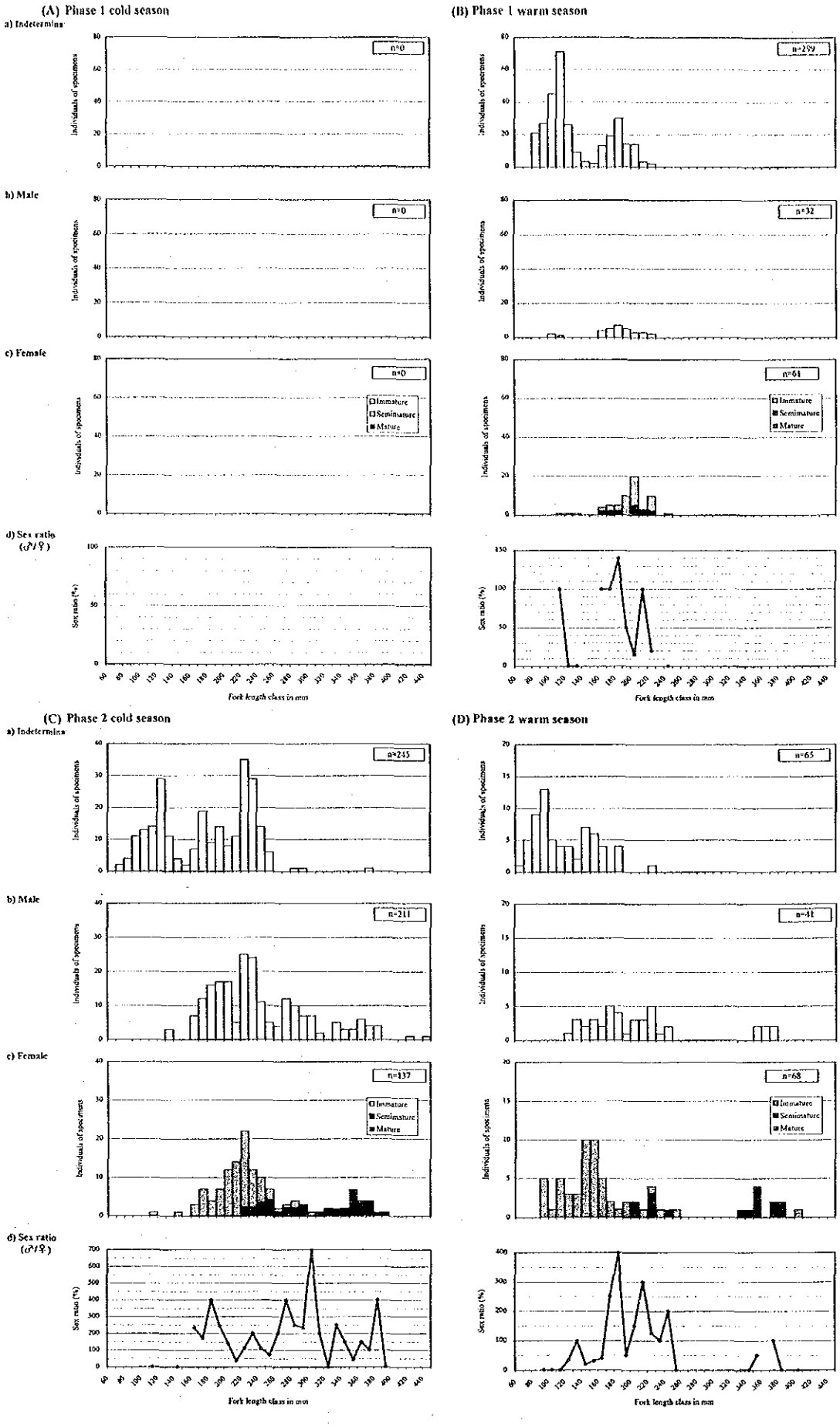


Figure 3.43 Sex ratio and female maturity stage by length class for Cunene horse mackerel *Trachurus trecae*.

Table 3.72 Stomach content analysis of Cunene horse mackerel *Trachurus trecae.*

(A) Stomach condition

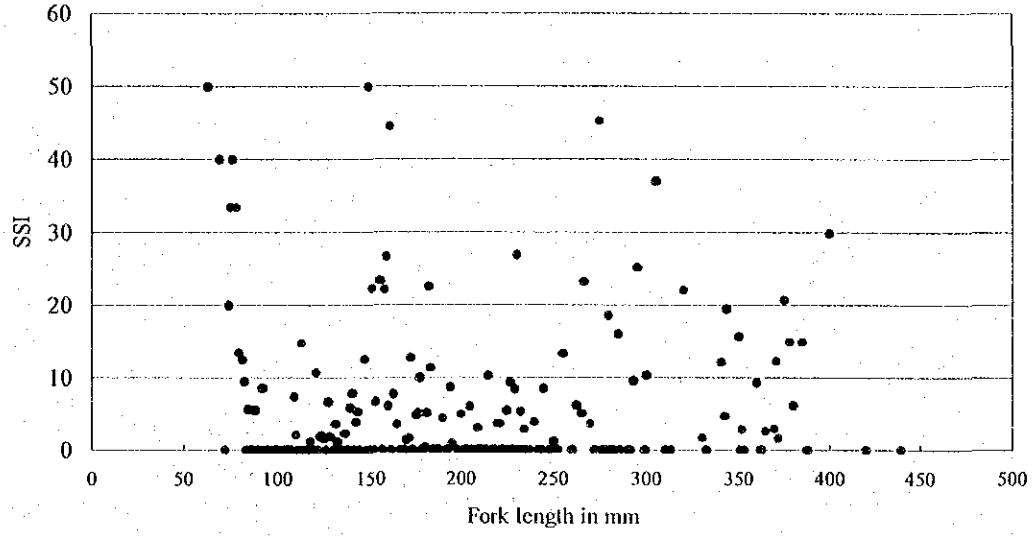
Phase	Season	Stomach condition				Stomach content Somatic Index (SSI)			
		n*	Empty (%)	Evert (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	-	-	-	-	-	-	-	-
	Warm	357	98.88	0.00	1.12	357	0.00	1.43	0.01
2	Cold	499	81.56	0.00	18.44	497	0.00	128.21	5.40
	Warm	162	51.85	0.62	47.53	153	0.00	70.00	11.30

(B) Stomach contents

Phase	Season	n*	Mollusca	Polychaeta	Crustacea			Fish	Unknown
			Abralia verauyi		Mysidacea	Shrimp	Other		
1	Cold	-							-
	Warm	4							100.00
2	Cold	92					17.39	6.52	76.09
	Warm	77	1.30	1.30	25.97	23.38		5.19	44.16

Remark. * : Individuals of specimens.

(A) Relationship between fork length and SSI



(B) Relationship between fork length and SCW

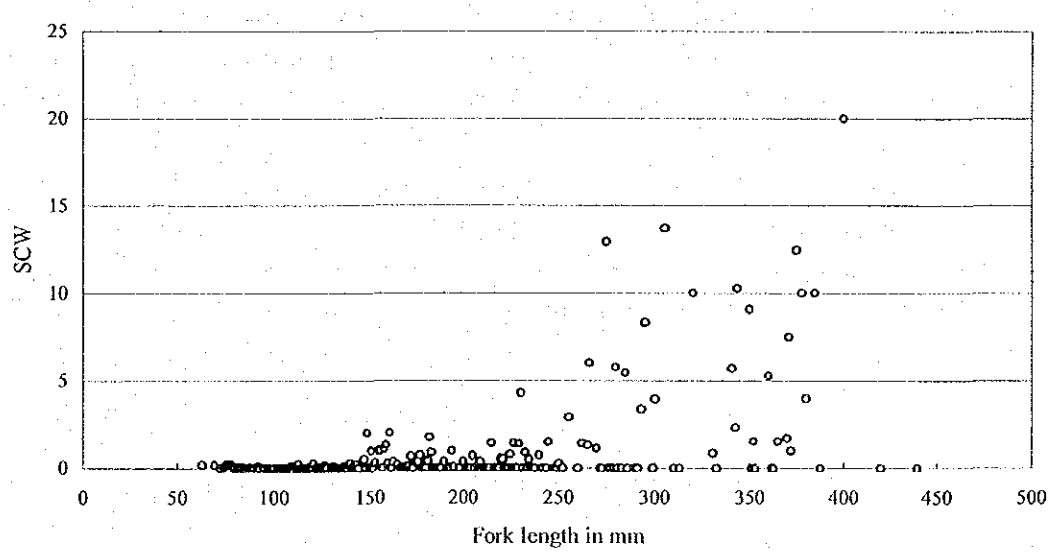


Fig. 3.44 Relationship between body length and SSI (A) and SCW (B) for Cunene horse mackerel *Trachurus trecae*.

6) Meagre *Argyrosomus regius*

a) Body length range and mean body length

Table 3.73 (page 3-216) presents the minimum, maximum and mean total lengths obtained for the meagre in each survey season at each stratum in each area.

The total length of the 16 samples obtained in the area surveyed by the *Amrigue* only in the warm season was between 40 and 275 mm. The mean total length was approximately 16 cm.

The total length of the 343 samples obtained in the area surveyed by the *Al-Awam* throughout the survey varied between 85 and 1,124 mm. The mean total length by area was between 21 and 34 cm approximately; in the North and Central areas, it increased in survey season order, while in the Southern area, it was higher in the cold season. The mean total length by area in the Phase 2 showed the geographic-dependent change: it increased from north to south in the cold season, and declined again from north to south in the warm season. The mean total length by stratum in the Phase 2 increased with depth.

b) Size composition

Figure 3.45 (page 3-213, 3-217 to 3-220) presents the evaluation of the size composition for the meagre stock. The total length class is indicated at intervals of 2 cm. For convenience, three groups were defined: (i) small-size (total length less than 30 cm), (ii) medium-size (length between 30 and 60 cm), (iii) large-size (length over 60 cm). Data from the Phase 1 cold season were too few and were not considered for the size composition study.

The total stock size in number for the meagre comprised mainly the small-size group, secondarily the medium-size group. The large-size group appeared only in the Phase 2 cold season. For all seasons, the size composition was complex: the small-size group had many modes, including a dominant mode at classes between 16 and 20 cm, while the medium-size group had one or many modes at classes between 30 and 60 cm.

The distribution of the three size groups was analyzed from the size composition at each stratum in each area. The small-size and medium-size groups were respectively distributed in all areas in all seasons. Most of the medium-size individuals were distributed at the 3-20 m stratum in the Central area and/or in the Southern area. The large-size group occurred slightly at the 3-20 m stratum in the Central and Southern areas.

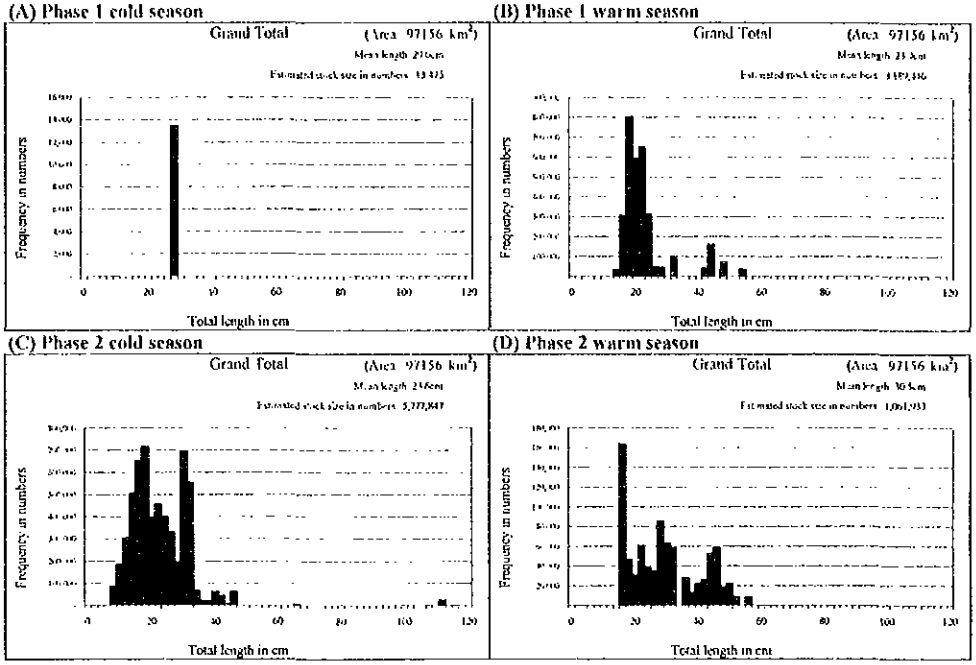


Figure 3.45 Size composition for meagre *Argyrosomus regius*.

c) Length-weight relationship

Figure 3.46 (page 3-214) presents the length-weight relationship of the meagre. The length-weight equations obtained from samples of all seasons except the Phase 1 cold season were the following:

Phase 1 warm season : $BW = 4.029\times10^{-2}\times TL^{2.519}$ (r=0.9213)
Phase 2 cold season : $BW = 1.455\times10^{-2}\times TL^{2.889}$ (r=0.9832)
Phase 2 warm season : $BW = 7.494\times10^{-3}\times TL^{3.084}$ (r=0.9952)

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

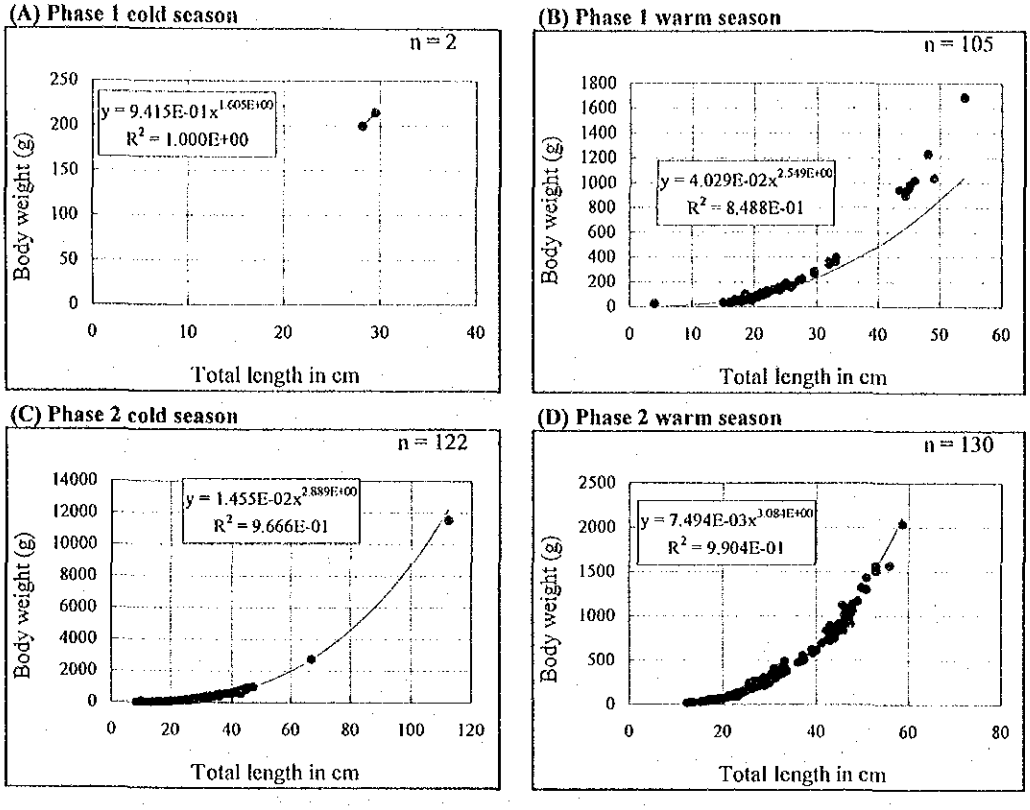


Figure 3.46 Length-weight relationship for meagre *Argyrosomus regius*.

d) Length and weight by sex

Table 3.74 (page 3-221) presents the total length and body weight observed in each sex for the meagre.

In the area surveyed by the *Amrigue*, sex could only be determied for a single individual (a male), whose total length and weight were respectively 275 mm and 225.0 g.

In the area surveyed by the *Al-Awam*, females were on the average larger in both total length and weight than males. Individuals whose sex could be determined by visual inspection had a minimum total length of 16 cm for males and females, but they were mostly larger than 17 or 18 cm. However, considering there were individuals of indetermined sex of about 50 cm, individual differences in gonadal development are supposedly significant.

e) Sex ratio and female maturity stage

Table 3.75 (page 3-222) summarizes the sex ratio and the female maturity stage for the meagre. Figure 3.47 (page 3-223) presents their distribution by length class.

The overall sex ratio varied between 0.29 and 0.44 in all seasons except in the Phase 1 cold season (a single female observed), which indicates females were mostly dominant. The sex ratio by area also showed that females were by far more numerous in all seasons except in the Southern area in the Phase 2 cold season (males slighly majoritary). This result is very different from the sex ratio equilibrium reported by Tixerant (1974).

The result that the female population was overwhelmingly majoritary was also reflected in the sex

ratio by length class figures, because but for a few exceptions, females were majoritary in all length classes. According to Tixerant (1974), body length of the smallest mature female would be 82 cm. However, a 100 cm -long female was found to be still semimature, and no fully mature female was recorded throughout the survey.

f) Feeding habits

Table 3.76 (page 3-224) presents the stomach condition and the stomach content composition of the meagre in each survey season. Figure 3.48 (page 3-225) presents the relationships between total length and SSI and SCW.

The ratio of the empty stomachs varied between 47 and 72%, except in the Phase 1 cold season when all stomachs examined were empty (only two samples obtained). In the Phase 2 warm season, 11% of the individuals had everted stomachs (i.e., sticking out from the mouth). The relationship between total length and SSI and SCW showed that the ingested quantity increased with the size of the individual, and that the small-size individuals are voracious eaters in relation to their body weight.

The meagre feeds basically on fish (soles, etc.) and crustaceans (crabs, shrimp, etc.). Mollusks (cuttlefish, etc.) and polychaetes were also found in the stomach of this species.

Table 3.73 Body length range and mean body length for meagre *Argyrosomus regius* : 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	0			1	40	40.0	0			2	205 ~ 230	217.5
Other	0			1	275	275.0	0			12	124 ~ 188	154.2
All area	0			2	40 ~ 275	157.5	0			14	124 ~ 230	163.2

(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	-	-	-	-	-	-	40	85 ~ 450	236.8	6	288 ~ 370	321.3
	20-30m	0			10	210 ~ 250	224.0	0			0		
	30-80m	0			0			0			21	258 ~ 560	345.0
	80-200m	0			0			0			0		
	200-400m	0			0			-	-	-	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	0			10	210 ~ 250	224.0	40	85 ~ 450	236.8	27	258 ~ 560	339.8
Central	3-20m	-	-	-	47	150 ~ 330	201.4	44	85 ~ 1,124	292.7	45	162 ~ 586	357.7
	20-30m	0			2	295 ~ 320	307.5	0			17	183 ~ 320	227.1
	30-80m	0			0			0			8	270 ~ 460	370.6
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	0			49	150 ~ 330	205.8	44	85 ~ 1,124	292.7	70	162 ~ 586	327.5
South	3-20m	-	-	-	44	160 ~ 540	244.2	35	150 ~ 670	321.5	13	160 ~ 430	226.2
	20-30m	2	282 ~ 295	288.5	0			1	270	270.0	1	296	296.0
	30-80m	0			0			2	360 ~ 415	387.5	5	220 ~ 450	352.8
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	2	282 ~ 295	288.5	44	160 ~ 540	244.2	38	150 ~ 670	323.6	19	160 ~ 450	263.2

Remark. - : no trawl.

Figure3.45 (A) contiaued.

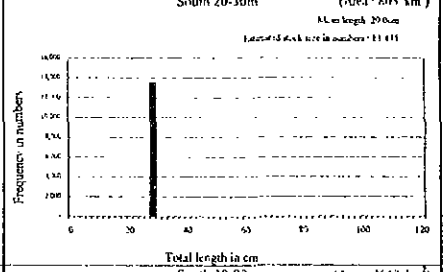
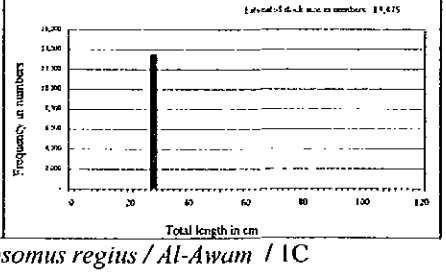
North 3-20m (Area : 9912 km²)	Central 3-20m (Area : 2783 km²)	South 3-20m (Area : 1485 km²)
No trawl	No trawl	No trawl
North 20-30m (Area : 1290 km²)	Central 20-30m (Area : 835 km²)	South 20-30m (Area : 805 km²)
No catch	No catch	
North 30-80m (Area : 2924 km²)	Central 30-80m (Area : 2870 km²)	South 30-80m (Area : 2610 km²)
No catch	No catch	No catch
North 80-200m (Area : 1147 km²)	Central 80-200m (Area : 2767 km²)	South 80-200m (Area : 3025 km²)
No catch	No catch	No catch
North 200-400m (Area : 936 km²)	Central 200-400m (Area : 1453 km²)	South 200-400m (Area : 994 km²)
No catch	No catch	No catch
North 400-600m (Area : 738 km²)	Central 400-600m (Area : 848 km²)	South 400-600m (Area : 583 km²)
No trawl	No trawl	No trawl
North Total (Area : 17688 km²)	Central Total (Area : 29241 km²)	South Total (Area : 21068 km²)
No catch	No catch	

Figure3.45 (II) continued.

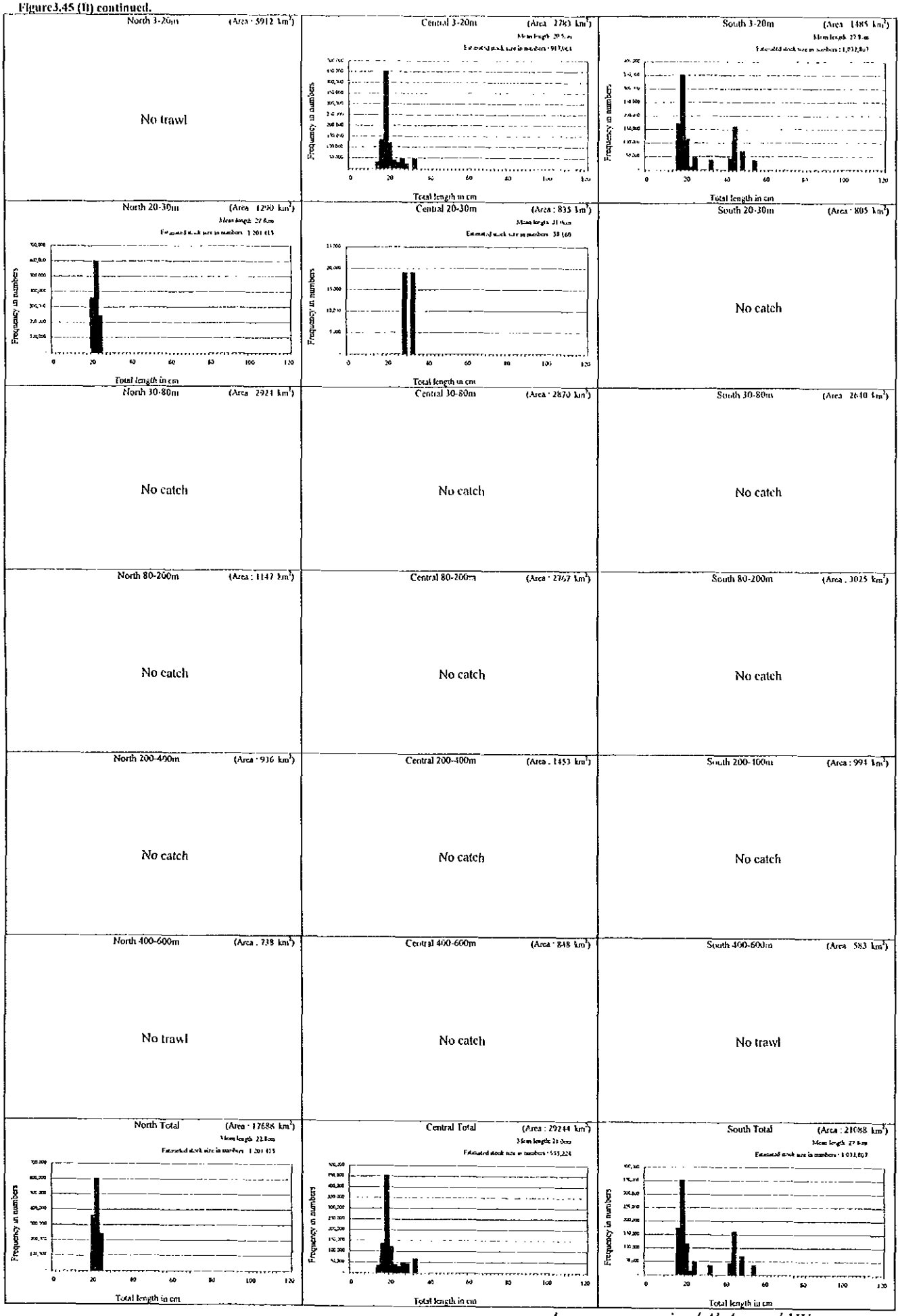


Figure3.45 (C) continued.

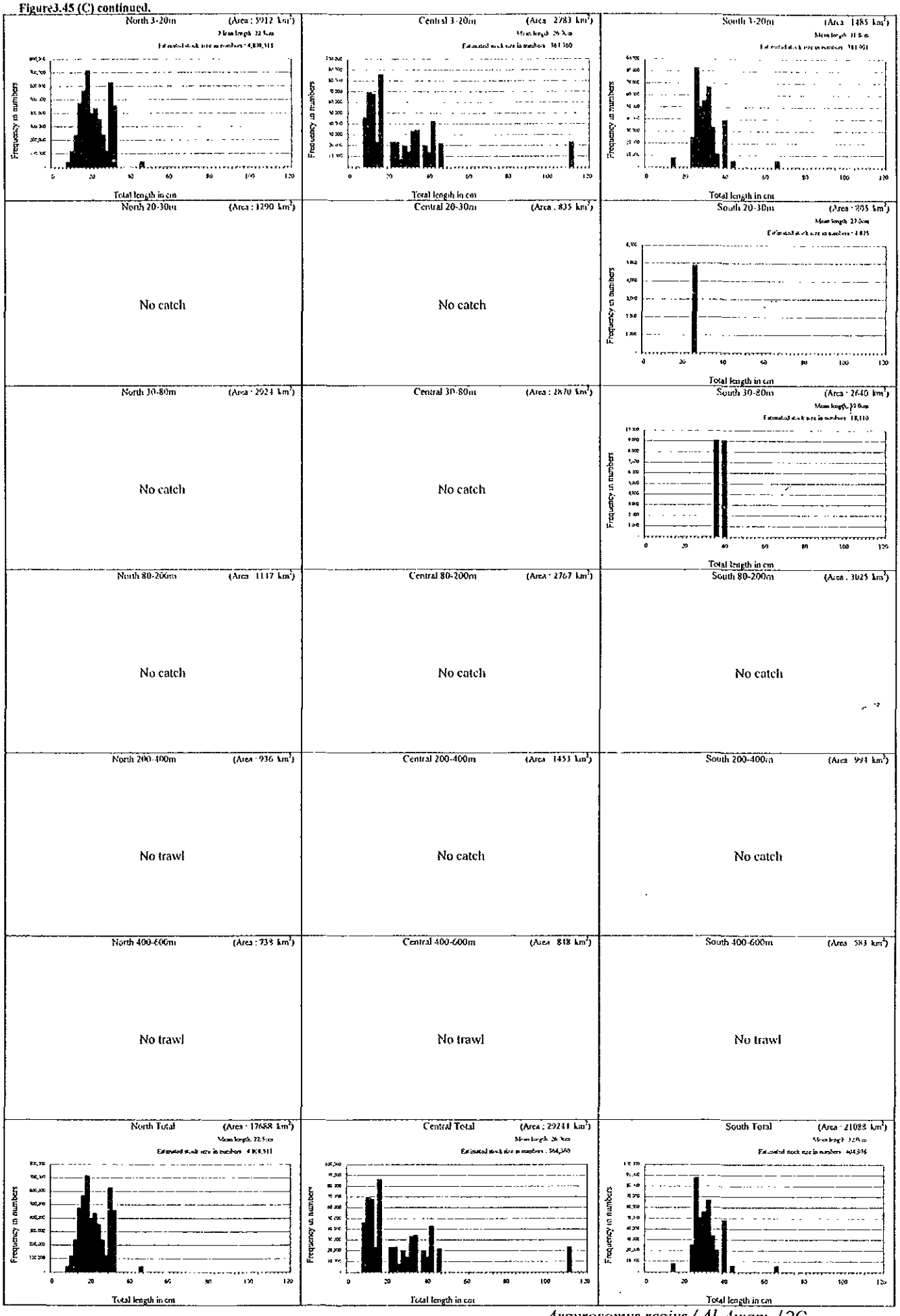


Figure3.45 (D) continued.

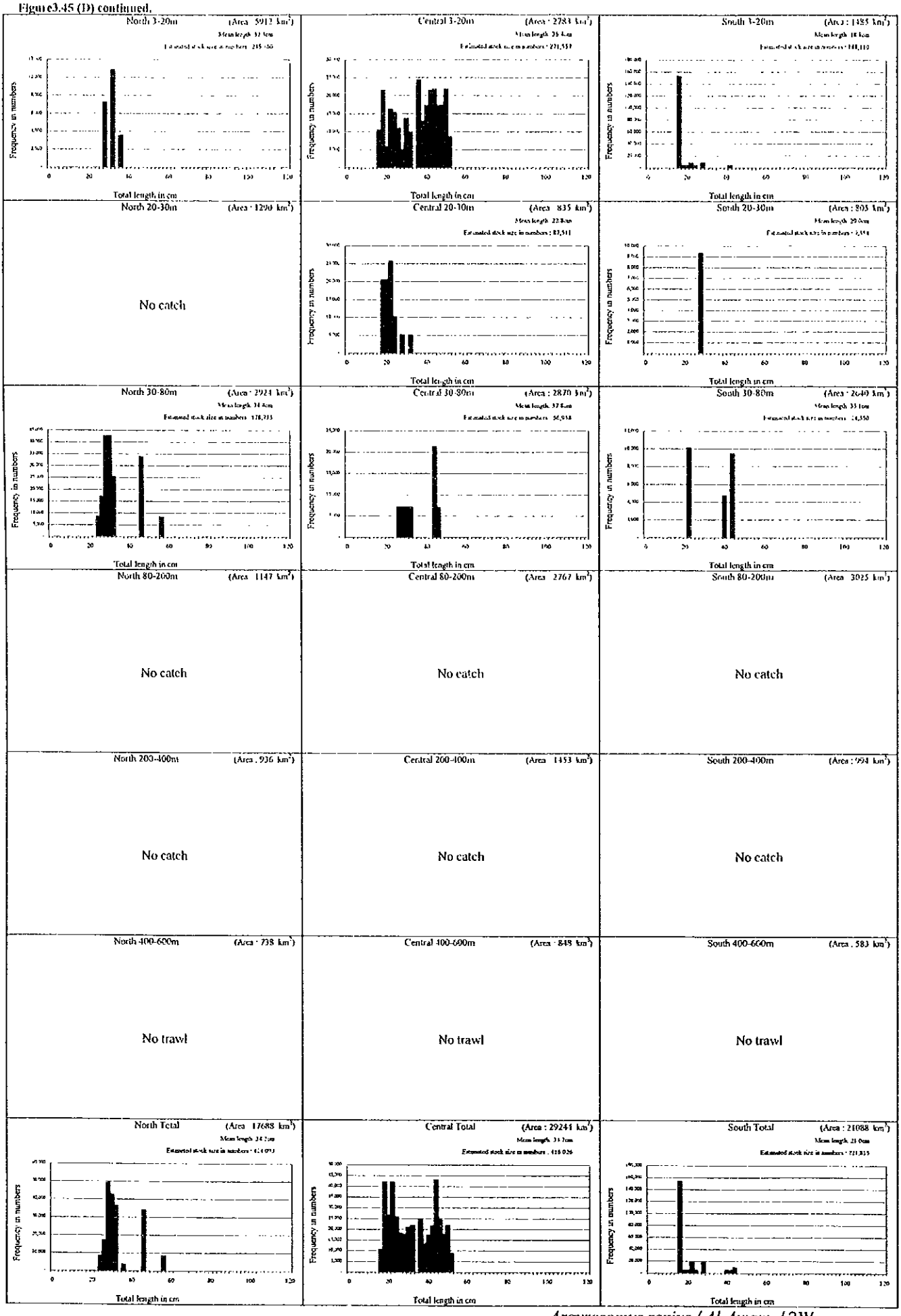


Table 3.74 Body length and weight by sex for meagre *Argyrosomus regius*.

(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	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	1	275	275.0	225.0	225.0
		Female	0				
		Indeterminate	1	40	40.0	24.5	24.5
		Total	2	40 ~ 275	157.5	24.5 ~ 225.0	124.8
2	Cold	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	0				
		Female	0				
		Indeterminate	14	124 ~ 230	163.2	18.0 ~ 125.0	44.6
		Total	14	124 ~ 230	163.2	18.0 ~ 125.0	44.6

(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	1	295	295.0	215.0	215.0
		Indeterminate	1	282	282.0	200.0	200.0
		Total	2	282 ~ 295	288.5	200.0 ~ 215.0	207.5
	Warm	Male	4	180 ~ 210	202.5	60.0 ~ 110.0	91.3
		Female	14	196 ~ 490	309.6	50.0 ~ 1,235.0	447.5
		Indeterminate	85	150 ~ 540	210.8	35.0 ~ 1,687.0	131.1
		Total	103	150 ~ 540	223.9	35.0 ~ 1,687.0	172.5
2	Cold	Male	18	160 ~ 473	328.9	40.0 ~ 1,005.0	413.3
		Female	41	173 ~ 1,124	357.9	55.0 ~ 11,540.0	732.9
		Indeterminate	63	85 ~ 449	223.1	5.0 ~ 835.0	157.1
		Total	122	85 ~ 1,124	284.0	5.0 ~ 11,540.0	388.4
	Warm	Male	21	185 ~ 560	313.2	55.0 ~ 1,570.0	404.2
		Female	69	162 ~ 586	340.6	43.0 ~ 2,040.0	533.0
		Indeterminate	26	160 ~ 475	269.8	35.0 ~ 950.0	254.7
		Total	116	160 ~ 586	319.8	35.0 ~ 2,040.0	447.3

Table 3.75 Sex ratio and female maturity stage for meagre *Argyrosomus regius.*

(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	0	E					0	1	E					0	0	E					0	0	E				
All area	0	0	E					0	1	E					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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	1	0.08	100.0	0.0	0.0	0.0	4	0	0.00	100.0	0.0	0.0	0.0
	20-30m	0	0	E					7	3	0.43	57.1	42.9	0.0	0.0	0	0	E					0	0	E				
	30-80m	0	0	E					0	0	E					0	0	E					11	5	0.45	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				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	0	0	E					7	3	0.43	57.1	42.9	0.0	0.0	12	1	0.08	100.0	0.0	0.0	0.0	15	5	0.33	100.0	0.0	0.0	0.0
Central	3-20m	-	-	-	-	-	-	-	2	0	0.00	100.0	0.0	0.0	0.0	22	8	0.36	18.2	81.8	0.0	0.0	30	5	0.17	93.3	6.7	0.0	0.0
	20-30m	0	0	E					0	0	E					0	0	E					14	3	0.21	85.7	14.3	0.0	0.0
	30-80m	0	0	E					0	0	E					0	0	E					3	5	1.67	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	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	0	0	E					2	0	0.00	100.0	0.0	0.0	0.0	22	8	0.36	18.2	81.8	0.0	0.0	47	13	0.28	91.5	8.5	0.0	0.0
South	3-20m	-	-	-	-	-	-	-	5	1	0.20	100.0	0.0	0.0	0.0	7	9	1.29	71.4	28.6	0.0	0.0	5	1	0.20	100.0	0.0	0.0	0.0
	20-30m	1	0	0.00	100.0	0.0	0.0	0.0	0	0	E					0	0	E					1	0	0.00	100.0	0.0	0.0	0.0
	30-80m	0	0	E					0	0	E					0	0	E					1	2	2.00	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	1	0	0.00	100.0	0.0	0.0	0.0	5	1	0.20	100.0	0.0	0.0	0.0	7	9	1.29	71.4	28.6	0.0	0.0	7	3	0.43	100.0	0.0	0.0	0.0
All	3-20m	-	-	-	-	-	-	-	7	1	0.14	100.0	0.0	0.0	0.0	41	18	0.44	51.2	48.8	0.0	0.0	39	6	0.15	94.9	5.1	0.0	0.0
	20-30m	1	0	0.00	100.0	0.0	0.0	0.0	7	3	0.43	57.1	42.9	0.0	0.0	0	0	E					15	3	0.20	86.7	13.3	0.0	0.0
	30-80m	0	0	E					0	0	E					0	0	E					15	12	0.80	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	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	1	0	0.00	100.0	0.0	0.0	0.0	14	4	0.29	78.6	21.4	0.0	0.0	41	18	0.44	51.2	48.8	0.0	0.0	69	21	0.30	94.2	5.8	0.0	0.0

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

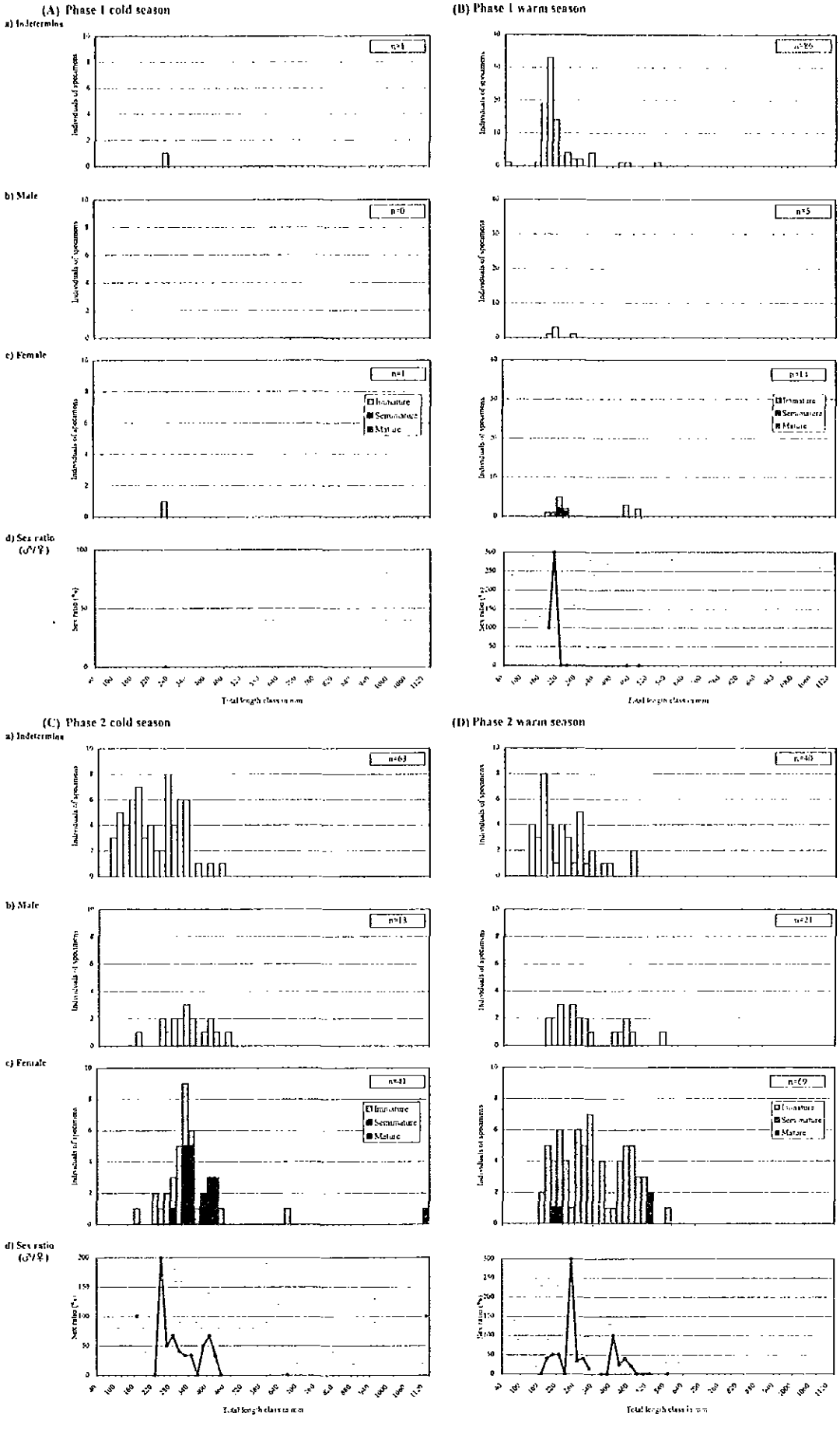


Figure 3.47 Sex ratio and female maturity stage by length class for meagre *Argyrosomus regius*.

Table 3.76 Stomach content analysis of meagre *Argyrosomus regius*.

(A) Stomach condition

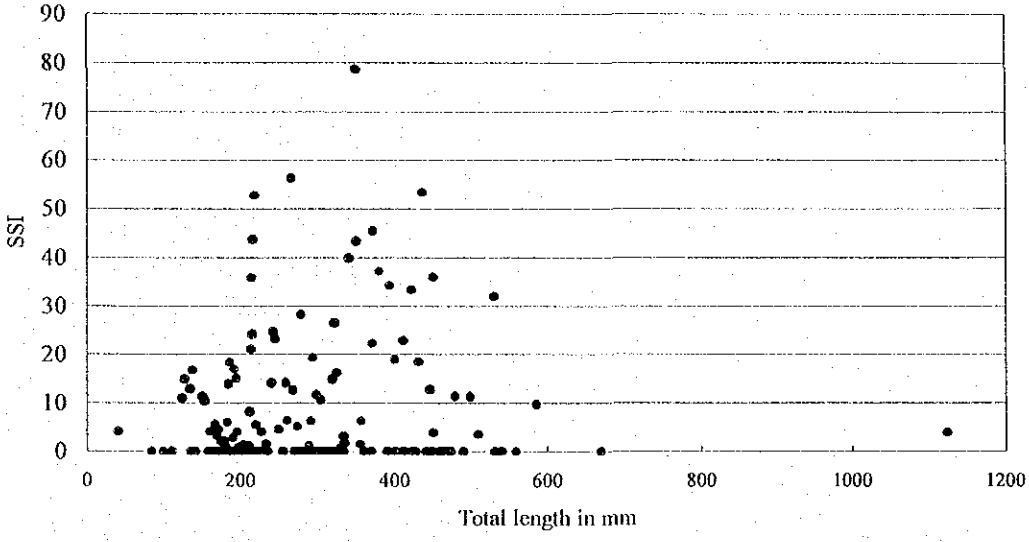
Phase	Season	Stomach condition				Stomach content Somatic Index (SSI)			
		n*	Empty (%)	Evert (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	2	100.00	0.00	0.00	2	0.00	0.00	0.00
	Warm	91	47.25	0.00	52.75	90	0.00	55.56	8.05
2	Cold	99	71.72	0.00	28.28	99	0.00	85.11	10.68
	Warm	124	58.87	11.29	29.84	108	0.00	64.14	5.30

(B) Stomach contents

Phase	Season	n*	Mollusca		Polychaeta	Crustacea			Fish		Unknown
			Sepia sp.	Decapoda		Crab	Shrimp	Other	Soleidae sp.	Other	
1	Cold	0									
	Warm	48		4.17		4.17	2.08	6.25		12.50	70.83
2	Cold	28	3.57							28.57	67.86
	Warm	37			2.70	21.62	21.62	2.70	2.70	32.43	18.92

Remark. * : Individuals of specimens.

(A) Relationship between total length and SSI



(B) Relationship between total length and SCW

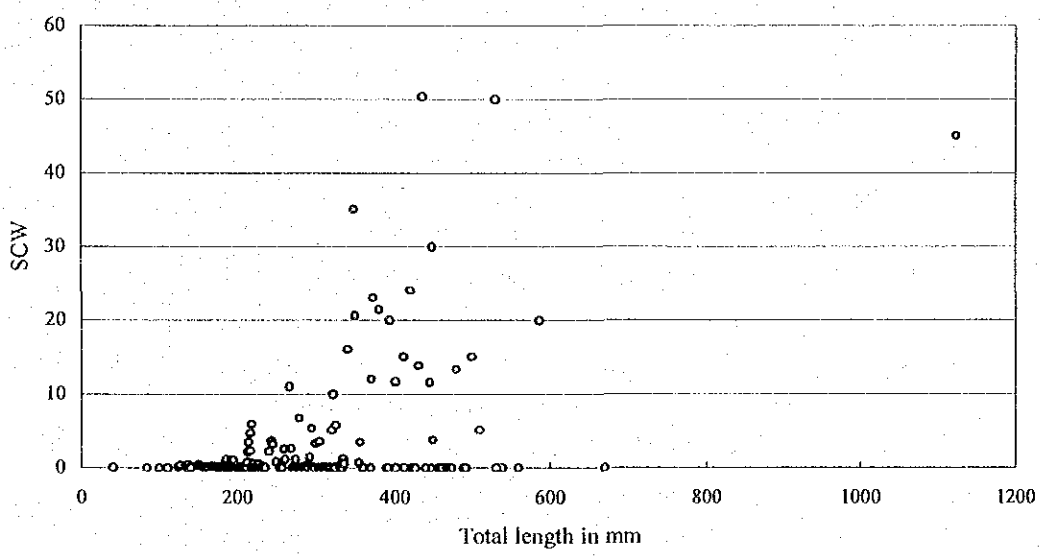


Figure 3.48 Relationship between body length and SSI (A) and SCW (B) for meagre *Argyrosomus regius*.

7) West African goatfish *Pseudupeneus prayensis*

a) Body length range and mean body length

Table 3.77 (page 3-230) presents the minimum, maximum and mean fork length obtained for the West African goatfish in each survey season and at each stratum in each area.

In the area surveyed by the *Amrigue*, the fork length varied between 58 and 203 mm, the mean fork length varying between 92 and 191 mm. The mean fork length was high in the cold season and low in the warm season. In the Banc d'Arguin, the mean fork length was smaller than in other area throughout the survey.

In the area surveyed by the *Al-Awam*, the fork length was between 55 and 260 mm. The mean fork length by area varied between 99 and 191 mm. In all areas, it was high in the cold season and low in the warm season. It was higher in the Northern area in the cold season and in the Southern area in the warm season. The mean fork length by stratum in the Northern area was higher at deep strata in the cold season and at shallow strata in the warm season. But in the Central and Southern areas, it did not always depend on depth.

b) Size composition

Figure 3.49 (page 3-227, 3-231 to 3-234) presents the evaluation of the size composition for the West African goatfish stock. The fork length class is indicated at intervals of 1cm.

The size composition of the total stock size in number showed a mono-modal distribution in the cold season (there were three modes in Phase 1, but the two lower-peak modes were not considered) and a bi-modal distribution in the warm season. In the cold season, the size composition basically comprised the medium-size group with a dominant mode between 18 and 20cm classes. In the warm season, it was composed of the small-size group with a dominant mode between 10 and 13cm classes, and the medium-size group with a dominant mode at classes around 20cm (particularly accentuated in Phase 1). Supposing the medium-size group in the cold season was the result of growth and survival of the small-size group in the warm season during the transitional period (about six months), some questions still remain unanswered. Where did the medium-size group in the warm season come from? (In the cold season, the small-size group with a dominant mode at classes around 10cm were not observed.) Why is that the modes reflecting the result of growth and survival of the medium-size group during the transitional periods (three or six months) were not observed in the warm and cold seasons respectively?

Also, considering that the small-size group in the warm season suggests that spawning takes place in the spring (as indicated below, the female maturity ratio in May and June varied between 3 and 17% throughout the area), still other questions arise. Was that the medium-size group in the cold season suggesting a spawning in the warm season (the female maturity ratio in September and October was higher than in May and June, varying between 34 and 49% over the entire area)? If so, where did the warm season group of the medium-size individuals come from? Why is it that there are no modes pointing out at the growth and survival of the warm season group of small-size individuals during the transitional period?

As for the size composition of the stock in number by area, the group of cold season the medium-size individuals was distributed over the entire area, particularly in the Central area. In the same way, the

groups of warm season small- and medium-size individuals were distributed all over, particularly in the Central area and/or in the Southern area.

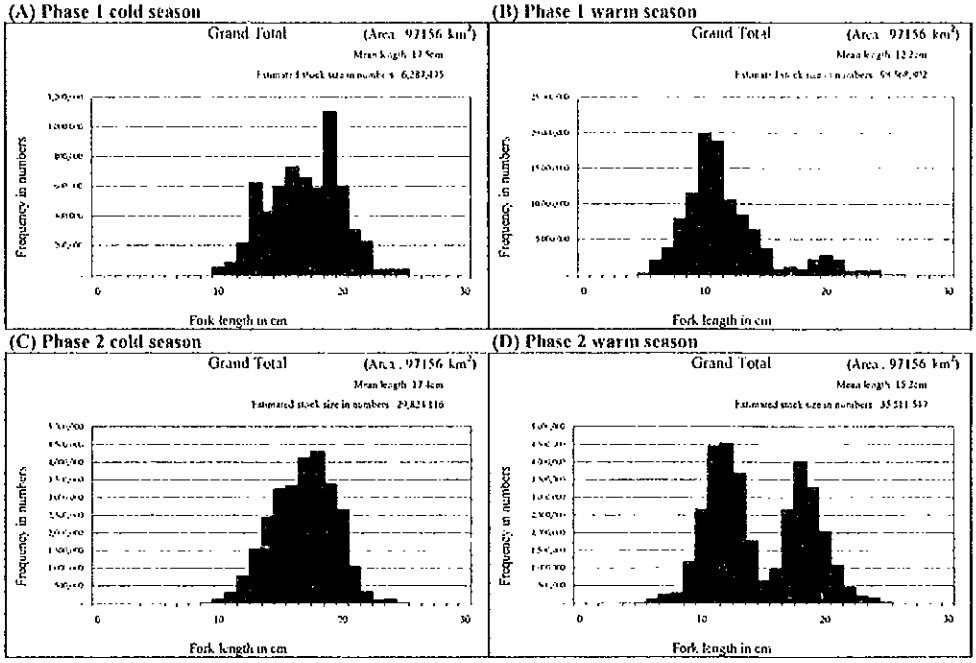


Figure 3.49 Size composition for West African goatfish *Pseudupeneus prayensis.*

c) Length-weight relationship

Figure 3.50 (page 3-228) presents the relationship between the fork length and weight for the West African goatfish. The length-weight equations obtained from all samples in each season were the following:

Phase 1 cold season	: BW=	$8.049\times10^{-3}\times TL^{3.265}$	(r=0.9848)
Phase 1 warm season	: BW=	$1.343\times10^{-2}\times TL^{3.092}$	(r=0.9842)
Phase 2 cold season	: BW=	$1.657\times10^{-2}\times TL^{3.010}$	(r=0.9782)
Phase 2 warm season	: BW=	$1.440\times10^{-2}\times TL^{3.063}$	(r=0.9904)

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

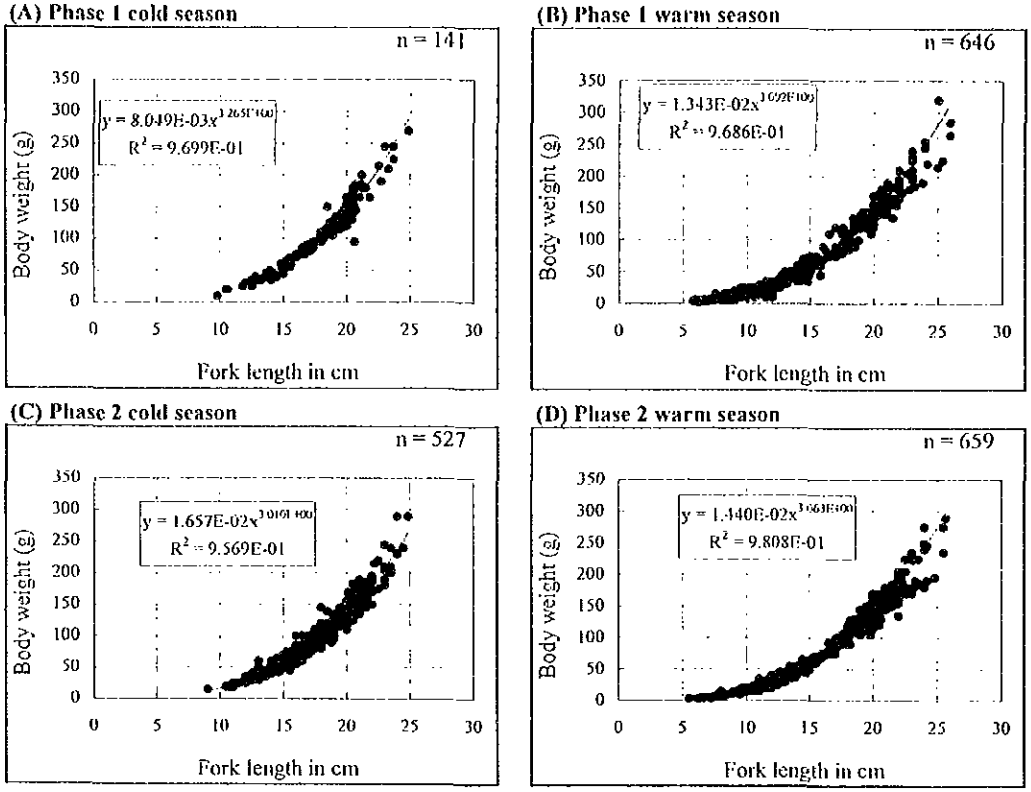


Figure 3.50 Length-weight relationship for West African goatfish *Pseudupeneus prayensis*.

d) Length and weight by sex

Table 3.78 (page 3-235) summarizes the fork length and body weight observed in each sex for the West African goatfish.

In the area surveyed by the *Amrigue*, males were on the average larger than females (in both fork length and weight). The average sizes in both sexes were larger in the cold season than in the warm season.

In the area surveyed by the *Al-Awam*, the average males were larger than the average females in the cold season and smaller in the warm season (length almost identical for both sexes in Phase 2). The average sizes of both males and females were larger in the cold season than in the warm season.

Individuals of both sexes with gonads developed enough to allow sex determination by visual inspection had a fork length of 7 to 8cm for the early ones, but generally over 10cm.

e) Sex ratio and female maturity stage

Table 3.79 (page 3-236) summarizes the sex ratio and the female maturity stage for the West African goatfish. Figure 3.51 (page 3-237) presents their distribution by length class.

In the area surveyed by the *Amrigue*, the overall sex ratio of this species varied between 0.17 and 0.36 (except for the Phase 1 cold season when, of the five individuals observed, four were males).

Predominance of females was more significant than in the area surveyed by the *Al-Awam*. No mature female was observed.

In the area surveyed by the *Al-Awam*, the overall sex ratio was, in survey order, 0.75, 0.65, 1.19 and 0.70. Except in the Phase 2 cold season, females were the majority. The sex ratio by area more often showed a predominance of females.

The female maturity ratio in the entire area was between 3 and 17% in the cold season and between 34 and 49% in the warm season. The ratio by stratum in the entire area was higher in shallow strata. The female maturity ratio by area was higher in the Northern area in the cold season and in the Central area or the Southern area in the warm season.

The sex ratio by length class depended on body length. This size-dependent change is shown below for the Phase 2 cold season, in which it was particularly conspicuous.

The sex ratio was 0% at the 10-11cm class (only females), 50% at the 14-15cm classes (twice more females than males), 100% at the 17-18cm class (male/female equilibrium), nearly 400% at the 22-23cm class (four times more males than females), and 100% at the 24-25cm class.

The fork length at first maturity was observed at the 11-12cm class in the warm season and at the 15-16cm class in the cold season.

f) Feeding habits

Table 3.80 (page 3-238) presents the stomach condition and the stomach content composition of the West African goatfish in each survey season. Figure 3.52 (page 3-239) presents the relationship between the fork length and SSI and SCW. These results considered all data collected by both the *Amrigue* and the *Al-Awam*.

The ratio of the empty stomach varied between 31 and 85%. 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 West African goatfish feeds mainly on crustaceans (shrimp, crabs, gammarids, *etc.*), but fish, polychaetes, starfish, mollusks (bivalves, cuttlefish or squid, *etc.*). in fact, it is an omnivore that can even eat seaweed.

Table 3.77 Body length range and mean body length for West African goatfish *Pseudupeneus prayensis* : 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	2	171 ~ 200	185.5	37	58 ~ 123	81.9	0			3	74 ~ 83	77.3
Other	3	184 ~ 203	195.0	72	64 ~ 143	97.7	11	120 ~ 176	145.5	6	112 ~ 130	121.5
All area	5	171 ~ 203	191.2	109	58 ~ 143	92.3	11	120 ~ 176	145.5	9	74 ~ 130	106.8

(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	-	-	-	-	-	-	38	125 ~ 218	176.7	4	143 ~ 212	187.8
	20-30m	7	167 ~ 204	187.1	0			23	140 ~ 220	183.5	28	95 ~ 225	144.6
	30-80m	25	149 ~ 227	191.8	20	70 ~ 170	99.3	8	170 ~ 220	199.4	45	100 ~ 240	167.0
	80-200m	0			0			0			0		
	200-400m	0			0			-	-	-	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	32	149 ~ 227	190.8	20	70 ~ 170	99.3	69	125 ~ 220	181.6	77	95 ~ 240	159.9
Central	3-20m	-	-	-	160	60 ~ 250	137.0	174	110 ~ 249	170.5	173	55 ~ 257	141.5
	20-30m	40	98 ~ 249	164.2	80	60 ~ 232	123.2	19	125 ~ 205	154.4	80	95 ~ 225	150.8
	30-80m	40	140 ~ 237	182.1	80	88 ~ 260	151.4	50	105 ~ 225	166.2	97	86 ~ 220	143.2
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	80	98 ~ 249	173.1	320	60 ~ 260	137.1	243	105 ~ 249	168.3	350	55 ~ 257	144.1
South	3-20m	-	-	-	50	95 ~ 260	158.7	60	90 ~ 245	190.2	59	154 ~ 255	188.9
	20-30m	0			40	106 ~ 220	160.3	46	138 ~ 225	192.8	60	140 ~ 226	183.5
	30-80m	24	136 ~ 233	172.5	107	60 ~ 250	139.0	98	120 ~ 240	170.9	104	62 ~ 248	163.5
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	24	136 ~ 233	172.5	197	60 ~ 260	148.3	204	90 ~ 245	181.5	223	62 ~ 255	175.6

Remark. - : no trawl.

Figure3.49 (A) continued.

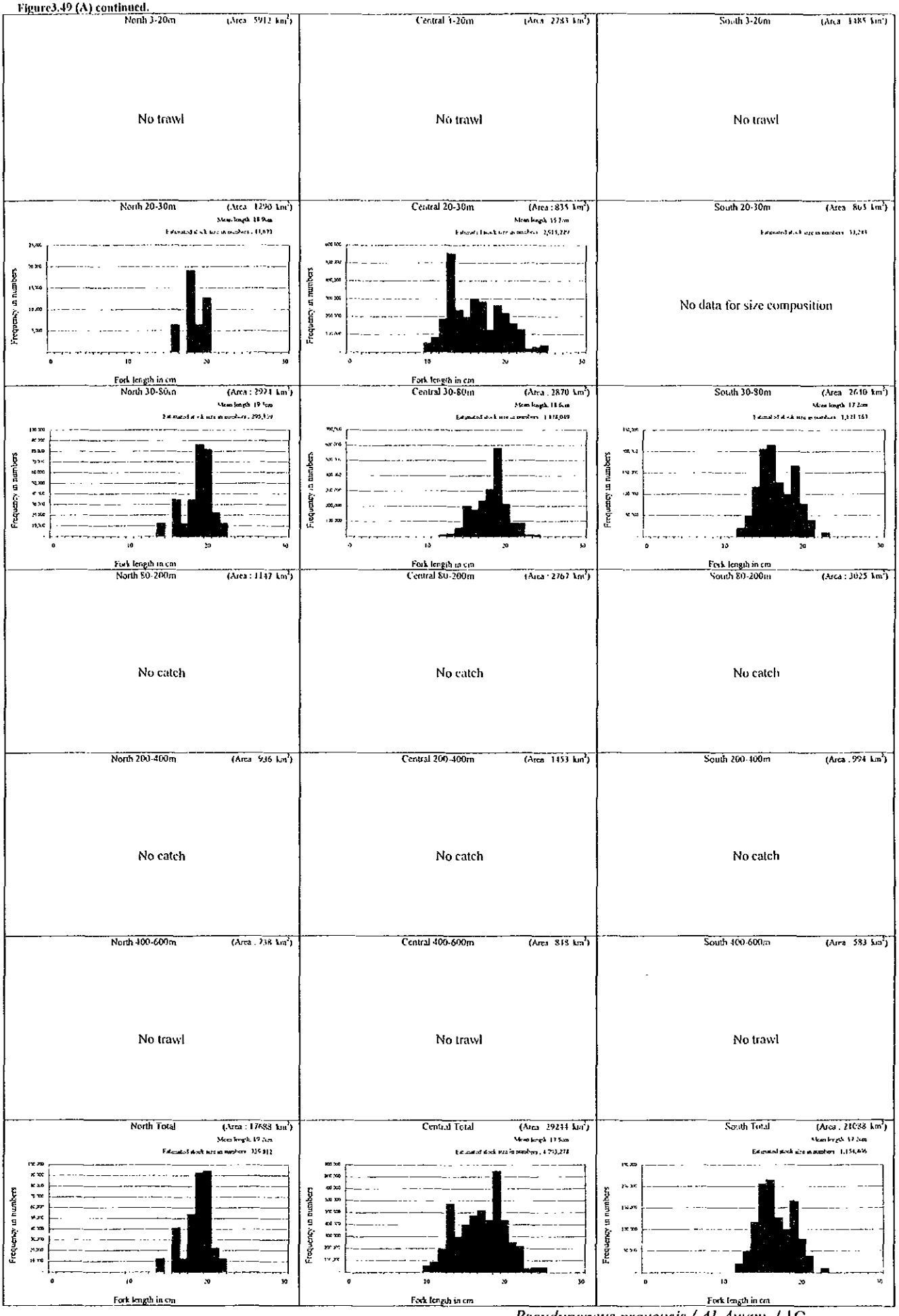


Figure3.49 (B) continued.

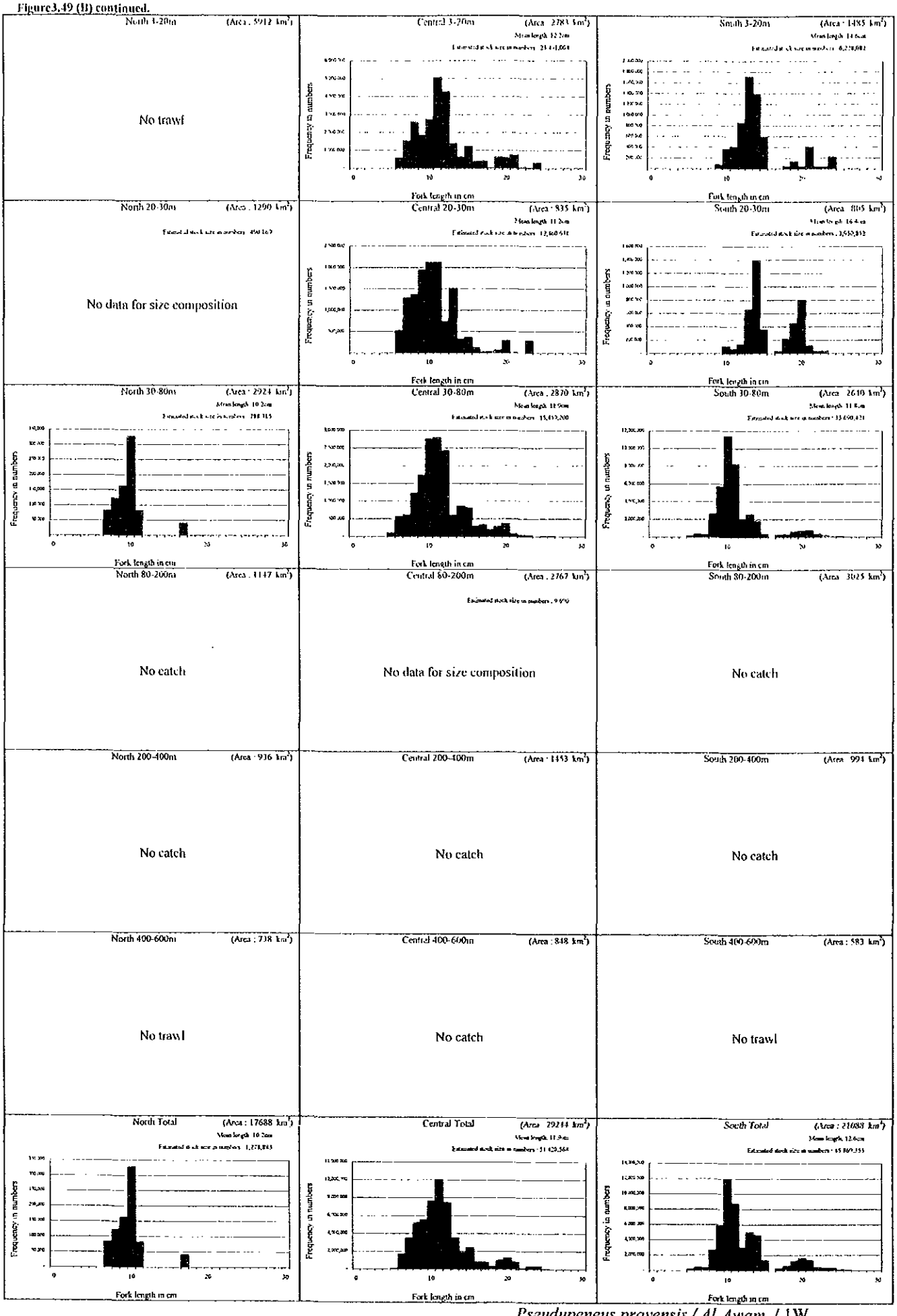


Figure3.49 (C) continued.

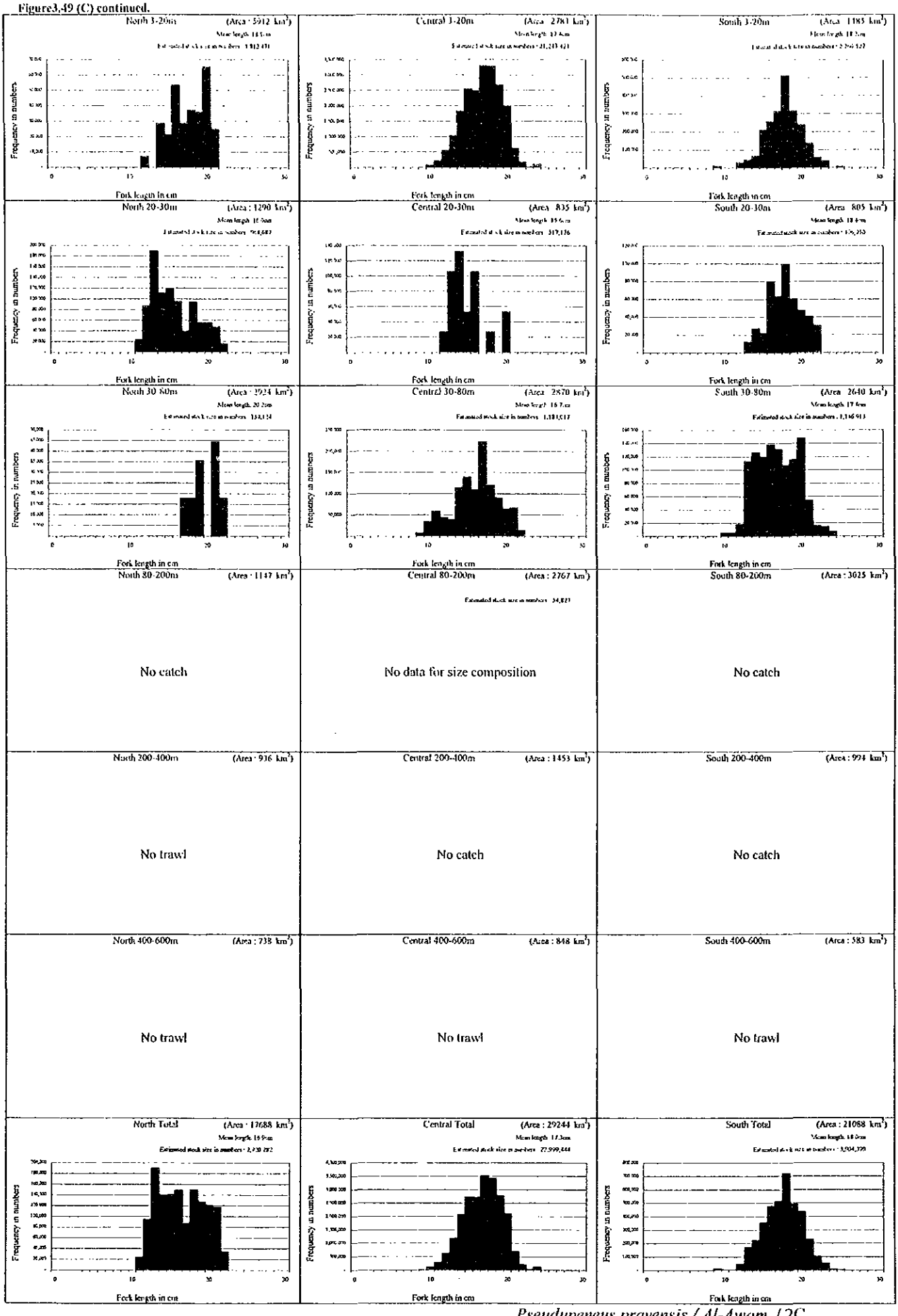


Figure3.49 (D) continued.

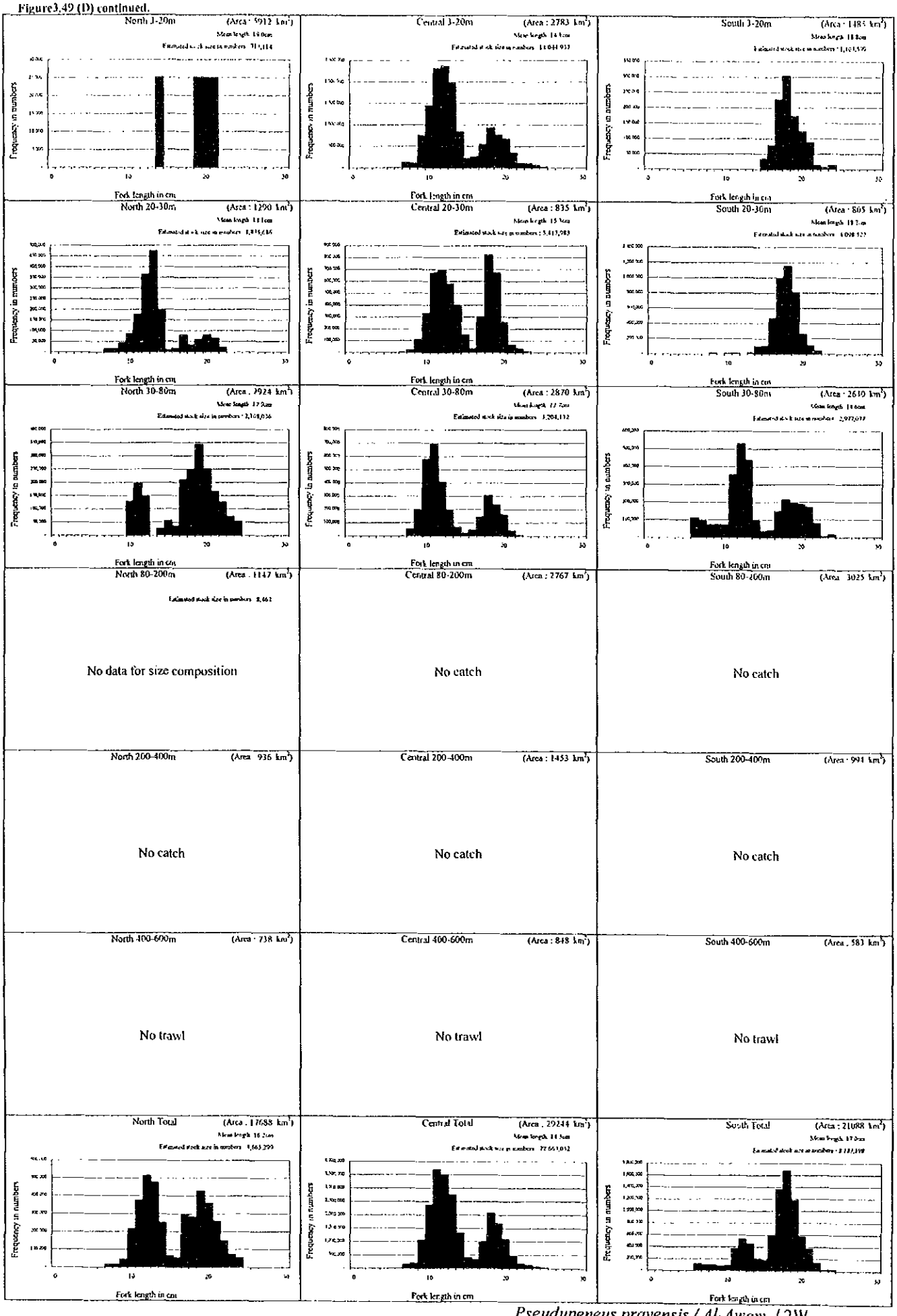


Table 3.78 Body length and weight by sex for West African goatfish *Pseudupeneus prayensis*.

(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	171 ~ 203	193.0	81.0 ~ 167.0	133.5
		Female	1	184	184.0	108.0	108.0
		Indeterminate	0				
		Total	5	171 ~ 203	191.2	81.0 ~ 167.0	128.4
	Warm	Male	10	105 ~ 138	121.6	19.0 ~ 43.0	30.9
		Female	28	77 ~ 142	107.4	7.0 ~ 48.0	21.9
		Indeterminate	51	58 ~ 131	82.0	3.0 ~ 39.0	10.8
		Total	89	58 ~ 142	94.4	3.0 ~ 48.0	16.6
2	Cold	Male	3	146 ~ 170	161.3	42.0 ~ 86.0	68.7
		Female	8	120 ~ 176	139.6	26.0 ~ 86.0	45.3
		Indeterminate	0				
		Total	11	120 ~ 176	145.5	26.0 ~ 86.0	51.6
	Warm	Male	1	129	129.0	35.0	35.0
		Female	6	74 ~ 130	106.3	5.5 ~ 37.0	22.9
		Indeterminate	2	75 ~ 119	97.0	5.8 ~ 27.0	16.4
		Total	9	74 ~ 130	106.8	5.5 ~ 37.0	22.8

(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	58	105 ~ 237	182.5	20.0 ~ 245.0	116.6
		Female	77	106 ~ 249	174.2	20.0 ~ 270.0	99.2
		Indeterminate	1	98	98.0	10.0	10.0
		Total	136	98 ~ 249	177.2	10.0 ~ 270.0	106.0
	Warm	Male	112	62 ~ 230	158.2	2.0 ~ 210.0	81.6
		Female	173	70 ~ 260	166.1	5.0 ~ 320.0	96.1
		Indeterminate	252	60 ~ 205	113.6	3.0 ~ 155.0	28.3
		Total	537	60 ~ 260	139.8	2.0 ~ 320.0	61.3
2	Cold	Male	243	110 ~ 249	187.0	18.0 ~ 290.0	120.4
		Female	205	105 ~ 245	169.4	19.0 ~ 240.0	87.5
		Indeterminate	68	90 ~ 235	151.4	15.0 ~ 240.0	62.8
		Total	516	90 ~ 249	175.3	15.0 ~ 290.0	99.7
	Warm	Male	240	95 ~ 248	163.0	14.0 ~ 250.0	89.8
		Female	345	82 ~ 257	163.2	7.0 ~ 290.0	88.0
		Indeterminate	65	55 ~ 138	99.5	3.0 ~ 45.0	18.4
		Total	650	55 ~ 257	156.8	3.0 ~ 290.0	81.7

Table 3.79 Sex ratio and female maturity stage for West African goatfish *Pseudupeneus prayensis*.

(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	2	E					3	1	0.33	100.0	0.0	0.0	0.0	0	0	E					2	0	0.00	100.0	0.0	0.0	0.0
Other	1	2	2.00	0.0	100.0	0.0	0.0	25	9	0.36	88.0	12.0	0.0	0.0	8	3	0.38	25.0	75.0	0.0	0.0	4	1	0.25	100.0	0.0	0.0	0.0
All area	1	4	4.00	0.0	100.0	0.0	0.0	28	10	0.36	89.3	10.7	0.0	0.0	8	3	0.38	25.0	75.0	0.0	0.0	6	1	0.17	100.0	0.0	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	13	0.59	22.7	72.7	4.5	0.0	4	0	0.00	25.0	0.0	75.0	0.0
	20-30m	6	1	0.17	33.3	50.0	16.7	0.0	0	0	E					8	14	1.75	62.5	25.0	12.5	0.0	19	9	0.47	68.4	26.3	5.3	0.0
	30-80m	17	8	0.47	47.1	23.5	29.4	0.0	3	4	1.33	66.7	33.3	0.0	0.0	5	3	0.60	0.0	80.0	20.0	0.0	20	24	1.20	20.0	20.0	60.0	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	23	9	0.39	43.5	30.4	26.1	0.0	3	4	1.33	66.7	33.3	0.0	0.0	35	30	0.86	28.6	62.9	8.6	0.0	43	33	0.77	41.9	20.9	37.2	0.0
Central	3-20m	-	-	-	-	-	-	-	56	37	0.66	32.1	30.4	37.5	0.0	75	83	1.11	84.0	16.0	0.0	0.0	85	49	0.58	47.1	8.2	44.7	0.0
	20-30m	23	16	0.70	43.5	34.8	21.7	0.0	13	9	0.69	7.7	46.2	46.2	0.0	10	7	0.70	80.0	20.0	0.0	0.0	44	32	0.73	25.0	15.9	59.1	0.0
	30-80m	16	24	1.50	43.8	43.8	12.5	0.0	27	12	0.44	3.7	59.3	37.0	0.0	21	25	1.19	61.9	33.3	4.8	0.0	56	34	0.61	41.1	28.6	30.4	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					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	39	40	1.03	43.6	38.5	17.9	0.0	96	58	0.60	20.8	40.6	38.5	0.0	106	115	1.08	79.2	19.8	0.9	0.0	185	115	0.62	40.0	16.2	43.8	0.0
South	3-20m	-	-	-	-	-	-	-	15	18	1.20	20.0	33.3	46.7	0.0	19	28	1.47	52.6	31.6	15.8	0.0	35	24	0.69	0.0	11.4	88.6	0.0
	20-30m	0	0	E					17	16	0.94	35.3	47.1	17.6	0.0	10	29	2.90	60.0	40.0	0.0	0.0	35	25	0.71	0.0	54.3	45.7	0.0
	30-80m	15	9	0.60	80.0	20.0	0.0	0.0	42	16	0.38	45.2	28.6	26.2	0.0	35	41	1.17	82.9	17.1	0.0	0.0	47	43	0.91	10.9	34.8	54.3	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	15	9	0.60	80.0	20.0	0.0	0.0	74	50	0.68	37.8	33.8	28.4	0.0	64	98	1.53	70.3	25.0	4.7	0.0	117	92	0.79	4.3	33.6	62.1	0.0
All	3-20m	-	-	-	-	-	-	-	71	55	0.77	29.6	31.0	39.4	0.0	116	124	1.07	67.2	29.3	3.4	0.0	124	73	0.59	33.1	8.9	58.1	0.0
	20-30m	29	17	0.59	41.4	37.9	20.7	0.0	30	25	0.83	23.3	46.7	30.0	0.0	28	50	1.79	67.9	28.6	3.6	0.0	98	66	0.67	24.5	31.6	43.9	0.0
	30-80m	48	41	0.85	56.3	29.2	14.6	0.0	72	32	0.44	30.6	40.3	29.2	0.0	61	69	1.13	68.9	27.9	3.3	0.0	123	101	0.82	26.2	29.5	44.3	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	77	58	0.75	50.6	32.5	16.9	0.0	173	112	0.65	28.9	37.6	33.5	0.0	205	243	1.19	67.8	28.8	3.4	0.0	345	240	0.70	28.2	22.7	49.1	0.0

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

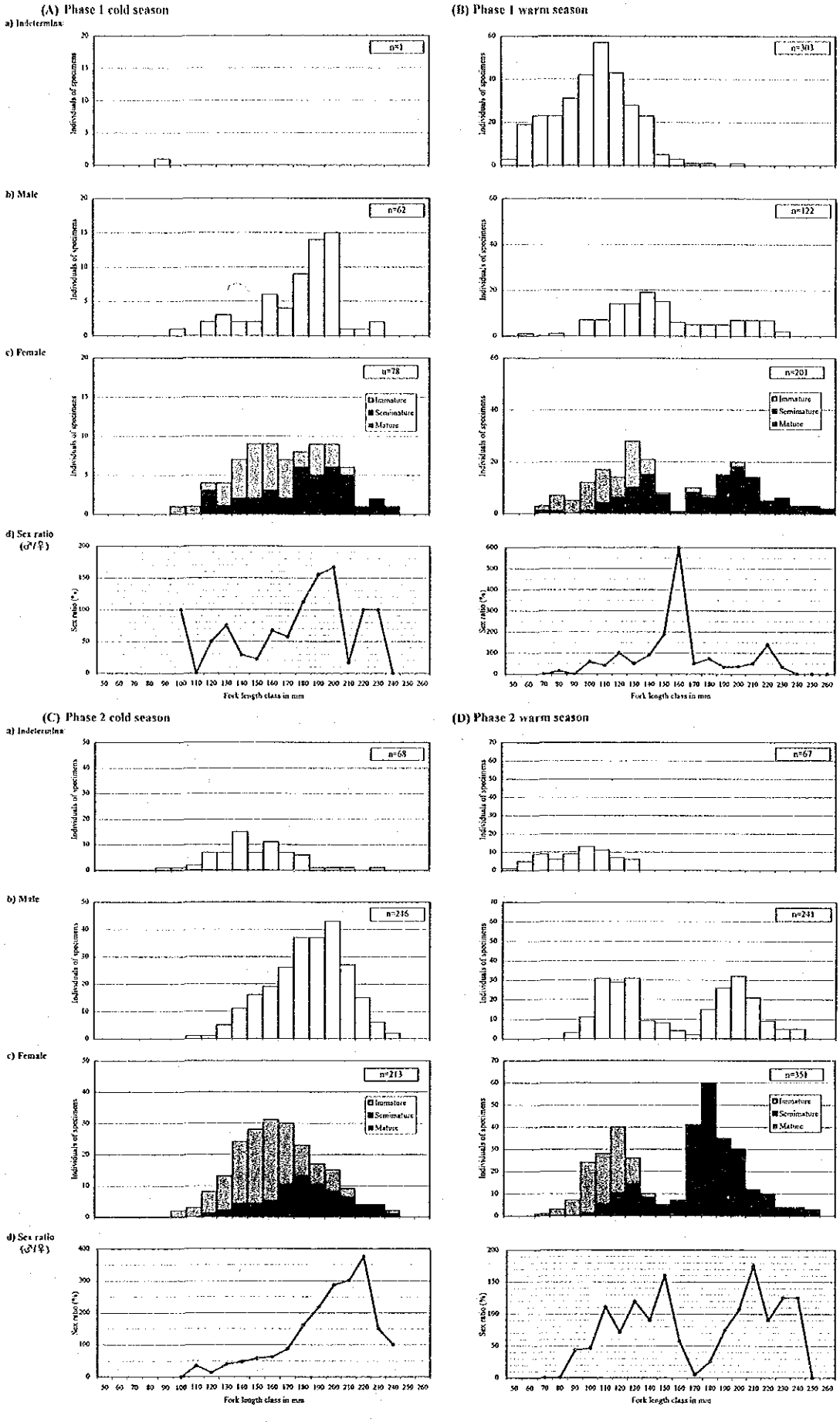


Figure 3.51 Sex ratio and female maturity stage by length class for West African goatfish *Pseudupeneus prayensis*.

Table 3.80 Stomach content analysis of West African goatfish *Pseudupeneus prayensis*.

(A) Stomach condition

Phase	Season	*Stomach condition*				*Stomach content Somatic Index (SSI)*			
		n*	Empty (%)	Evert (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	141	30.50	0.00	69.50	134	0.00	35.56	9.24
	Warm	564	79.26	0.00	20.74	563	0.00	135.00	4.54
2	Cold	376	85.37	0.00	14.63	372	0.00	98.46	3.38
	Warm	610	50.00	0.00	50.00	602	0.00	71.43	6.89

(B) Stomach contents

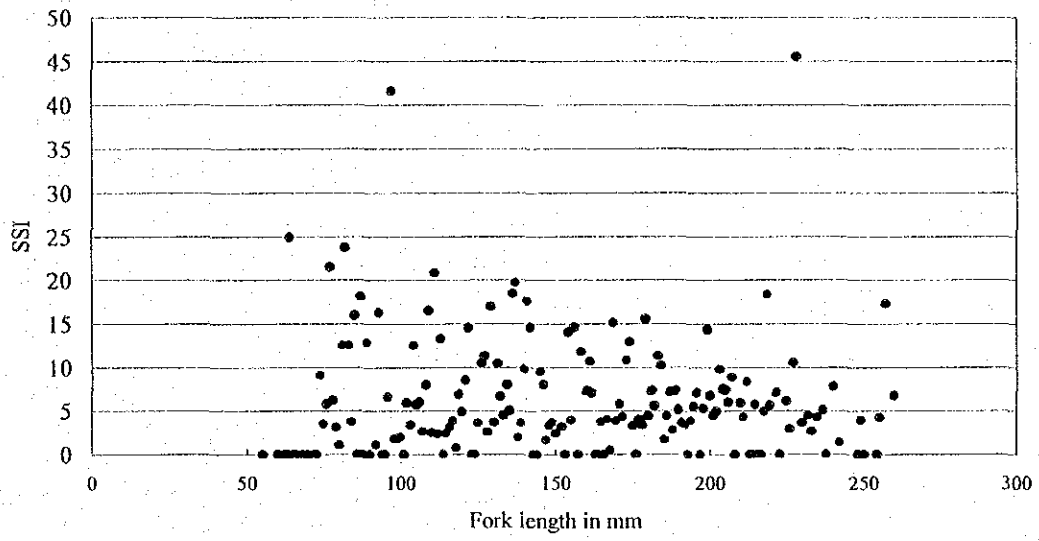
Phase	Season	n*	Algae	Mollusca			Polychaeta
				Bivalvia	Decapoda	Other	
1	Cold	98					1.02
	Warm	117			0.85		1.71
2	Cold	55				1.82	3.64
	Warm	303	0.33	4.95	0.99		3.96

(Continued)

Phase	Season	Crustacea				Echinodermata	Fish	Unknown
		Gammaridae	Crab	Shrimp	Other	Asterozoa		
1	Cold			8.16	64.29			26.53
	Warm	0.85		19.66	7.69		1.71	68.38
2	Cold			1.82	18.18	5.45	5.45	69.09
	Warm		1.65	35.31	9.24		8.25	38.94

Remark. * : Individuals of specimens.

(A) Relationship between fork length and SSI



(B) Relationship between fork length and SCW

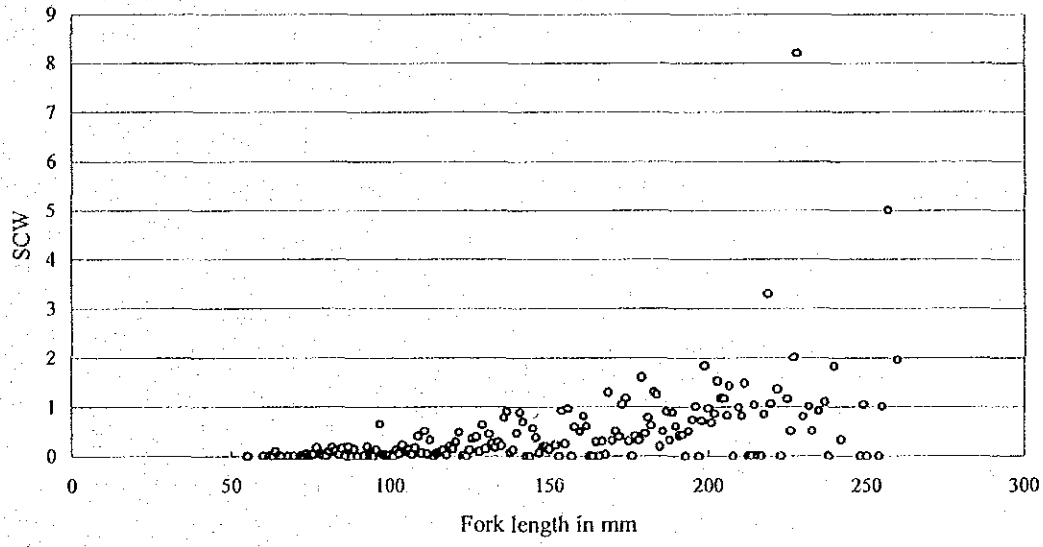


Figure 3.52 Relationship between body length and SSI (A) and SCW (B) for West African goatfish *Pseudupeneus prayensis.*

8) Bluespotted seabream *Pagrus caeruleostictus*

a) Body length range and mean body length

Table 3.81 (page 3-244) presents the minimum, maximum and mean fork length obtained for the bluespotted seabream.

In the area surveyed by the *Amrigue*, the fork length and the mean fork length varied between 40 and 215 mm and between 73 and 171 mm respectively. The mean fork length by area in each season was higher in the cold than in the warm season and higher in the Banc d'Arguin.

In the area surveyed by the *Al-Awam*, the fork length was between 43 and 514 mm. The mean fork length by area varied between 163 and 499 mm. By season, it was higher in the cold season than in the warm season in each area; by area, it was higher in the Northern and Southern areas. The mean fork length by stratum was, but for a few exceptions, higher in deep strata.

b) Size composition

Figure 3.53 (page 3-241, 3-245 to 3-248) presents the evaluation of the size composition for the bluespotted seabream stock. The fork length class in these figures is indicated at intervals of 1cm. For convenience, three groups were defined: (i) small-size (fork length less than 20cm), (ii) medium-size (length between 20 and 40cm), (iii) large-size (length over 40cm).

Regardless of season, the total stock size in number of the bluespotted seabream essentially comprised the medium-size group, but also the small-size and large-size groups even if the frequency of occurrence of the latter group was low (almost zero in the warm season). The small-size group comprised two popurations, one with a mode at the class near 15cm in the cold season (hereinafter called S*ℓ* group), and another with a mode at the 8-9cm class in the warm season, though not much conspicuous in Phase 2 (hereinafter referred to as Ss group). The medium-size group also formed two populations: one with a mode at classes between 20 and 25cm (hereinafter called Ms group), and another with a mode at classes between 30 and 35cm, not much salient in the Phase 2 warm season (hereinafter named M*ℓ* group). On the other hand, the large-size group was a population without a distinct mode (hereinafter called L group). The Ss and S*ℓ* groups suggest the bluespotted seabream has at least two spawning periods anterior to both survey seasons, and that the one providing for the Ss group should be the main spawning season.

The study of the distribution of these five groups was based on the size composition by stratum and by area. The Ss group was distributed mainly in the Central area, particularly at the 3-20 m stratum, but was also found in low quantities at the 20-30 m stratum in the Northern area. The S*ℓ* group was distributed in the Northern area and/or in the Central area, the main distribution zone still being at the 3-20 m stratum in the Central area. The Ms group was widespread over the entire survey area, and the main distribution areas were at the 3-20 m stratum ①in the Central area and/or in the Southern area in the cold season, ② in the Central and Southern areas in the Phase 1 warm season, and ③in the Northern area in the Phase 2 warm season. The M*ℓ* group was scattered over the survey area, but mainly distributed in the Central area, particularly at the 30-80 m stratum in the cold season. As for the L group, it was confined to the Central and Southern areas in the cold season.

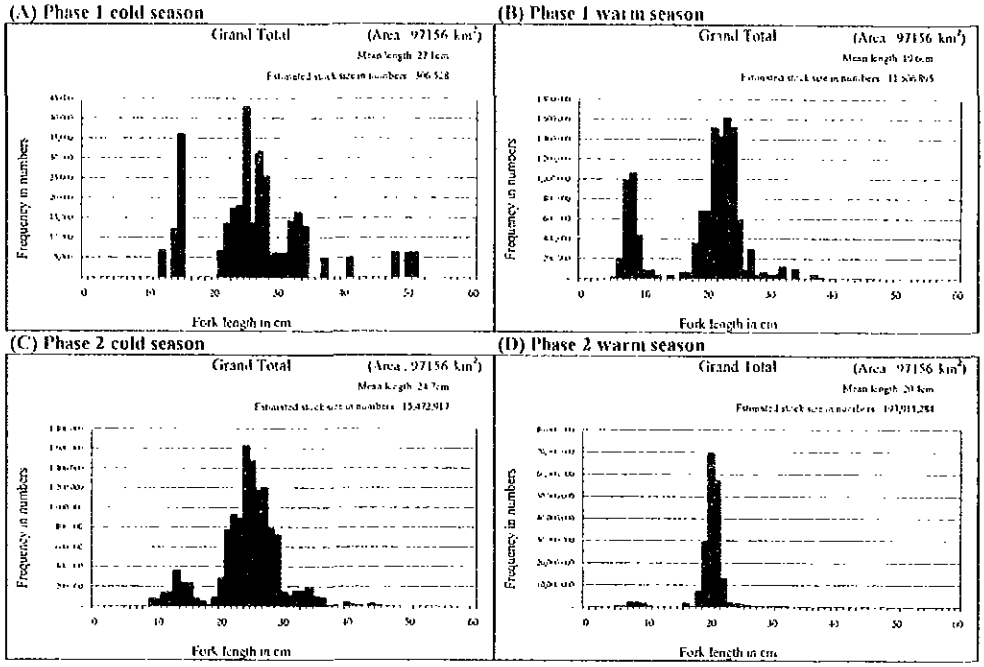


Figure 3.53 Size composition for bluespotted seabream *Pagrus caeruleostictus*.

c) Length-weight relationship

Figure 3.54 presents the relationship between the fork length and weight in the bluespotted seabream. The length-weight equations obtained were the following:

Phase 1 cold season	: BW=	$6.530\times10^{-3}\times TL^{3.366}$	(r=0.9540)
Phase 1 warm season	: BW=	$2.502\times10^{-2}\times TL^{3.047}$	(r=0.9962)
Phase 2 cold season	: BW=	$2.217\times10^{-2}\times TL^{3.023}$	(r=0.9953)
Phase 2 warm season	: BW=	$2.166\times10^{-2}\times TL^{3.031}$	(r=0.9980)

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

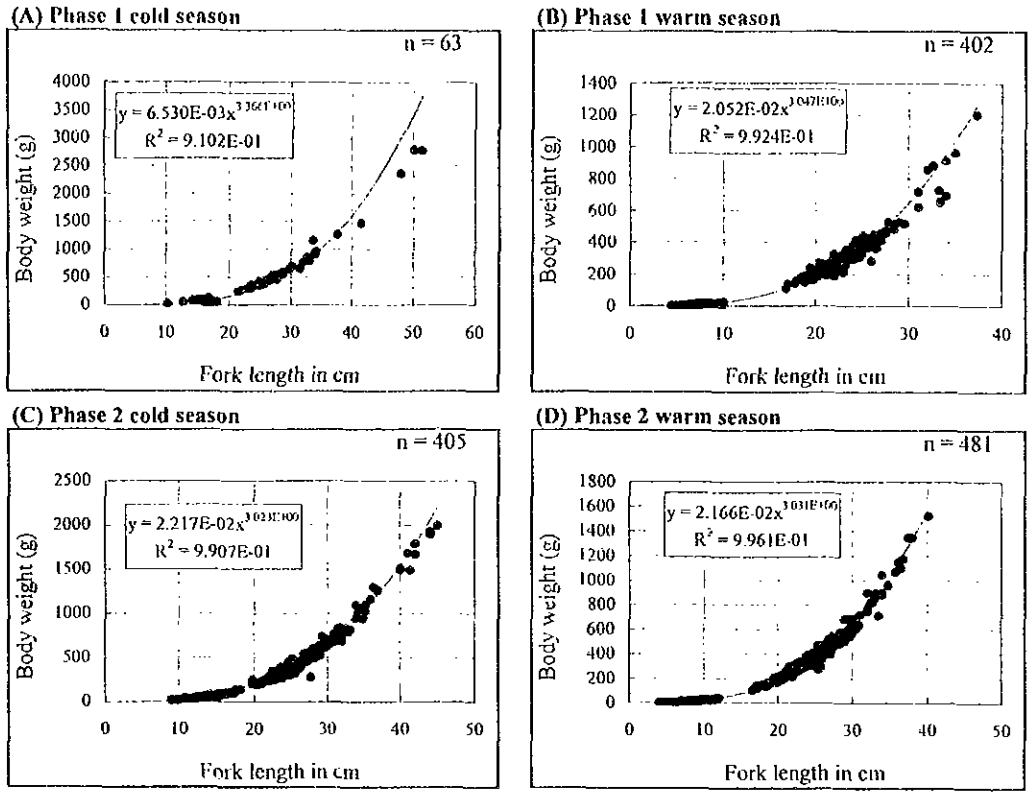


Figure 3.54 Length-weight relationship for bluespotted seabream *Pagrus caeruleostictus*.

d) Length and weight by sex

Table 3.82 (page 3-249) summarizes the fork length and body weight observed in each sex for the bluespotted seabream.

In the area surveyed by the *Anrigue*, the mean fork length by sex of this species was between 140 and 178 mm for females and 147 mm for males.

In the area surveyed by the *Al-Awam*, the fork length by sex varied between 90 and 514 mm for males and between 100 and 440 mm for females. The mean fork length by sex varied between 234 and 297 mm for males and between 233 and 262 mm for females. The mean fork length of males was larger than that of females in all seasons except in the Phase 1 warm season. The average sizes of both males and females were larger in the cold season than in the warm season.

The fork length of individuals with gonads developed enough to allow sex recognition by visual inspection was around 10cm for early ones of both sexes and about 17cm for late ones of both sexes. Considering that the fork length of individuals of indetermined sex could be near 34cm, it is likely that individual differences were significant.

e) Sex ratio and female maturity stage

Table 3.83 (page 3-250) summarizes the sex ratio and the female maturity stage for the bluespotted seabream. Figure 3.55 (page 3-251) presents their distribution by length class. Samples obtained in the

area surveyed by the *Amrigue* were too few (14 immature females, 3 males) and their data were not included in this analysis.

The overall sex ratio of this species was between 0.52 and 0.81 and females were therefore dominant regardless of season. The results were identical for the sex ratio by area. The sex ratio by stratum depended on depth only in the Phase 2 warm season, when it was 0.60, 0.91 and 1.17 towards deeper strata.

The female maturity ratio in the entire area was between 4 and 11% in the cold season and between 33 and 49% in the warm season. There is no clear about the depth-dependent change, but the maturity ratio was often high at the 3-20 m and 20-30 m strata. By area, the female maturity ratio observed in Phase 2 showed a geographic-dependent change, with higher values in the Southern area, with those values declining northwards.

The sex ratio by length class didn't show the size-dependent change: females were the majority in most classes (although the percentage was lower than 100% and fluctuated significantly).

The fork length at first maturity was observed at the 24-25cm class in the cold season, and at the 19-20cm class in the warm season. According to Dah *et al.* (1991), the fork length of the smallest mature individual should be between 23 and 27cm. The results obtained in the cold season corroborates that observation.

f) Feeding habits

Table 3.84 (page 3-252) presents the stomach condition and the stomach content composition of the bluespotted seabream in each survey season. Figure 3.56 (page 3-253) presents the relationship between the fork length and SSI and SCW. Those results were based on all data collected by the two vessels.

The ratio of the empty stomach varied between 44 and 60%. In the Phase 1 cold season, a single sample had an everted stomach. 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 bluespotted seabream feeds mainly on crustaceans (crabs, shrimp, anomurans, *etc.*) and mollusks (bivalves, gastropods, cuttlefish or squid, octopus, *etc.*). Its diet is quite varied, and includes also sponges, jellyfish, polychaetes, starfish, sea squirts and fish.

Table 3.81 Body length range and mean body length for bluespotted seabream *Pagrus caeruleostictus* : 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	13	103 ~ 215	171.0	15	45 ~ 95	76.0	8	114 ~ 163	132.1	48	40 ~ 114	73.1
Other	0			12	44 ~ 90	68.8	1	90	90.0	0		
All area	13	103 ~ 215	171.0	27	44 ~ 95	72.8	9	90 ~ 163	127.4	48	40 ~ 114	73.1

(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	-	-	-	-	-	-	73	90 ~ 353	243.6	80	185 ~ 340	225.6
	20-30m	0			0			5	257 ~ 340	294.0	13	82 ~ 250	209.2
	30-80m	0			0			0			11	250 ~ 402	330.5
	80-200m	0			0			0			0		
	200-400m	0			0			-	-	-	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	0			0			78	90 ~ 353	246.8	104	82 ~ 402	234.7
Central	3-20m	-	-	-	185	60 ~ 326	163.8	120	97 ~ 400	192.4	146	43 ~ 368	174.1
	20-30m	24	128 ~ 287	211.3	66	50 ~ 278	161.8	2	180 ~ 413	296.5	7	200 ~ 255	225.0
	30-80m	23	249 ~ 415	301.1	0			20	260 ~ 450	355.5	20	220 ~ 348	264.7
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	47	128 ~ 415	255.2	251	50 ~ 326	163.3	142	97 ~ 450	216.9	173	43 ~ 368	186.6
South	3-20m	-	-	-	84	192 ~ 373	234.2	145	198 ~ 420	253.4	102	170 ~ 358	240.3
	20-30m	3	480 ~ 514	498.7	21	190 ~ 250	225.9	22	215 ~ 285	243.9	46	205 ~ 270	230.3
	30-80m	0			19	240 ~ 350	271.9	9	225 ~ 260	244.4	8	243 ~ 282	260.3
	80-200m	0			0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	3	480 ~ 514	498.7	124	190 ~ 373	238.5	176	198 ~ 420	251.7	156	170 ~ 358	238.4

Remark. - : no trawl.

Figure3.53 (A) continued.

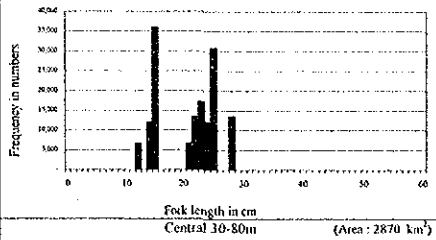
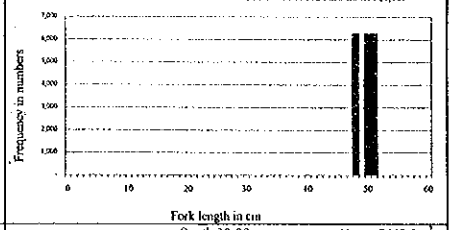
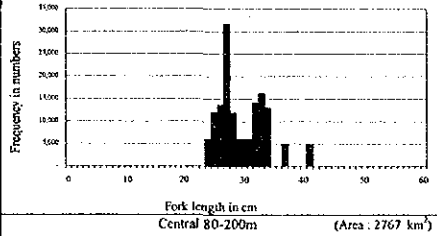
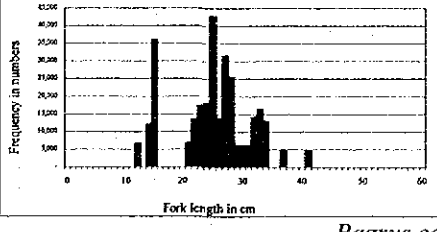
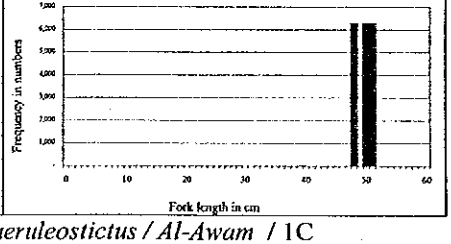
North 3-20m (Area : 5912 km²) No trawl	Central 3-20m (Area : 2783 km²) No trawl	South 3-20m (Area : 1485 km²) No trawl
North 20-30m (Area : 1290 km²) No catch	Central 20-30m (Area : 835 km²) Mean length: 21.1cm Estimated stock size in numbers : 151,083 	South 20-30m (Area : 805 km²) Mean length: 50.2cm Estimated stock size in numbers : 18,126 
North 30-80m (Area : 2924 km²) No catch	Central 30-80m (Area : 2870 km²) Mean length: 30.1cm Estimated stock size in numbers : 137,316 	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 trawl	South 400-600m (Area : 583 km²) No trawl
North Total (Area : 17688 km²) No catch	Central Total (Area : 29244 km²) Mean length: 25.6cm Estimated stock size in numbers : 288,401 	South Total (Area : 21088 km²) Mean length: 50.2cm Estimated stock size in numbers : 18,126 

Figure3.53 (B) continued.

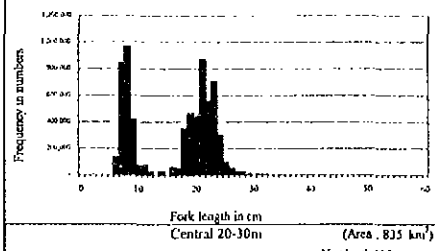
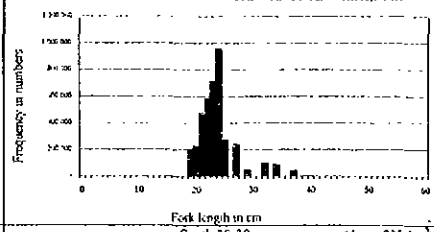
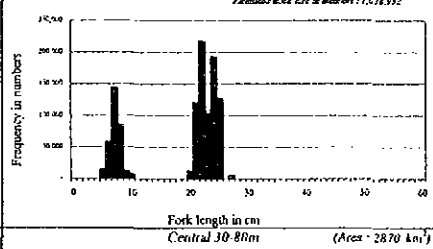
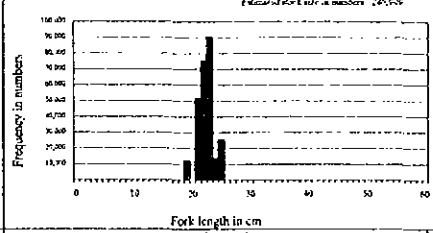
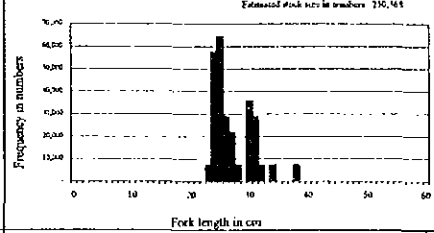
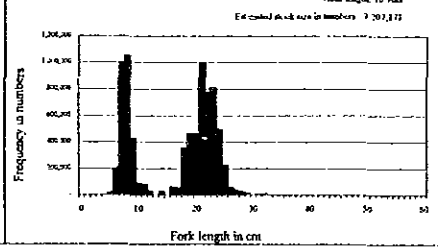
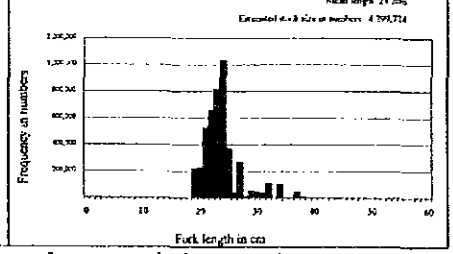
North 3-20m (Area : 5912 km²) No trawl	Central 3-20m (Area : 2783 km²) 	South 3-20m (Area : 1485 km²) 
North 20-30m (Area : 1290 km²) No catch	Central 20-30m (Area : 835 km²) 	South 20-30m (Area : 805 km²) 
North 30-80m (Area : 2924 km²) No catch	Central 30-80m (Area : 2870 km²) No catch	South 30-80m (Area : 2640 km²) 
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) No catch	Central Total (Area : 29244 km²) 	South Total (Area : 21058 km²) 

Figure3.53 (C) continued.

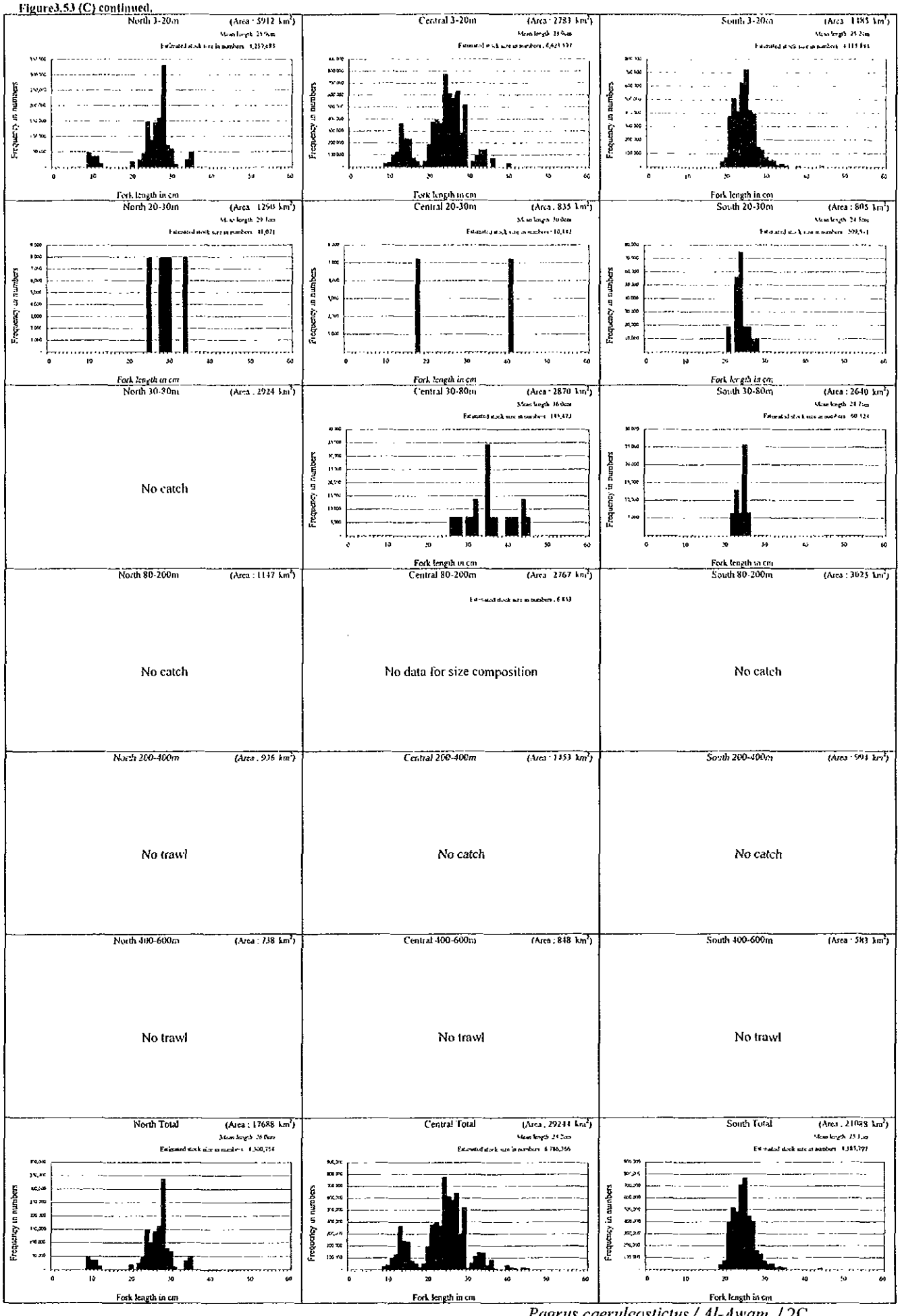


Figure3.53 (D) continued.

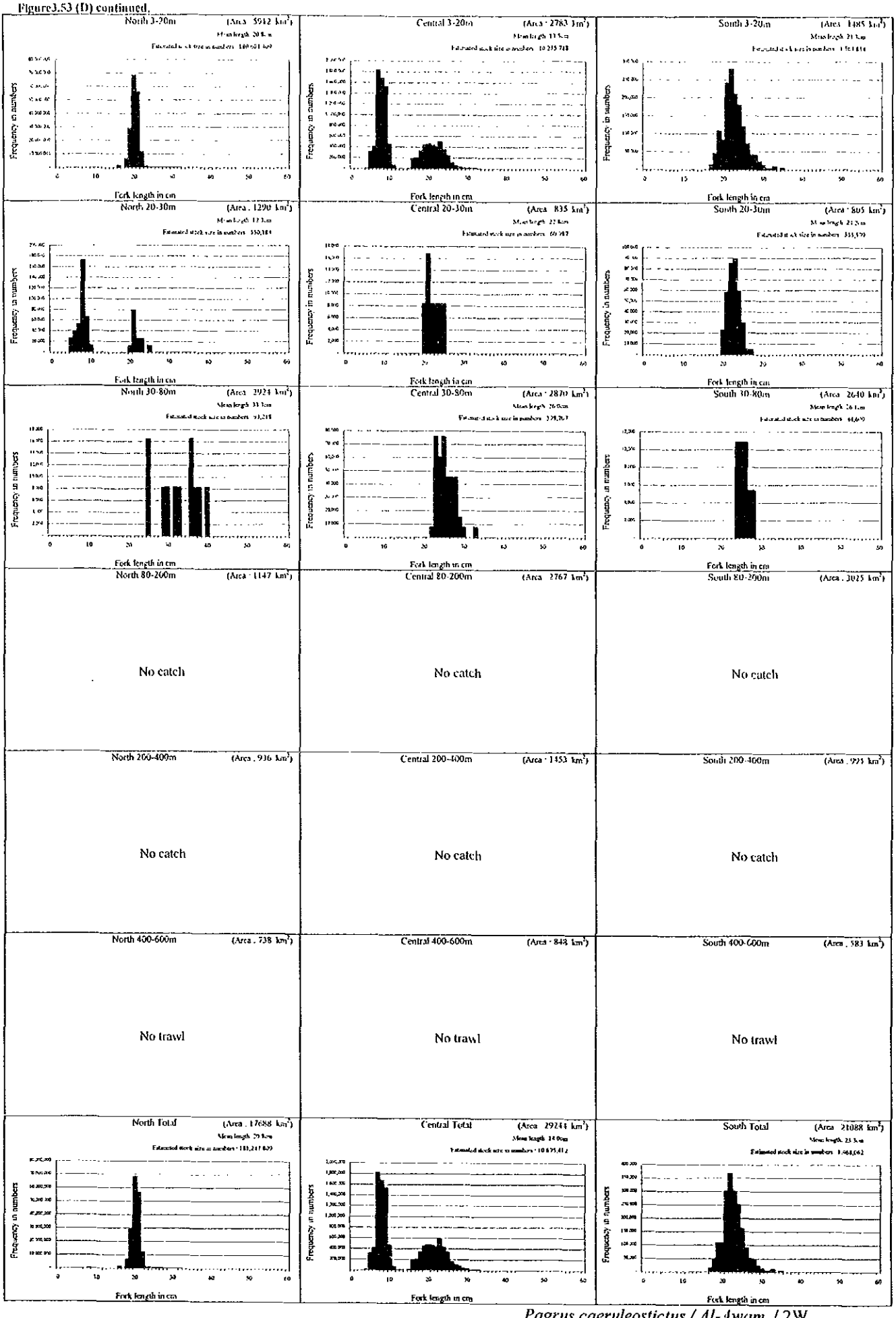


Table 3.82 Body length and weight by sex for bluespotted seabream *Pagrus caeruleostictus*.

(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	0				
		Female	7	163 ~ 215	178.4	35.0 ~ 249.0	85.4
		Indeterminate	6	103 ~ 180	162.3	26.0 ~ 54.0	43.8
		Total	13	103 ~ 215	171.0	26.0 ~ 249.0	66.2
	Warm	Male	0				
		Female	0				
		Indeterminate	27	44 ~ 95	72.8	2.0 ~ 18.0	9.6
		Total	27	44 ~ 95	72.8	2.0 ~ 18.0	9.6
2	Cold	Male	2	130 ~ 163	146.5	50.0 ~ 92.0	71.0
		Female	1	140	140.0	70.0	70.0
		Indeterminate	6	90 ~ 140	119.0	20.0 ~ 60.0	40.2
		Total	9	90 ~ 163	127.4	20.0 ~ 92.0	50.3
	Warm	Male	0				
		Female	0				
		Indeterminate	48	40 ~ 114	73.1	1.5 ~ 27.0	9.9
		Total	48	40 ~ 114	73.1	1.5 ~ 27.0	9.9

(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	21	128 ~ 514	296.7	55.0 ~ 2,790.0	814.8
		Female	26	143 ~ 340	261.6	75.0 ~ 1,160.0	505.0
		Indeterminate	3	146 ~ 158	153.3	80.0 ~ 95.0	88.3
		Total	50	128 ~ 514	269.8	55.0 ~ 2,790.0	610.1
	Warm	Male	87	168 ~ 350	234.0	110.0 ~ 965.0	325.9
		Female	166	170 ~ 373	235.8	140.0 ~ 1,205.0	325.1
		Indeterminate	122	50 ~ 227	90.6	3.5 ~ 325.0	30.2
		Total	375	50 ~ 373	188.2	3.5 ~ 1,205.0	229.3
2	Cold	Male	127	129 ~ 450	263.0	50.0 ~ 1,995.0	485.4
		Female	204	130 ~ 440	253.0	50.0 ~ 1,930.0	433.1
		Indeterminate	65	90 ~ 343	143.6	16.5 ~ 975.0	93.9
		Total	396	90 ~ 450	238.3	16.5 ~ 1,995.0	394.2
	Warm	Male	155	90 ~ 380	236.0	15.0 ~ 1,350.0	349.4
		Female	223	100 ~ 402	233.2	20.0 ~ 1,525.0	331.2
		Indeterminate	55	43 ~ 215	96.1	2.0 ~ 255.0	30.1
		Total	433	43 ~ 402	216.8	2.0 ~ 1,525.0	299.5

Table 3.83 Sex ratio and female maturity stage for bluespotted seabream *Pagrus caeruleostictus*.

(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: 5-20m)	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV	♀	♂	(♂/♀)	I	II	III	IV
Banc d'Arguin	7	0	0.00	100.0	0.0	0.0	0.0	0	0	E					1	2	2.00	100.0	0.0	0.0	0.0	2	0	0.00	100.0	0.0	0.0	0.0
Other	0	0	E					0	0	E					0	0	E					4	1	0.25	100.0	0.0	0.0	0.0
All area	7	0	0.00	100.0	0.0	0.0	0.0	0	0	E					1	2	2.00	100.0	0.0	0.0	0.0	6	1	0.17	100.0	0.0	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39	25	0.59	25.6	71.8	2.6	0.0	47	31	0.66	74.5	25.5	0.0	0.0
	20-30m	0	0	E					0	0	E					3	2	0.67	0.0	66.7	0.0	33.3	7	5	0.71	100.0	0.0	0.0	0.0
	30-80m	0	0	E					0	0	E					0	0	E					7	4	0.57	57.1	42.9	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	0	0	E					0	0	E					42	25	0.60	23.8	71.4	2.4	2.4	61	40	0.66	75.4	24.6	0.0	0.0
Central	3-20m	-	-	-	-	-	-	-	70	52	0.46	21.4	51.4	25.7	1.4	44	27	0.61	52.3	45.5	2.3	0.0	51	43	0.84	29.4	25.5	45.1	0.0
	20-30m	10	11	1.10	70.0	20.0	10.0	0.0	18	17	0.94	0.0	33.3	66.7	0.0	0	1	E					6	1	0.17	0.0	0.0	100.0	0.0
	30-80m	16	7	0.44	25.0	75.0	0.0	0.0	0	0	E					10	10	1.00	0.0	50.0	50.0	0.0	5	15	3.00	0.0	20.0	80.0	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	26	18	0.69	42.3	53.8	3.8	0.0	88	49	0.56	17.0	47.7	34.1	1.1	54	38	0.70	42.6	46.3	11.1	0.0	62	59	0.95	24.2	22.6	53.2	0.0
South	3-20m	-	-	-	-	-	-	-	53	24	0.45	50.9	18.9	30.2	0.0	89	53	0.60	42.0	39.8	18.2	0.0	73	29	0.40	1.4	15.1	83.6	0.0
	20-30m	0	3	E					11	9	0.82	9.1	54.5	36.4	0.0	11	11	1.00	81.8	18.2	0.0	0.0	21	25	1.19	0.0	25.0	75.0	0.0
	30-80m	0	0	E					14	5	0.36	14.3	50.0	35.7	0.0	8	0	0.00	25.0	75.0	0.0	0.0	6	2	0.33	0.0	100.0	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	0	3	E					78	38	0.49	38.5	29.5	32.1	0.0	108	64	0.59	44.9	40.2	15.0	0.0	100	56	0.56	1.0	22.2	76.8	0.0
All	3-20m	-	-	-	-	-	-	-	123	56	0.46	34.1	37.4	27.6	0.8	172	103	0.60	40.9	48.5	10.5	0.0	171	103	0.60	29.8	21.1	49.1	0.0
	20-30m	10	14	1.40	70.0	20.0	10.0	0.0	29	26	0.90	3.4	41.4	55.2	0.0	14	14	1.00	64.3	28.6	0.0	7.1	34	31	0.91	21.2	15.2	63.6	0.0
	30-80m	16	7	0.44	25.0	75.0	0.0	0.0	14	5	0.36	14.3	50.0	35.7	0.0	18	10	0.56	11.1	61.1	27.8	0.0	18	21	1.17	22.2	55.6	22.2	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	26	21	0.81	42.3	53.8	3.8	0.0	166	87	0.52	27.1	39.2	33.1	0.6	204	127	0.62	39.9	48.3	11.3	0.5	223	155	0.70	27.9	23.0	49.1	0.0

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

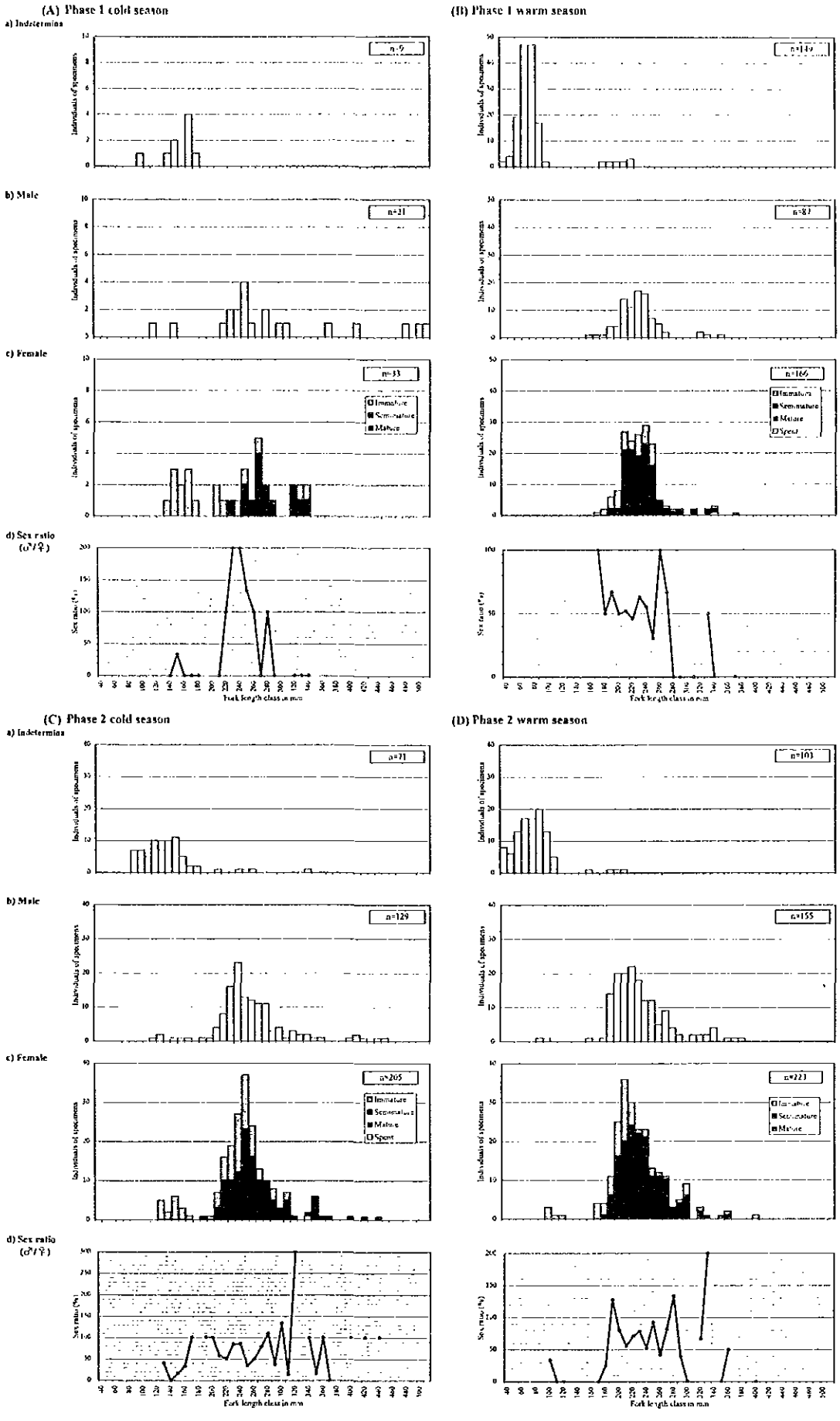


Figure 3.55 Sex ratio and female maturity stage by length class for bluespotted seabream *Pagrus caeruleostictus*.

Table 3.84 Stomach content analysis of bluespotted seabream *Pagrus caeruleostictus*.

(A) Stomach condition

Phase	Season	Stomach condition				Stomach content Somatic Index (SSI)			
		n*	Empty (%)	Evert (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	63	43.55	1.59	54.86	59	0.00	90.91	8.47
	Warm	367	55.59	0.00	44.41	359	0.00	111.11	7.02
2	Cold	295	60.00	0.00	40.00	290	0.00	70.00	8.32
	Warm	447	58.39	0.00	41.61	436	0.00	152.67	5.77

(B) Stomach contents

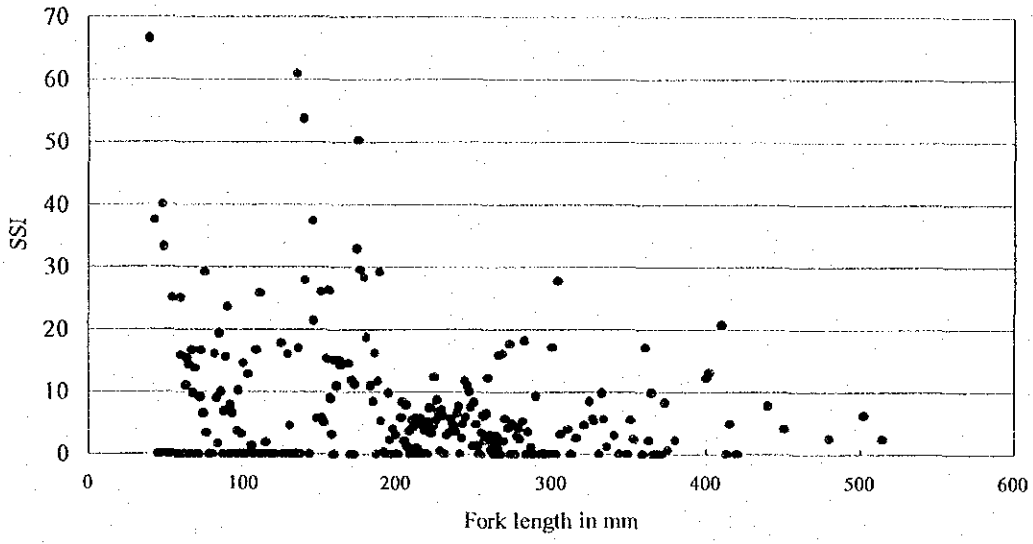
Phase	Season	n*	Sponges	Jelly Fish	Mollusca					Polychaeta
					Gastropoda	Bivalvia	Decapoda	Octopoda	Other	
1	Cold	35		2.86	5.71	11.43				5.71
	Warm	163			1.84	3.07	0.61	0.61	1.84	3.07
2	Cold	118			3.39	1.69			9.32	
	Warm	183	1.09		0.55	31.69		1.64	1.64	1.64

(Continued)

Phase	Season	Crustacea				Echinodermata	Protochordata	Fish	Unknown
		Crab	Anomura	Shrimp	Other	Asterozoa	Ascidiacea		
1	Cold	20.00			22.86			2.86	31.43
	Warm	1.84		0.61	4.91			4.29	79.14
2	Cold	11.02		2.54	2.54	1.69		2.54	66.10
	Warm	21.31	0.55	7.65	11.48	0.55	0.55	0.55	25.14

Remark. * : Individuals of specimens.

(A) Relationship between fork length and SSI



(B) Relationship between fork length and SCW

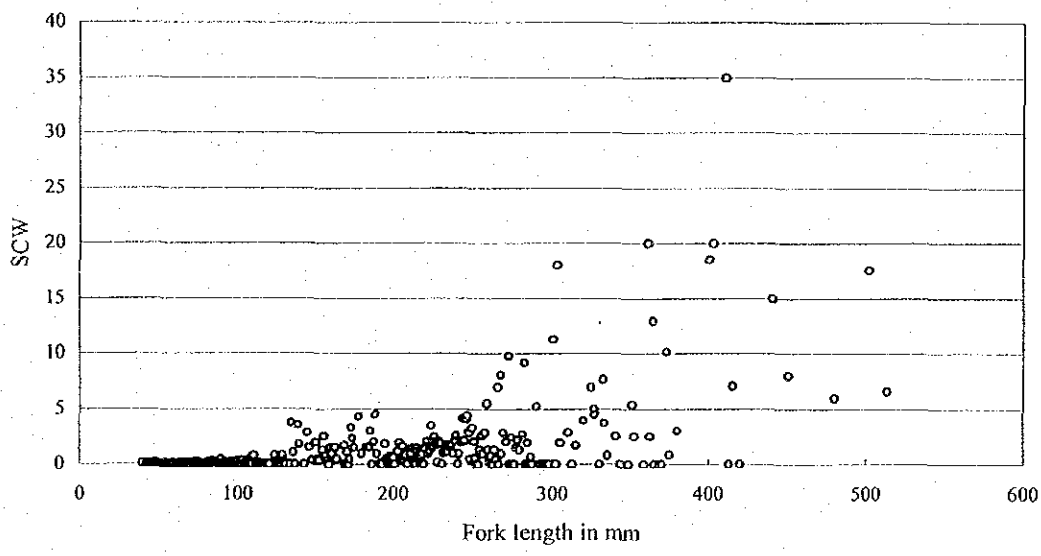


Figure 3.56 Relationship between body length and SSI (A) and SCW (B) for bluespotted seabream *Pagrus caeruleostictus.*

9) Angola dentex *Dentex angolensis*

a) Body length range and mean body length

Table 3.85 (page 3-258) presents the minimum, maximum and mean fork length obtained for the Angola dentex.

The fork length of this species varied between 148 and 337 mm. In the Phase 1 cold season, the mean fork length by area varied between 204 and 280 mm and was higher in the Central area. In the same season, the mean fork length by stratum in the Southern area increased with depth.

b) Size composition

Figure 3.57 (page 3-255, 3-259 to 3-260) presents the evaluation of the size composition for the Angola dentex. The fork length class is indicated at intervals of 1cm.

The size composition of the total stock size in number (data were obtained in each area only in the Phase 1 cold season) presents a poly-modal distribution with three modes (the mode at the 26-27cm class was not considered). The total stocks mainly comprised the small-size group with a predominant mode at the 17-18cm class, then the medium-size group with a mode at the 23-24cm class, and finally the large-size group with a mode at the 30-31cm class.

In the Phase 1 warm season, the stock size in number of the Southern area (all at the 30-80 m stratum) was formed by a group of individuals with a dominant mode at the 12-13cm class and the other one with a predominant mode at the 19-20cm class. The individuals observed at the 7-8cm class (with a low-peak mode) suggests they were newborn larvae.

In the Phase 2 warm season, the stock size in number of the Central area (all at the 80-200 m stratum) comprised only a population at the 25-26cm class (this result was expanded from a single sample).

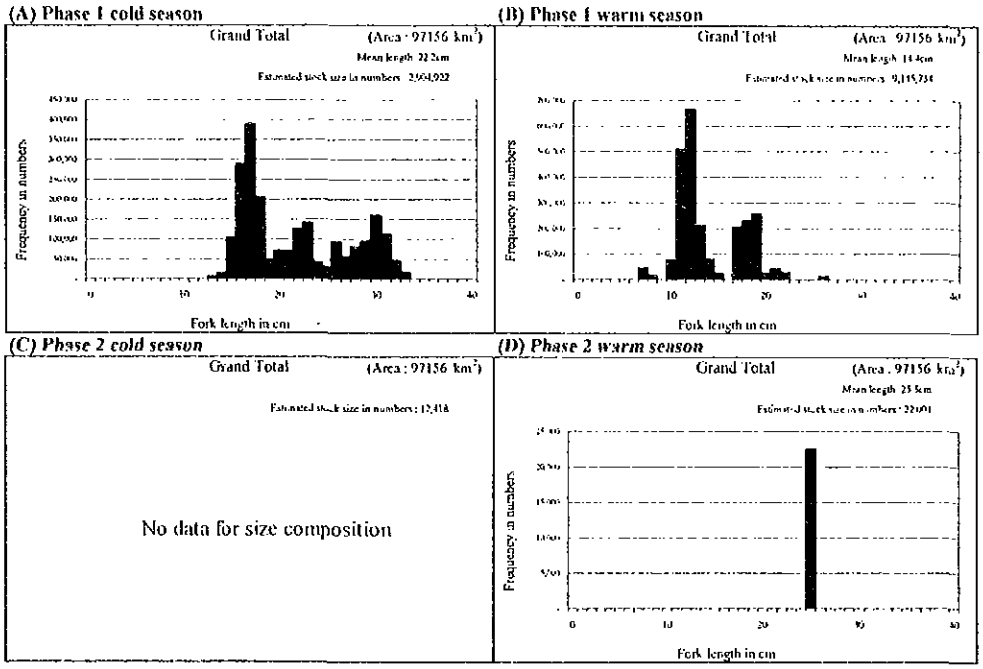


Figure 3.57 Size composition for Angola dentex *Dentex angolensis.*

c) Length-weight relationship

Figure 3.58 (page 3-256) presents the relationship between the fork length and weight for the Angola dentex. The length-weight equations obtained from all samples were the following:

Phase 1 cold season : $BW = 1.917\times10^{-2}\times TL^{3.065}$ (r=0.9930)

Phase 1 warm season : $BW = 2.247\times10^{-2}\times TL^{2.968}$ (r=0.9940)

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

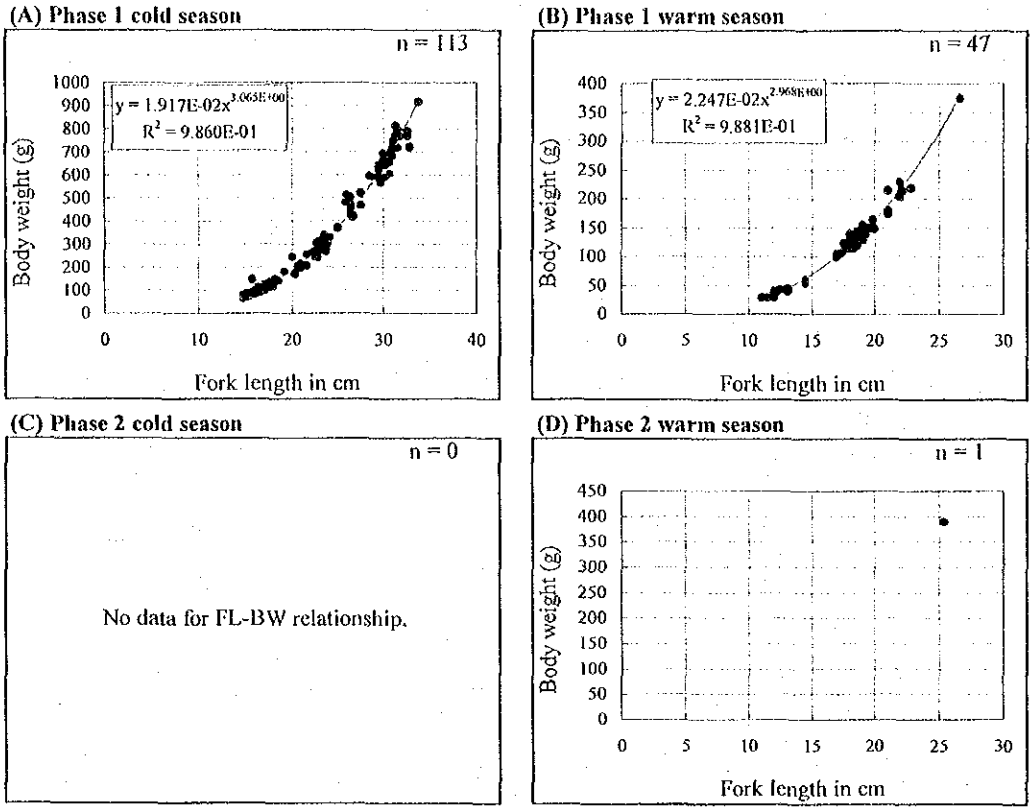


Figure 3.58 Length-weight relationship for Angola dentex *Dentex angolensis.*

d) Length and weight by sex

Table 3.86 (page 3-262) summarizes the fork length and body weight observed in each sex for the Angola dentex.

In the cold season, males had the mean fork length of approximately 263 mm, larger than that of females; in the warm season, however, males and females were approximately of the same size (about 185 mm on the average, but males were heavier).

The minimum fork length of individuals with sufficient gonadal development to allow sex determination varied between 12cm for early individuals of both sexes and 15cm for late ones.

e) Sex ratio and female maturity stage

Table 3.87 (page 3-263) summarizes the sex ratio and the female maturity stage for the Angola dentex. Figure 3.59 (page 3-264) presents their distribution by length class.

The overall sex ratio of this species (Phase 1) was 0.41 in the cold season and 0.23 in the warm season; females were thus clearly major in all seasons. The sex ratio by area in the cold season varied between 0.21 and 0.67, with females still in the majority. The sex ratio by stratum was 1.0 at the 30-80 m stratum and 0.33 at the 80-200 m stratum. Data were too few to allow for a definitive conclusion on the depth-dependent of the sex ratio.

The female maturity ratio was 2.5% in the cold season (0% in the Southern area) and 30% in the Southern area in the warm season. One could presume the spawning period of the Angola dentex is either long or split in two instances.

In the Phase I cold season, the sex ratio by length class showed the size-dependent change within a given classes. Males were not observed at the 14-15cm class, but in the 15-25cm classes, the ratio increased progressively up to 100% (male/female equilibrium).

The length at first maturity observed in the cold season was at the 28-29cm class, and in the warm season at the 18-19cm class.

f) Feeding habits

Table 3.88 (page 3-265) presents the stomach condition and the stomach content composition of the Angola dentex in each survey season. Figure 3.60 (page 3-266) presents the relationship between the fork length and SSI and SCW.

The feeding habits of the Angola dentex were studied only in the Phase I, in which data were relatively numerous. The ratio of the empty stomach in the cold and warm seasons was 71% and 65% respectively. In the cold season, the ratio of the stomach eversion was 8%.

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 Angola dentex feeds mainly on crustaceans. In the cold season, fish and Polychaetes were also found in the stomach.

Table 3.85 Body length range and mean body length for Angola dentex *Dentex angolensis* : 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	0			0			0			0		
Other	0			0			0			0		
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	-	-	-	-	-	-	0			0		
	20-30m	0			0			0			0		
	30-80m	0			0			0			0		
	80-200m	40	157 ~ 315	211.6	0			0			0		
	200-400m	0			0			-	-	-	0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	40	157 ~ 315	211.6	0			0			0		
Central	3-20m	-	-	-	0			0			0		
	20-30m	0			0			0			0		
	30-80m	0			0			0			0		
	80-200m	25	155 ~ 337	280.4	0			0			1	253	253.0
	200-400m	0			0			0			0		
	400-600m	-	-	-	0			-	-	-	-	-	-
	3-600m	25	155 ~ 337	280.4	0			0			1	253	253.0
South	3-20m	-	-	-	0			0			0		
	20-30m	0			0			0			0		
	30-80m	40	148 ~ 295	193.0	47	110 ~ 266	171.6	0			0		
	80-200m	8	216 ~ 307	259.8	0			0			0		
	200-400m	0			0			0			0		
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-
	3-600m	48	148 ~ 307	204.1	47	110 ~ 266	171.6	0			0		

Remark. - : no trawl.

Figure3.57 (A) continued.

North 3-20m (Area : 5912 km²)

No trawl

Central 3-20m (Area : 7783 km²)

No trawl

South 3-20m (Area : 1485 km²)

No trawl

North 20-30m (Area : 1290 km²)

No catch

Central 20-30m (Area : 835 km²)

No catch

South 20-30m (Area : 805 km²)

No data for size composition

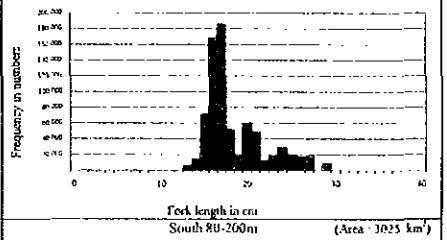
North 30-80m (Area : 2924 km²)

No catch

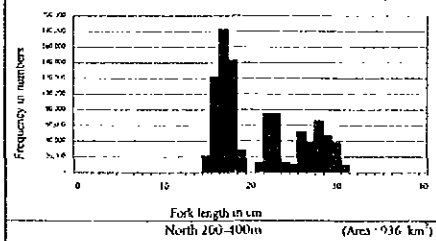
Central 30-80m (Area : 2870 km²)

No data for size composition

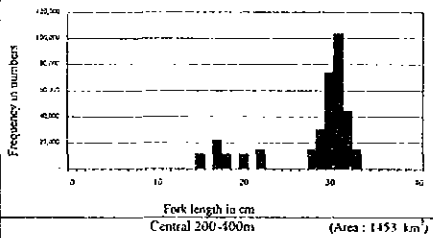
South 30-80m (Area : 2640 km²)



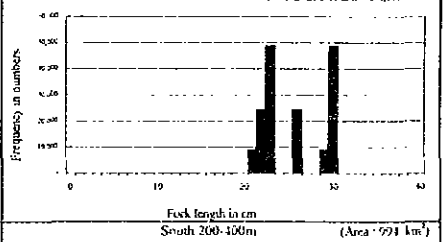
North 80-200m (Area : 1147 km²)



Central 80-200m (Area : 2767 km²)



South 80-200m (Area : 3025 km²)



North 200-400m (Area : 936 km²)

No 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

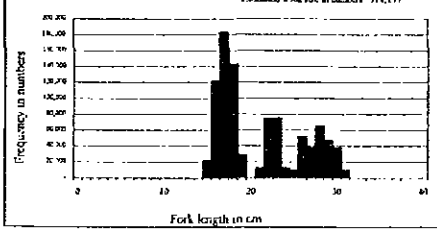
Central 400-600m (Area : 848 km²)

No trawl

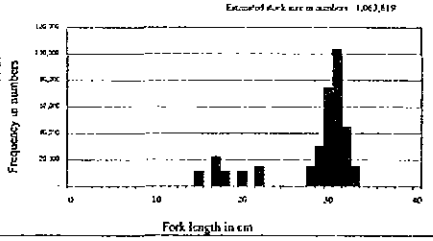
South 400-600m (Area : 583 km²)

No trawl

North Total (Area : 17688 km²)



Central Total (Area : 29244 km²)



South Total (Area : 21088 km²)

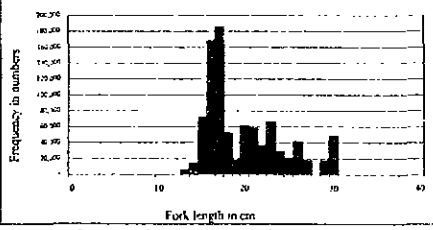


Figure3.57 (B) continued.

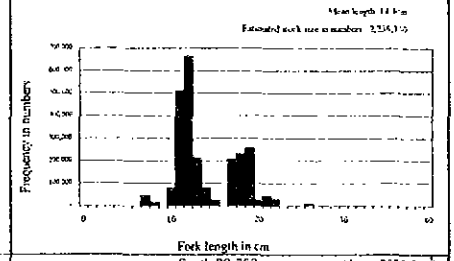
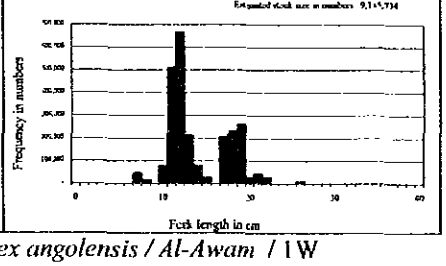
North 3-20m (Area 5912 km²) No trawl	Central 3-20m (Area 2783 km²) No catch	South 3-20m (Area 1485 km²) No catch
North 20-30m (Area 1290 km²) No catch	Central 20-30m (Area 835 km²) No catch	South 20-30m (Area 805 km²) No catch
North 30-80m (Area 2924 km²) No catch	Central 30-80m (Area 2870 km²) No catch	South 30-80m (Area 2640 km²) 
North 80-200m (Area : 1147 km²) No catch	Central 80-200m (Area 2767 km²) No catch	South 80-200m (Area : 3025 km²) No data for size composition
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) No catch	Central Total (Area : 29244 km²) No catch	South Total (Area : 21088 km²) 

Figure3.57 (D) continued.

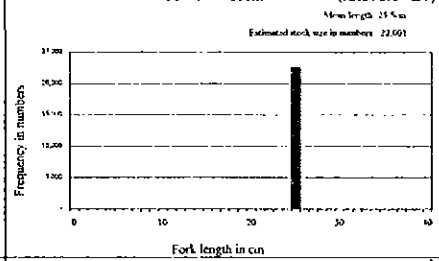
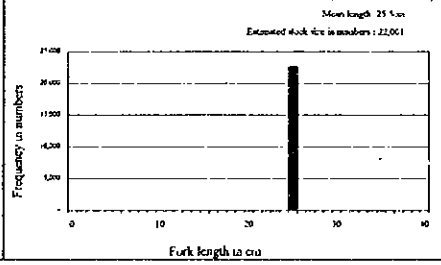
North 3-20m (Area : 5912 km²) No catch	Central 3-20m (Area : 2781 km²) No catch	South 3-20m (Area : 1485 km²) No catch
North 20-30m (Area : 1290 km²) No catch	Central 20-30m (Area : 835 km²) No catch	South 20-30m (Area : 805 km²) No catch
North 30-80m (Area : 2924 km²) No catch	Central 30-80m (Area : 2670 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) 	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 : 728 km²) No trawl	Central 400-600m (Area : 848 km²) No trawl	South 400-600m (Area : 583 km²) No trawl
North Total (Area : 17688 km²) No catch	Central Total (Area : 29244 km²) 	South Total (Area : 21088 km²) No catch

Table 3.86 Body length and weight by sex for Angola dentex *Dentex angolensis*.

(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	0				
		Female	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
2	Cold	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	0				
		Female	0				
		Indeterminate	0				
		Total	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	32	155 ~ 337	262.9	85.0 ~ 920.0	484.5
		Female	79	148 ~ 312	209.6	65.0 ~ 815.0	261.0
		Indeterminate	2	151 ~ 155	153.0	80.0 ~ 85.0	82.5
		Total	113	148 ~ 337	223.7	65.0 ~ 920.0	321.2
	Warm	Male	7	122 ~ 266	184.4	40.0 ~ 375.0	152.1
		Female	30	120 ~ 228	185.0	35.0 ~ 230.0	136.3
		Indeterminate	10	110 ~ 145	122.5	30.0 ~ 55.0	37.8
		Total	47	110 ~ 266	171.6	30.0 ~ 375.0	117.7
2	Cold	Male	0				
		Female	0				
		Indeterminate	0				
		Total	0				
	Warm	Male	1	253	253.0	390.0	390.0
		Female	0				
		Indeterminate	0				
		Total	1	253	253.0	390.0	390.0

Table 3.87 Sex ratio and female maturity stage for Angola dentex *Dentex angolensis*.

(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	0	E					0	0	E					0	0	E					0	0	E				
All area	0	0	E					0	0	E					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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	E					0	0	E				
	20-30m	0	0	E					0	0	E					0	0	E					0	0	E				
	30-80m	0	0	E					0	0	E					0	0	E					0	0	E				
	80-200m	33	7	0.21	87.9	9.1	3.0	0.0	0	0	E					0	0	E					0	0	E				
	200-400m	0	0	E					0	0	E					-	-	-	-	-	-	-	0	0	E				
	400-600m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	33	7	0.21	87.9	9.1	3.0	0.0	0	0	E					0	0	E					0	0	E				
Central	3-20m	-	-	-	-	-	-	-	0	0	E					0	0	E					0	0	E				
	20-30m	0	0	E					0	0	E					0	0	E					0	0	E				
	30-80m	0	0	E					0	0	E					0	0	E					0	0	E				
	80-200m	15	10	0.67	40.0	53.3	6.7	0.0	0	0	E					0	0	E					0	1	E				
	200-400m	0	0	E					0	0	E					0	0	E					0	0	E				
	400-600m	-	-	-	-	-	-	-	0	0	E					-	-	-	-	-	-	-	-	-	-	-	-	-	-
	All stratum	15	10	0.67	40.0	53.3	6.7	0.0	0	0	E					0	0	E					0	0	E				
South	3-20m	-	-	-	-	-	-	-	0	0	E					0	0	E					0	0	E				
	20-30m	0	0	E					0	0	E					0	0	E					0	0	E				
	30-80m	9	9	1.00	100.0	0.0	0.0	0.0	30	7	0.23	10.0	60.0	30.0	0.0	0	0	E					0	0	E				
	80-200m	22	6	0.27	86.4	13.6	0.0	0.0	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	31	15	0.48	90.3	9.7	0.0	0.0	30	7	0.23	10.0	60.0	30.0	0.0	0	0	E					0	0	E				
All	3-20m	-	-	-	-	-	-	-	0	0	E					0	0	E					0	0	E				
	20-30m	0	0	E					0	0	E					0	0	E					0	0	E				
	30-80m	9	9	1.00	100.0	0.0	0.0	0.0	30	7	0.23	10.0	60.0	30.0	0.0	0	0	E					0	0	E				
	80-200m	70	23	0.33	77.1	20.0	2.9	0.0	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	79	32	0.41	79.7	17.7	2.5	0.0	30	7	0.23	10.0	60.0	30.0	0.0	0	0	E					0	0	E				

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

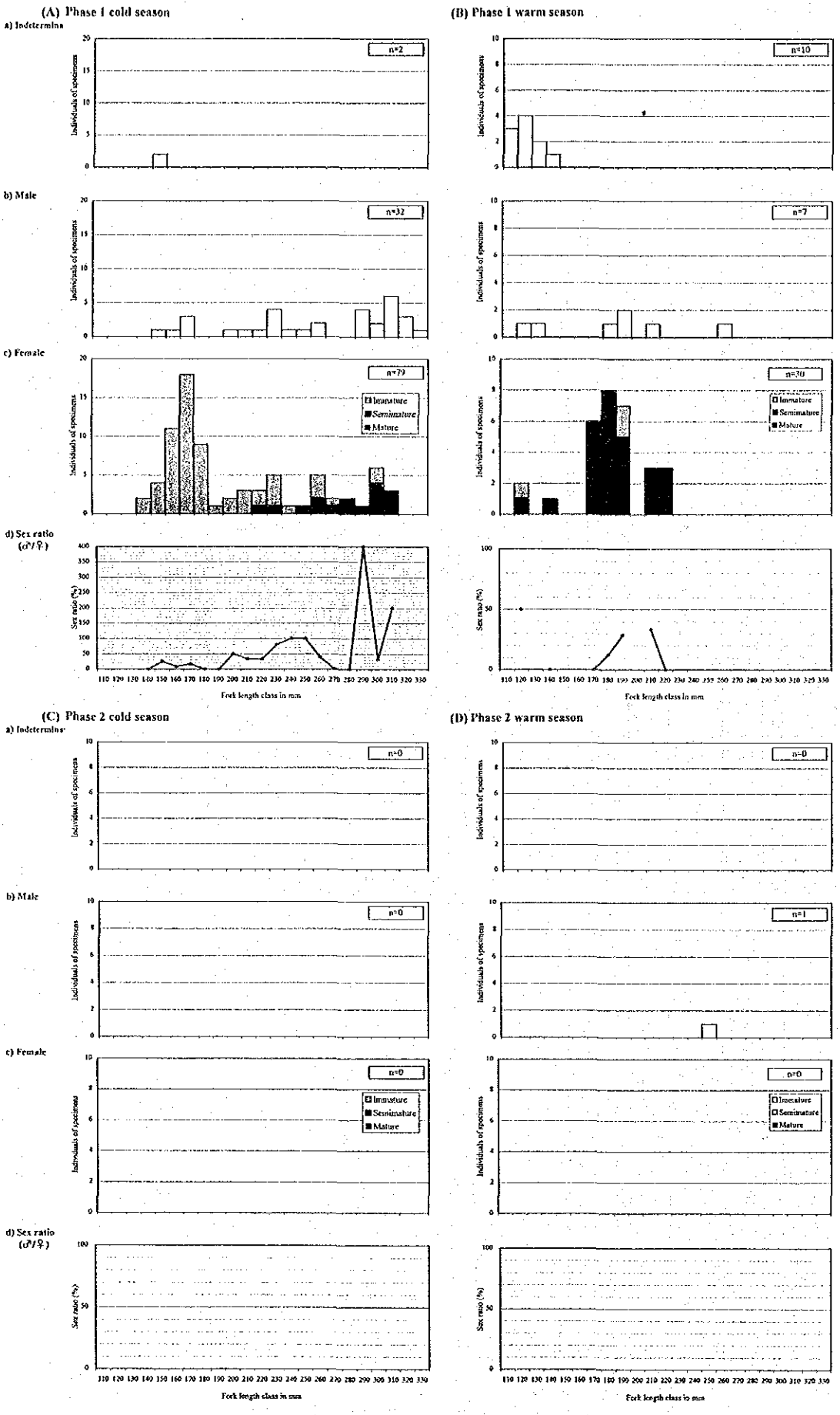


Figure 3.59 Sex ratio and female maturity stage by length class for Angola dentex *Dentex angolensis*.

Table 3.88 Stomach content analysis of Angola dentex *Dentex angolensis*.

(A) Stomach condition

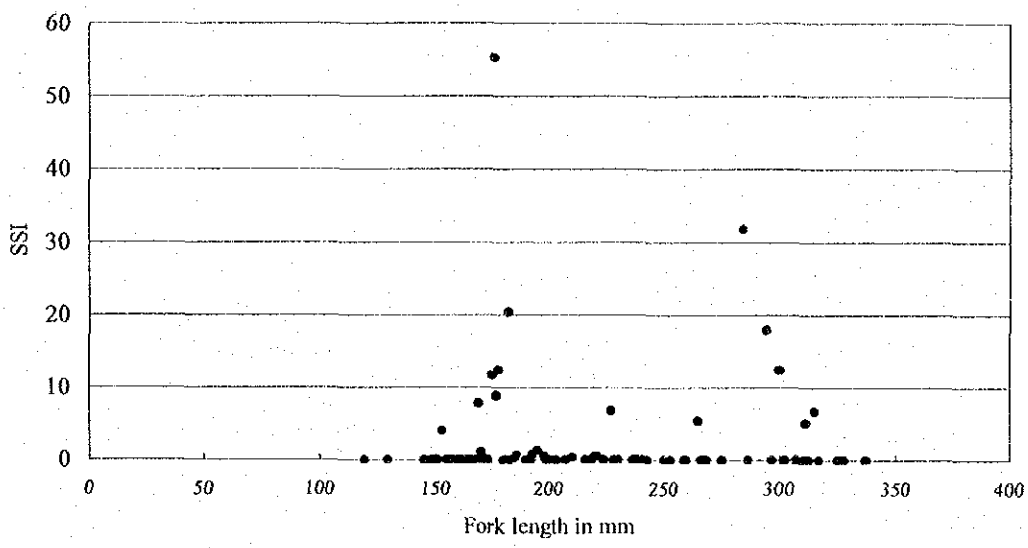
Phase	Season	Stomach condition				Stomach content Somatic Index (SSI)			
		n*	Empty (%)	Evert (%)	Feeding (%)	n*	Min.	Max.	Mean
1	Cold	113	70.80	7.96	21.24	100	0.00	72.09	4.37
	Warm	34	64.71	0.00	35.29	33	0.00	4.55	0.39
2	Cold	0	-	-	-	0	-	-	-
	Warm	1	100.00	0.00	0.00	1	0.00	0.00	0.00

(B) Stomach contents

Phase	Season	n*	Polychaeta	Crustacea	Fish	Unknown
1	Cold	24	4.17	45.83	29.17	20.83
	Warm	12		8.33		91.67
2	Cold	0				
	Warm	0				

Remark. * : Individuals of specimens.

(A) Relationship between fork length and SSI



(B) Relationship between fork length and SCW

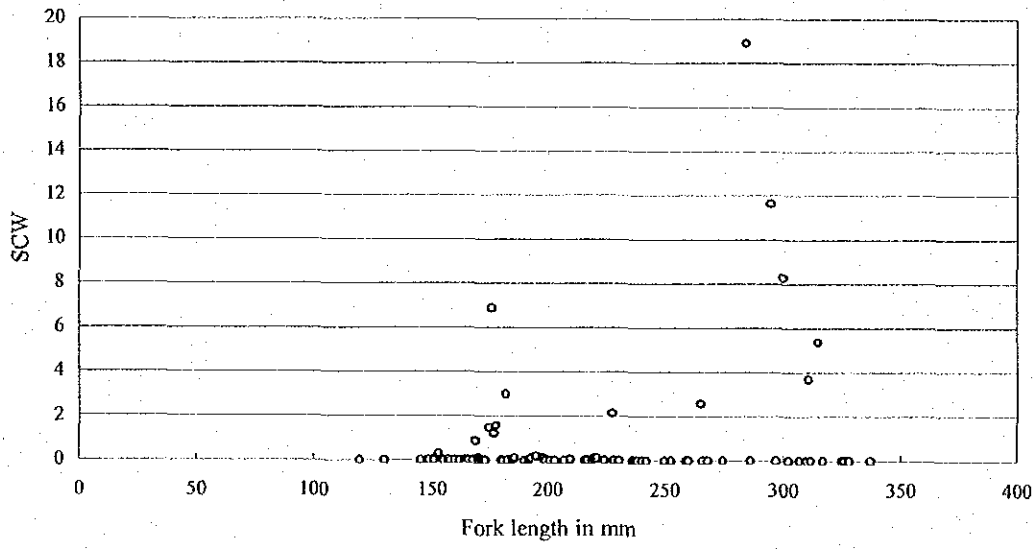


Figure 3.60 Relationship between body length and SSI (A) and SCW (B) for Angola dentex *Dentex angolensis.*