The CPUA values of this species in all areas were roughly 20-30 throughout all seasons. The CPUA values in The Sea of Marmara were extremely high, being roughly 100-130 throughout all seasons, and reaching roughly 200-300 particularly at strata of 101-200 m (Table 5-1-3-56).

Table 5-1-3-56 Catch Per Unit Area of Deep-Water Pink Shrimp

Sub area	Stratum (m)	Mean catch in kg/km²			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~100	96.2	122.1	68.0	69.1
	101~200	236.9	218.9	245.6	313.8
	201~500	7.0	51.9	10.5	82.9
	Sub total	102.4	130.9	81.9	108.8
North Aegean Sea	20~100	0.3	3.4	1.4	0.5
	101~200	2.8	1.4	0.2	4.3
	201~500	16.1	23.3	21.9	18.4
	Sub total	4.6	8.5	6.0	5.2
South Aegean Sea	20~100	0	0.5	0	0
	101~200	2.9	10.8	1.2	2.5
	201~500	15.0	3.5	2.5	0.5
	Sub total	4.6	3.4	1.1	1.0
West Mediterranean Sea	20~100	0	0	0	0
	101~200	0	0	1.8	17.7
	201~500	1.5	12.9	0.4	0.8
	Sub total	0.4	3.9	0.7	6.2
East Mediterranean Sea	20~100	0.8	1.8	2.6	4.1
	101~200	11.7	20.7	2.7	0
	201~500	20.3	29.7	0.4	13.9
	Sub total	5.2	9.1	2.4	5.8
All area	20~100	26.3	29.1	16.2	24.2
	101~200	34.4	31.0	27.0	53.0
	201~500	13.2	19.5	10.3	16.1
	Total	25.2	27.4	17.0	29.4

2) Stock Size

The estimations of the stock size of deep-water pink shrimp are indicated in Table 5-1-3-57. The total stock size of this species for each season consisted of 1,050 tons in spring (95% confidence interval: ±548 tons, CV: 24%), 1,291 tons in summer (95% confidence interval: ±604 tons, CV: 20%), 784 tons in autumn (95% confidence interval: ±380 tons, CV: 24%) and 1,099 tons in winter (95% confidence interval: ±534 tons, CV: 22%). The percentage of the total stock size of this species in The Sea of Marmara was high at roughly 70% throughout all seasons. In comparison with other important species, the stock size of this species was stable throughout all seasons, being generally 1,000 tons.

Although the maximum difference in the estimated stock size of this species between seasons was roughly 500 tons, this is not

significant in consideration of the 95% confidence intervals of each season.

Table 5-1-3-57 Estimation of Stock Size of Deep-Water Pink Shrimp

Sub area	Stratum (m)	Stock size in tons (t)			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~100	582.1	662.9	352.4	430.3
	101~200	142.4	131.6	147.6	188.6
	201~500	9.3	69.2	14.0	110.6
	Sub total	733.8	863.6	514.0	729.6
North Aegean Sea	20~100	2.1	28.8	12.0	3.7
	101~200	11.4	5.5	1.7	21.2
	201~500	161.3	232.5	221.2	272.8
	Sub total	174.8	266.8	234.9	297.6
South Aegean Sea	20~100	0	1.6	0.	0
	101~200	2.9	13.2	1.4	2.7
	201~500	66.8	15.7	11.2	2.4
	Sub total	69.7	30.5	12.6	5.1
West Mediterranean Sea	20~100	0	0	0	0
	101~200	0	0	1.1	10.5
	201~500	2.1	18.6	0.6	1.2
	Sub total	2.1	18.6	1.7	11.7
East Mediterranean Sea	20~100	4.7	10.9	15.6	24.3
	101~200	20.6	36.4	4.8	0
	201~500	44.2	64.7	0.9	30.3
	Sub total	69.5	112.0	21.2	54.6
All area	20~100	589.0	704.1	380.0	458.3
	101~200	177.3	186.6	156.6	223.0
	201~500	283.7	400.7	247.9	417.3
	Total	1,050.0	1,291.4	784.4	1,098.6
* 95% confidence interval		± 547.6	± 603.8	± 380.2	± 533.9

* 95% confidence interval was calculated to total stock size.

(20) Norway Lobster *Nephrops norvegicus*

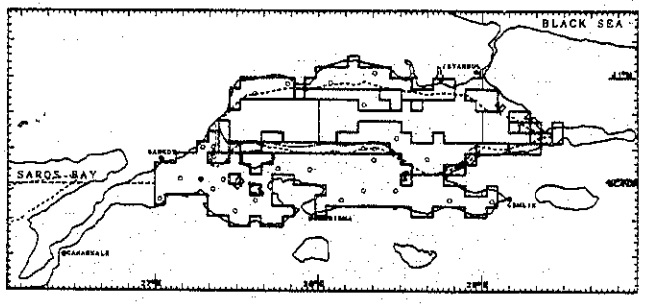
1) Distribution

This species was distributed primarily in the Aegean Sea at points north of 28° north latitude, and particularly at depths of 201 m or more. In The Sea of Marmara, the distribution of this species was limited to depths of 100 m or less in the southwest portion (Figs. 5-1-3-20-1 to 5-1-3-20-4). In addition, the appearance frequency of this species was 20-30% in the North Aegean Sea, where this species is primarily distributed, and was stable in the South Aegean Sea at roughly 15% (Table 5-1-3-58).

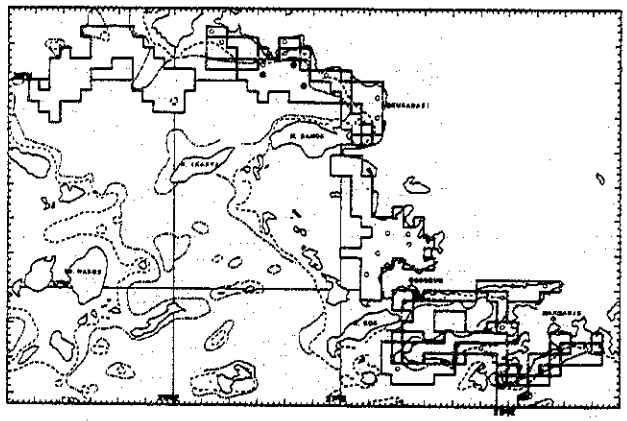
Table 5-1-3-58 Appearance Frequency of Norway Lobster*

Sub area	Stratum (m)	Appearance Frequency (%)			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~100	5	9	19	7
	101~500	0	0	0	0
	Sub total	4	7	15	5
North Aegean Sea	20~100	0	3	3	0
	101~200	38	13	36	25
	201~500	70	85	77	100
	Sub total	22	28	27	27
South Aegean Sea	20~100	0	0	0	0
	101~200	0	0	0	25
	201~500	50	40	40	25
	Sub total	13	14	14	15
West Mediterranean Sea	20~500	0	0	0	0
East Mediterranean Sea	20~500	0	0	0	0
All area	20~100	1	3	5	2
	101~200	12	6	14	14
	201~500	39	54	43	40
	Total	10	15	15	14

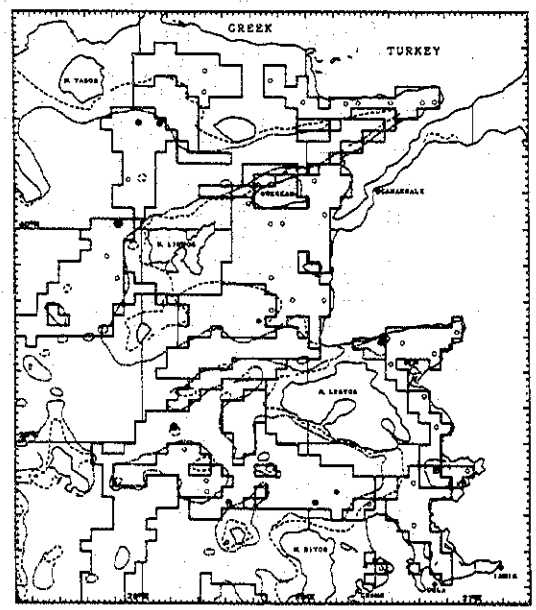
* Appearance frequency: No. caught / No. of trawls x 100%



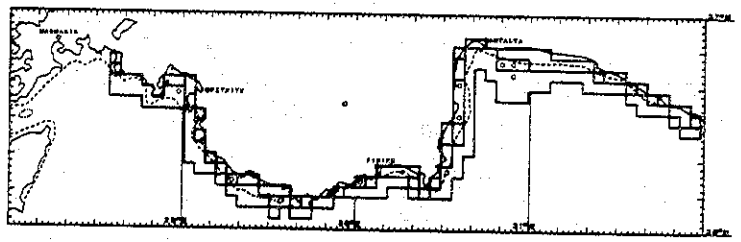
The Sea of Marmara



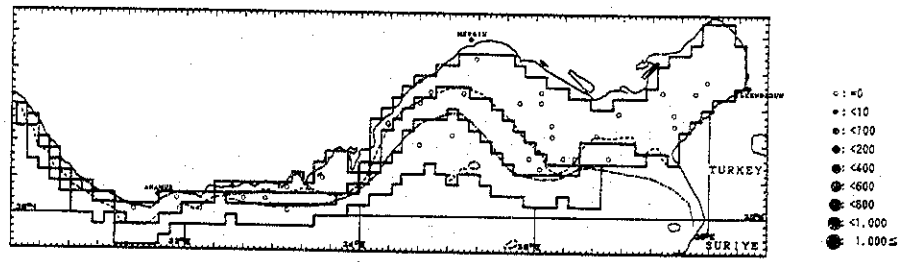
South Aegean Sea



North Aegean Sea

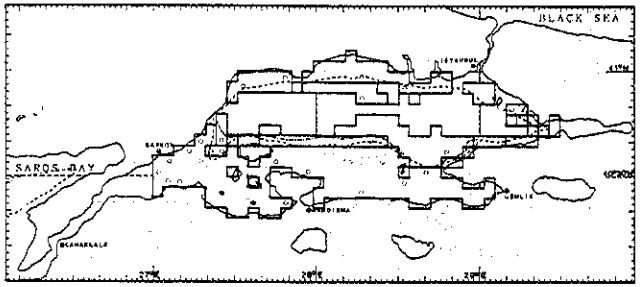


West Mediterranean Sea

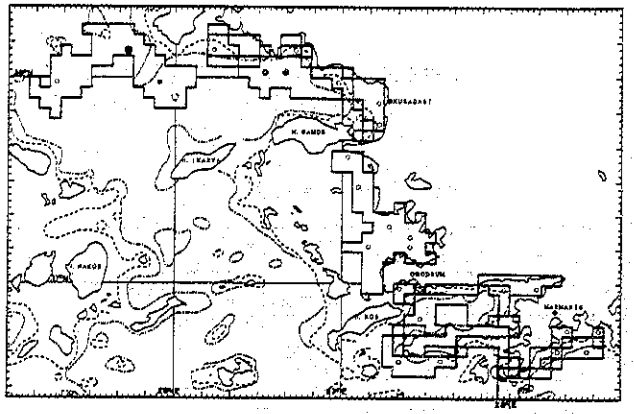


East Mediterranean Sea

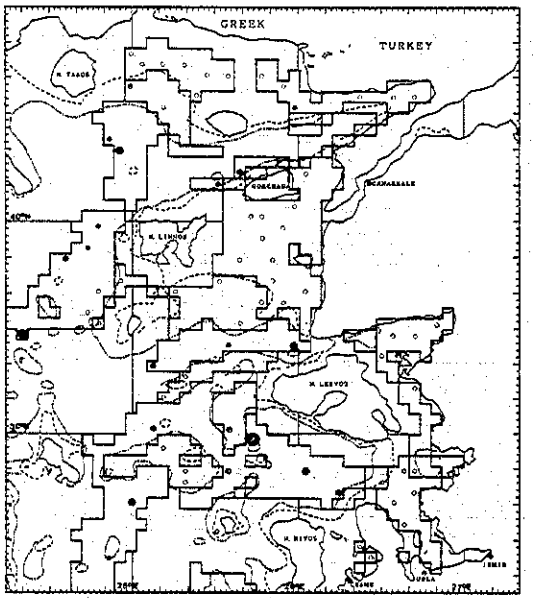
Fig.5-1-3-20-1 The catch in kg of Norway lobster *Nephrops norvegicus* at each stations in the spring season survey



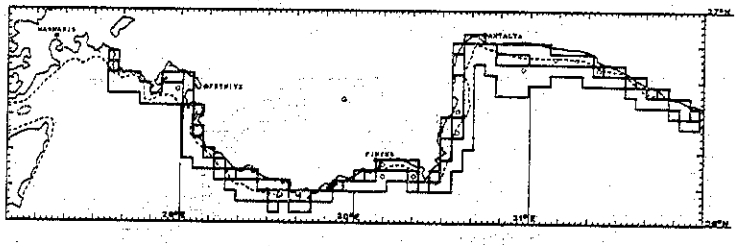
The Sea of Marmara



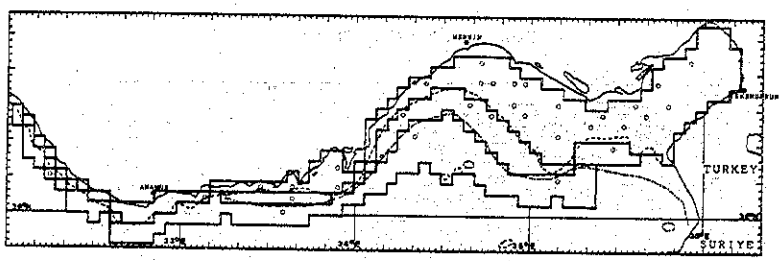
South Aegean Sea



North Aegean Sea

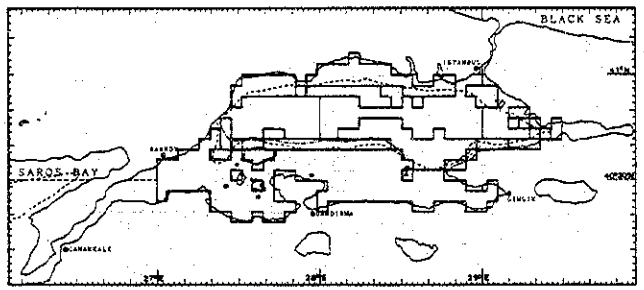


West Mediterranean Sea

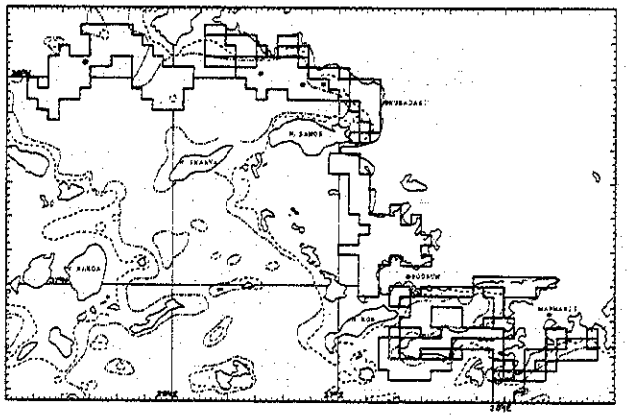


East Mediterranean Sea

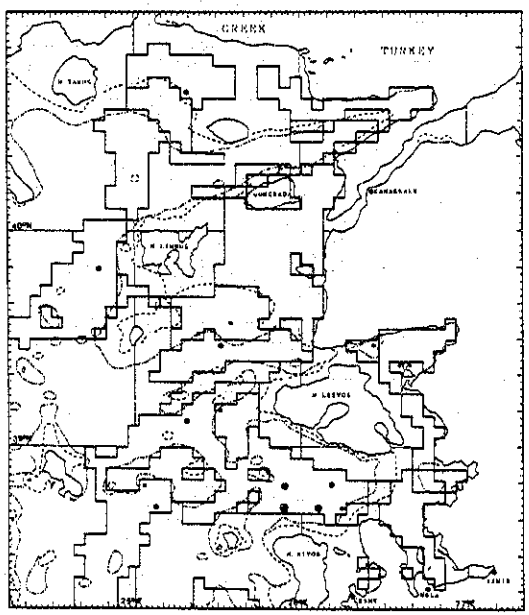
Fig.5-1-3-20-2 The catch in kg of Norway lobster *Nephrops norvegicus* at each stations in the summer season survey



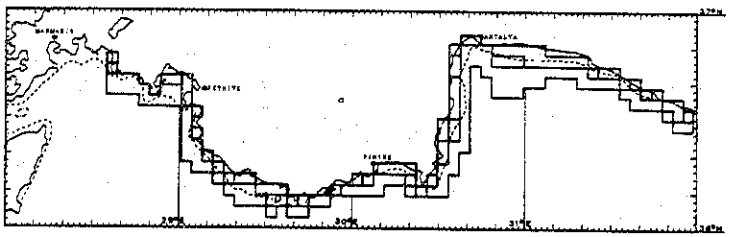
The Sea of Marmara



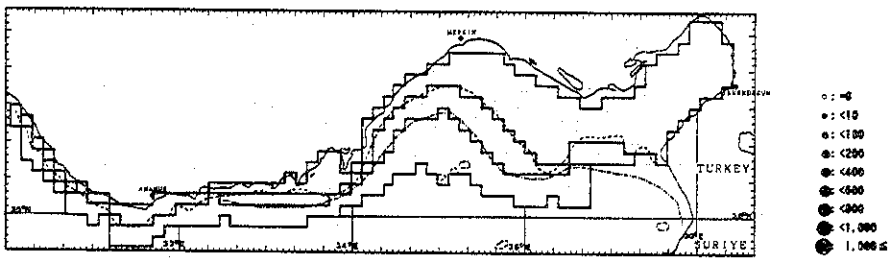
South Aegean Sea



North Aegean Sea

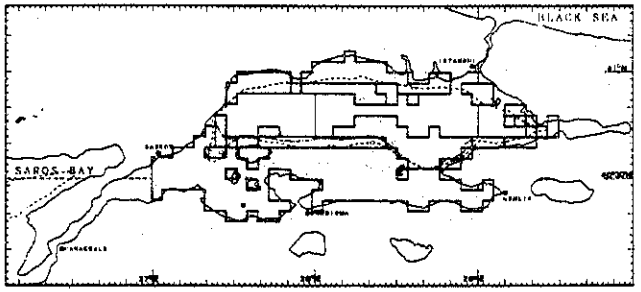


West Mediterranean Sea

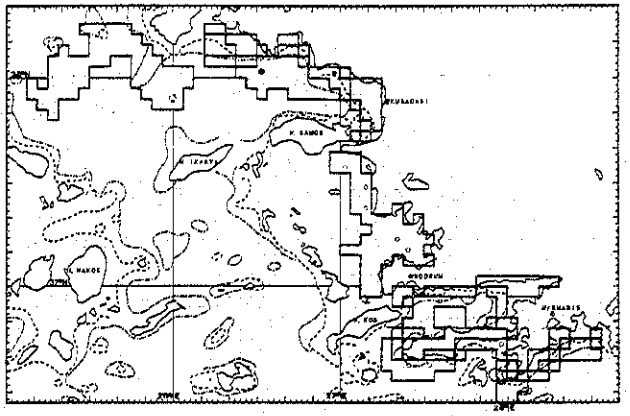


East Mediterranean Sea

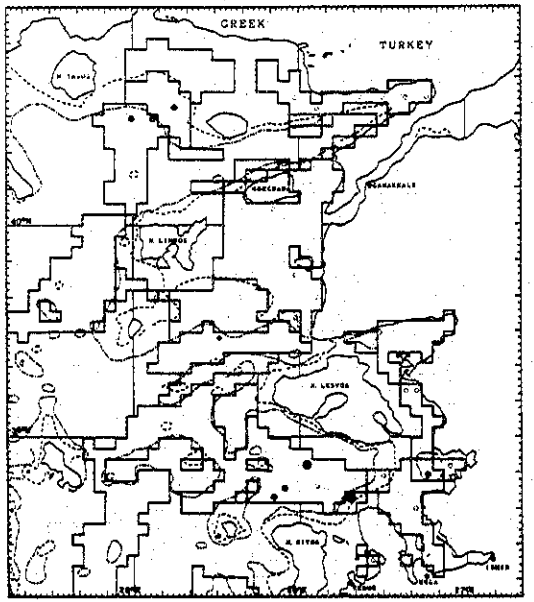
Fig.5-1-3-20-3 The catch in kg of Norway lobster *Nephrops norvegicus* at each stations in the autumn season survey



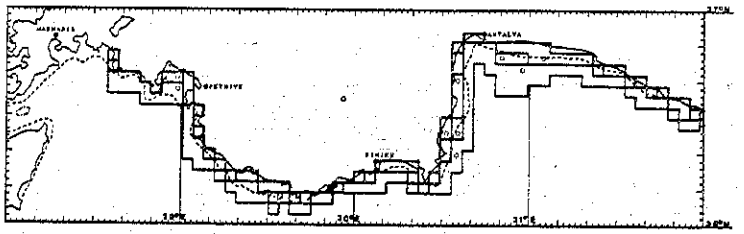
The Sea of Marmara



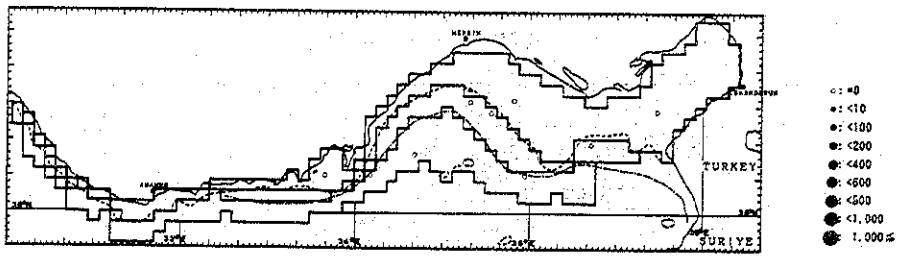
South Aegean Sea



North Aegean Sea



West Mediterranean Sea



East Mediterranean Sea

Fig.5-1-3-20-4 The catch in kg of Norway lobster *Nephrops norvegicus* at each stations in the winter season survey

The CPUA values of this species were high at roughly 60-100 at strata of 201-500 m in the North Aegean Sea. In addition, the CPUA values at similar strata in the South Aegean Sea were roughly 6-30 (Table 5-1-3-59).

Table 5-1-3-59 Catch Per Unit Area of Norway Lobster

Sub area	Stratum (m)	Mean catch in kg/km²			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~100	0	0	0.3	0
	101~500	0	0	0	0
	Sub total	0	0	0.3	0
North Aegean Sea	20~100	0	0.2	0.5	0
	101~200	3.7	0.8	0.2	4.7
	201~500	63.6	99.2	59.1	102.0
	Sub total	16.0	28.2	14.0	22.8
South Aegean Sea	20~200	0	0	0	0
	201~500	29.8	22.1	5.9	5.8
	Sub total	7.8	7.9	2.2	2.0
West Mediterranean Sea	20~500	0	0	0	0
East Mediterranean Sea	20~500	0	0	0	0
All area	20~100	0	0.1	0.3	0
	101~200	1.3	0.4	0.1	1.7
	201~500	34.0	56.6	24.5	38.1
	Total	7.2	12.9	5.4	9.0

2) Stock Size

The estimations of the stock size of Norway lobster are indicated in Table 5-1-3-60. The total stock size of this species for each season consisted of 783 tons in spring (95% confidence interval: ±722 tons, CV: 41%), 1,094 tons in summer (95% confidence interval: ±937 tons, CV: 41%), 719 tons in autumn (95% confidence interval: ±523 tons, 33%) and 1,221 tons in winter (95% confidence interval: ±1,166 tons, CV: 39%). The stock size of this species for each season were stable at generally 1,000 tons, indicating a similar trend as that of deep-water pink shrimp *Parapenaeus longirostris* described previously. The stock size of this species in the North Aegean Sea was overwhelmingly large, accounting for 80% of the total stock size in spring, and more than 90% of the total stock size in the other seasons.

Differences in the estimated stock size of this species between seasons were a maximum of 500 tons (between winter and autumn). However, these differences are not significant in consideration of the estimation accuracy (range of 95% confidence interval in each season: ±523 to ±1,166 tons).

Table 5-1-3-60 Estimation of Stock Size of Norway Lobster

Sub area	Stratum (m)	Stock size in tons (t)			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~100	0	0	1.8	0
	101~500	0	0	0	0
	Sub total	0	0	1.8	0
North Aegean Sea	20~100	0	1.3	4.4	0
	101~200	14.9	3.2	1.7	16.7
	201~500	635.5	991.0	684.3	1,178.2
	Sub total	650.4	995.5	690.4	1,194.9
South Aegean Sea	20~200	0	0	0	0
	201~500	132.6	98.2	26.4	25.6
	Sub total	132.6	98.2	26.4	25.6
West Mediterranean Sea	20~500	0	0	0	0
East Mediterranean Sea	20~500	0	0	0	0
All area	20~100	0	1.3	6.1	0
	101~200	14.9	3.2	1.7	16.7
	201~500	768.1	1,089.2	710.8	1,203.8
	Total	783.1	1,093.7	718.6	1,220.5
* 95% confidence interval		± 721.6	± 937.1	± 522.5	±1,166.3

* 95% confidence interval was calculated to total stock size.

(21) Horned Octopus *Eledone cirrhosa*

1) Distribution

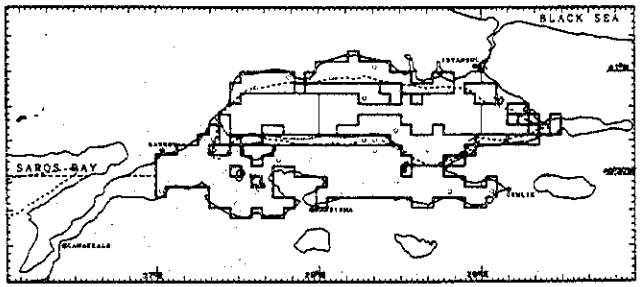
This species was widely distributed in all areas surveyed, excluding The Sea of Marmara, particularly in summer (Figs. 5-1-3-21-1 to 5-1-3-21-4). In addition, the appearance frequency of this species in all areas was high at roughly 60% in summer, and roughly 30% in other seasons. The appearance frequency of this species in the North Aegean Sea was higher in comparison with other areas throughout all seasons (range throughout all seasons: roughly 50-90%) (Table 5-1-3-61).

Table 5-1-3-61 Appearance Frequency of Horned Octopus*

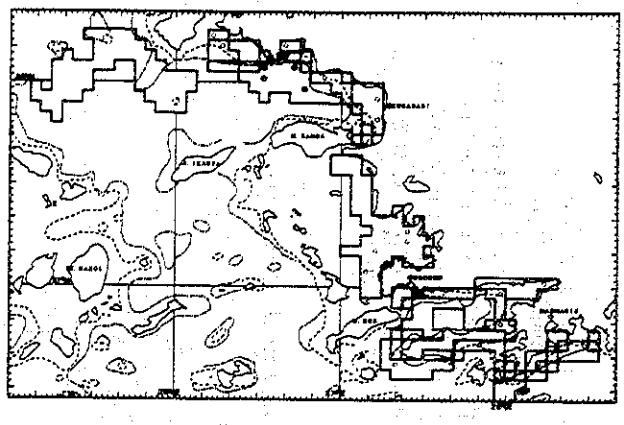
Sub area	Stratum (m)	Appearance Frequency (%)			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~500	0	0	0	0
North Aegean Sea	20~100	41	80	25	39
	101~200	50	100	73	88
	201~500	100	95	69	100
	Sub total	56	89	45	64
South Aegean Sea	20~100	0	92	8	80
	101~200	20	100	0	25
	201~500	67	60	40	0
	Sub total	22	82	18	39
West Mediterranean Sea	20~100	50	25	25	0
	101~200	33	33	0	33
	201~500	0	0	0	0
	Sub total	30	20	10	11
East Mediterranean Sea	20~100	0	25	44	25
	101~200	29	57	72	0
	201~500	0	0	0	0
	Sub total	6	29	44	10
All area	20~100	15	48	22	27
	101~200	31	74	45	43
	201~500	54	64	39	35
	Total	25	57	30	33

* Appearance frequency: No. caught / No. of trawls x 100%

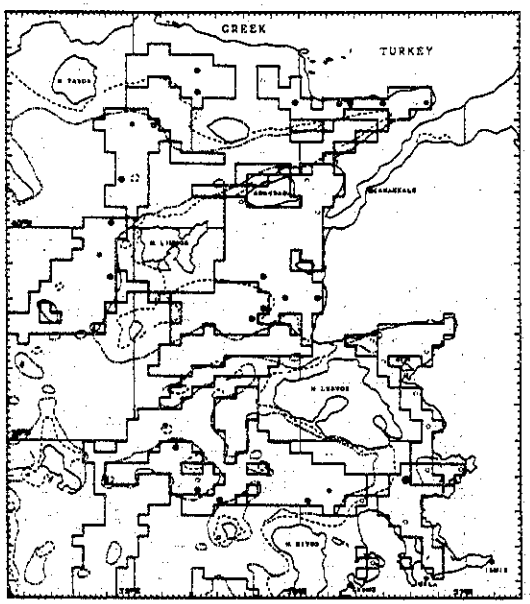
The CPUA values of this species in all areas were high at 56 in summer and low at 10 or less in other seasons. The CPUA of this species in the North Aegean Sea in summer was extremely high at roughly 120 (Table 5-1-3-62).



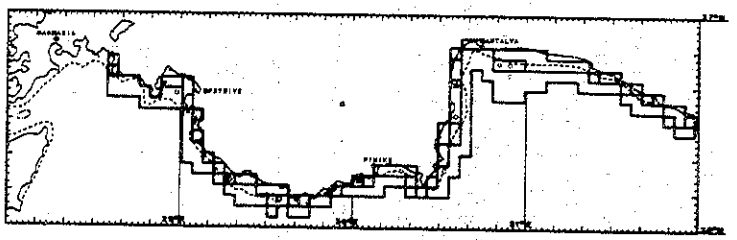
The Sea of Marmara



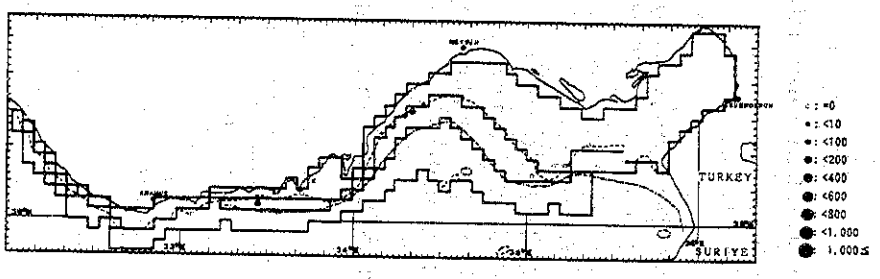
South Aegean Sea



North Aegean Sea

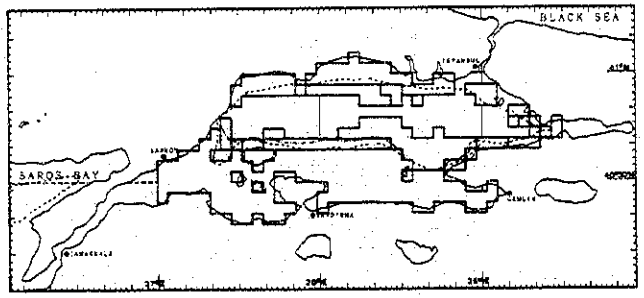


West Mediterranean Sea

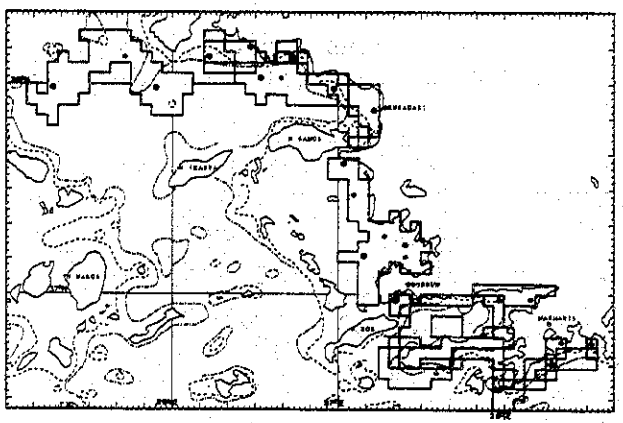


East Mediterranean Sea

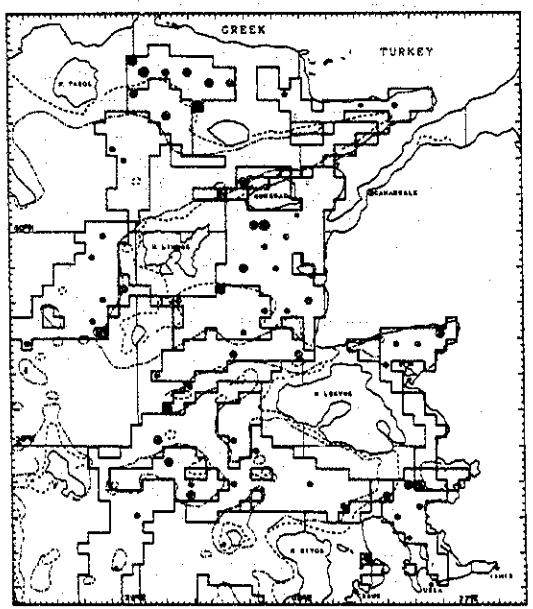
Fig.5-1-3-21-1 The catch in kg of horned octopus *Eledone cirrhose* at each stations in the spring season survey



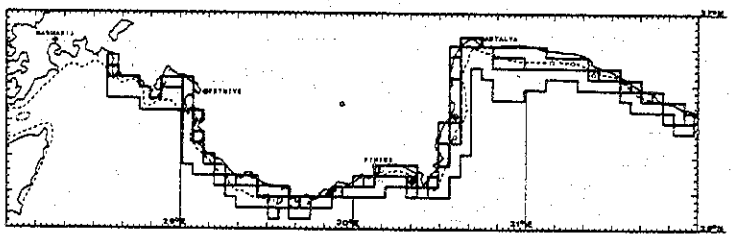
The Sea of Marmara



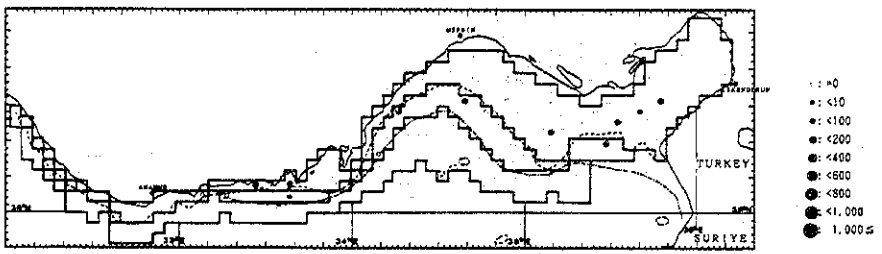
South Aegean Sea



North Aegean Sea

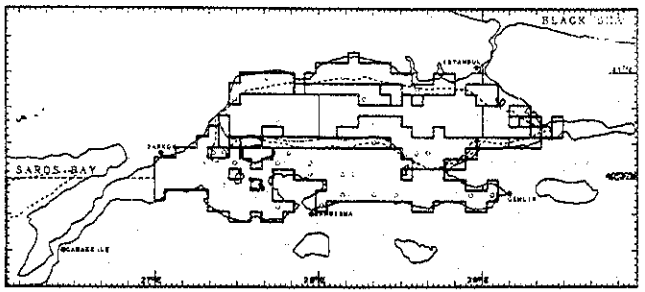


West Mediterranean Sea

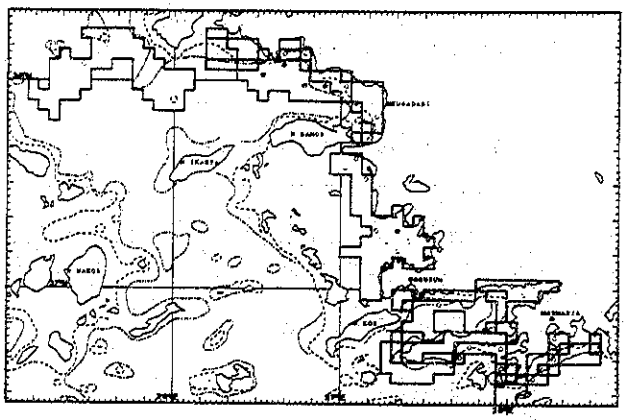


East Mediterranean Sea

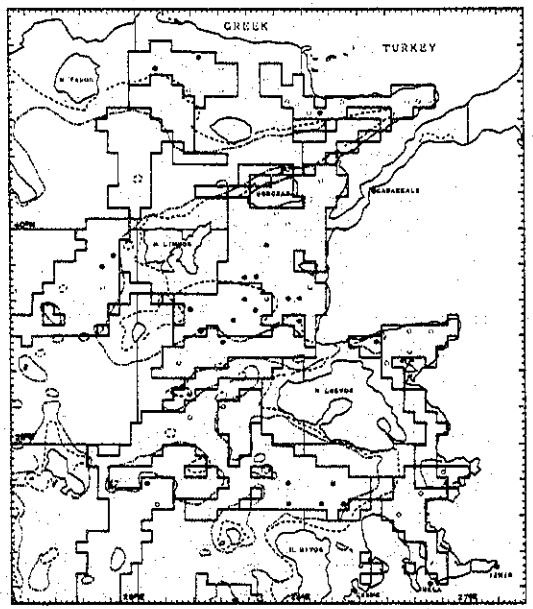
Fig.5-1-3-21-2 The catch in kg of horned octopus *Eledone cirrhos* at each stations in the summer season survey



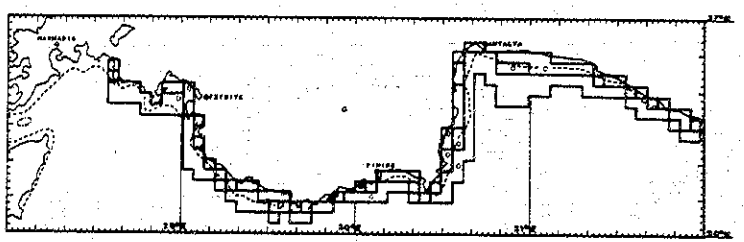
The Sea of Marmara



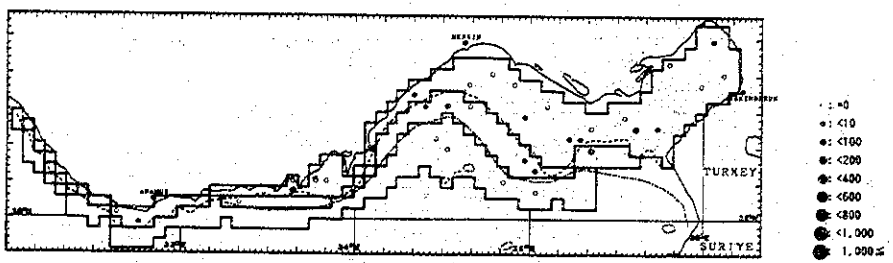
South Aegean Sea



North Aegean Sea

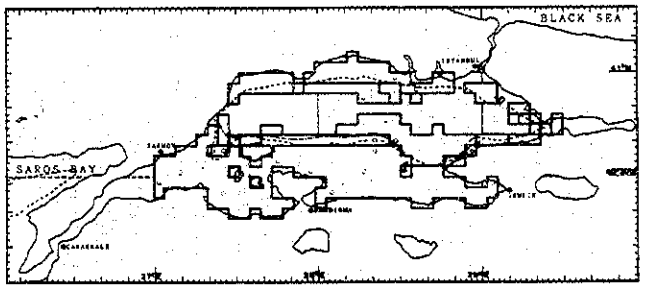


West Mediterranean Sea

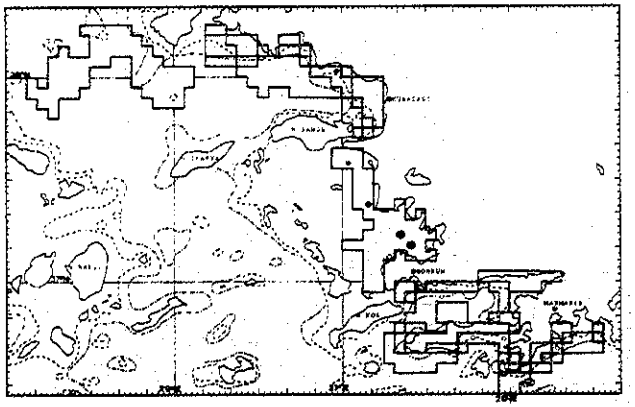


East Mediterranean Sea

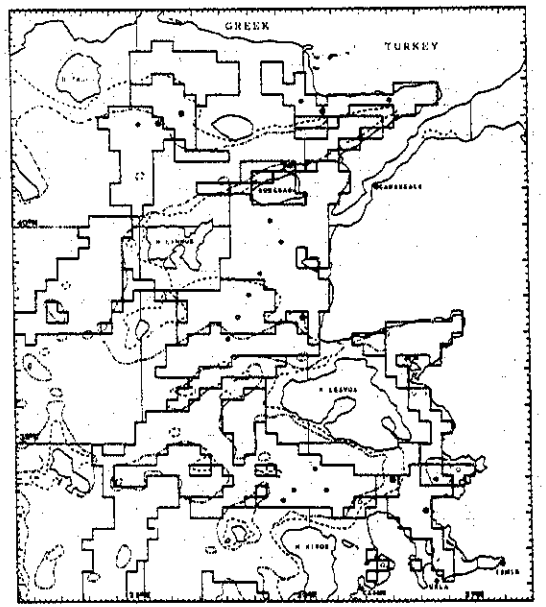
Fig.5-1-3-21-3 The catch in kg of horned octopus *Eledone cirrhose* at each stations in the autumn season survey



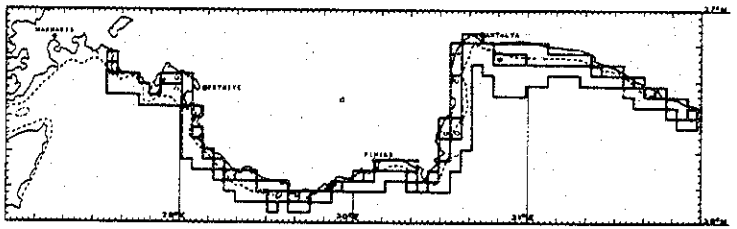
The Sea of Marmara



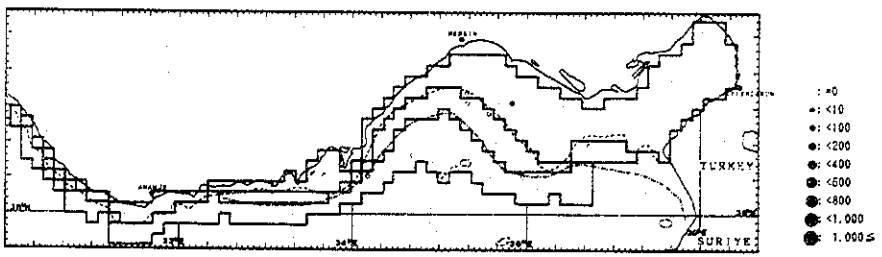
South Aegean Sea



North Aegean Sea



West Mediterranean Sea



East Mediterranean Sea

Fig.5-1-3-21-4 The catch in kg of horned octopus *Eledone cirrhose* at each stations in the winter season survey

Table 5-1-3-62 Catch Per Unit Area of Horned Octopus

Sub area	Stratum (m)	Mean catch in kg/km²			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~500	0	0	0	0
North Aegean Sea	20~100	18.1	127.6	0.2	5.0
	101~200	7.9	152.5	2.5	10.0
	201~500	18.2	69.0	0.4	4.8
	Sub total	16.2	116.7	0.7	6.1
South Aegean Sea	20~100	0	31.3	0.6	65.3
	101~200	3.2	59.0	0	1.7
	201~500	14.0	7.7	0	0
	Sub total	4.4	27.8	0.3	23.2
West Mediterranean Sea	20~100	1.4	16.1	2.2	0
	101~200	1.8	15.1	0	2.2
	201~500	0	0	0	0
	Sub total	1.1	11.0	0.9	0.7
East Mediterranean Sea	20~100	0	11.6	4.6	0.6
	101~200	5.7	23.4	4.4	0
	201~500	0	0	0	0
	Sub total	1.1	12.9	4.0	0.2
All area	20~100	6.2	53.2	1.4	8.2
	101~200	4.6	82.4	2.0	4.2
	201~500	11.1	37.4	0.2	1.7
	Total	6.9	55.7	1.3	5.8

2) Stock Size

The estimations of the stock size of horned octopus are indicated in Table 5-1-3-63. The total stock size of this species for each season consisted of 427 tons in spring (95% confidence interval: ±165 tons, CV: 18%), 2,734 tons in summer (95% confidence interval: ±541 tons, CV: 10%), 56 tons in autumn (95% confidence interval: ±29 tons, CV: 25%) and 472 tons in winter (95% confidence interval: ±495 tons, CV: 38%). The stock size of this species was largest in summer, while that in spring and winter were roughly 1/7 of that amount, and that in autumn was roughly 1/50 of that amount.

This species is normally observed in the Mediterranean Sea, and thrives in schools on sandy mud bottoms at depths of 30-500 m. The breeding season lasts from March to August (and peaks in June), with larvae beginning a demersal life after spending 15-20 months floating on the surface. Consequently, this species reproduces from spring through summer, and this species born during that year complete their planktonic life style in the autumn of the following year. At that time, they are surmised to begin a demersal life style, maturing from the spring to the summer two years later. In addition, with respect to body length composition discussed in section 5-1-4, since small individuals are only observed in autumn while larger individuals observed in

spring and summer are not observed at that time, the life span of this species is most likely 2 years.

Based on the above, the stock size of this species is believed to demonstrate repeating seasonal fluctuations, reaching a maximum in summer and minimum in autumn. In addition, the stock size is most likely greatly affected by the degree of natural decrease during the planktonic period of the larvae of this species. The maximum difference in the estimated stock size of this species between seasons was roughly 2,500 tons, and these differences were most likely due to the life history of this species.

Table 5-1-3-63 Estimation of Stock Size of Horned Octopus

Sub area	Stratum (m)	Stock size in tons (t)			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~500	0	0	0	0
North Aegean Sea	20~100	134.9	1,089.6	2.0	54.9
	101~200	31.9	617.7	10.6	45.1
	201~500	182.3	689.2	4.4	49.8
	Sub total	349.2	2,396.5	17.0	149.8
South Aegean Sea	20~100	0	100.5	2.0	315.0
	101~200	2.8	72.0	0	1.8
	201~500	62.5	34.2	0	0
	Sub total	65.3	206.6	2.0	316.8
West Mediterranean Sea	20~100	1.6	18.0	2.5	0
	101~200	1.0	9.0	0	1.3
	201~500	0	0	0	0
	Sub total	2.6	26.9	2.5	1.3
East Mediterranean Sea	20~100	0	68.5	27.1	3.6
	101~200	10.0	35.9	7.8	0
	201~500	0	0	0	0
	Sub total	10.0	104.4	34.9	3.6
All area	20~100	136.5	1,276.5	33.6	373.5
	101~200	45.8	734.6	18.5	48.2
	201~500	244.8	723.4	4.4	49.8
	Total	427.2	2,734.4	56.4	471.5
* 95% confidence interval		± 165.2	± 541.2	± 28.6	± 494.6

* 95% confidence interval was calculated to total stock size.

Finally, the CPUA values and stock size estimations by season of the 21 important species (consisting of 18 species of fishes and 3 species of invertebrates) are indicated in Table 5-1-3-64 and Table 5-1-3-65 together with the overall figures for all fishes and invertebrates.

With respect to the ranking of CPUA for the 18 important species of fishes, the highest CPUA was recorded for hake *Merluccius merluccius* and the second highest was recorded for red mullet *Mullus barbatus* throughout all seasons. The CPUA of Atlantic horse-mackerel *Trachurus trachurus* was also high

throughout all seasons. The CPUA values for the 18 important species of fishes accounted for roughly 30-40% of the total CPUA for all fishes. With respect to the ranking of CPUA for the 3 important species of invertebrates, the highest CPUA was recorded for deep-water pink shrimp *Parapeneus longirostris* throughout all seasons except summer. The CPUA values for the 3 species of important invertebrates accounted for 50-70% of the total CPUA for all invertebrates (Table 5-1-3-64).

Table 5-1-3-64 Catch Per Unit Area by Season of 21 Important Species

Species \ Season	Spring	Summer	Autumn	Winter
Saurida undosquamis	3.5	16.4	3.4	5.4
Merluccius merluccius	72.6	154.9	46.8	57.9
Serranus cabrilla	8.7	8.0	3.3	4.7
S. scriba	0.2	1.2	0	0.1
Trachurus trachurus	16.3	31.3	19.2	21.2
Mullus barbatus	42.6	59.9	27.0	36.0
M. surmuletus	4.4	5.8	1.0	2.5
Upeneus moluccensis	2.8	20.3	3.2	13.5
Sparus aurata	0.9	1.0	0.7	0.8
Dentex macrophthalmus	4.7	22.2	4.4	9.6
Diplodus annularis	9.9	17.6	3.8	5.0
D. vulgaris	0.6	0.5	0.3	3.6
Pagellus erythrinus	21.6	28.8	10.4	7.3
P. acarne	7.0	5.7	11.0	3.7
P. bogaraveo	1.5	0.2	0.2	1.3
Sphyraena sphyraena	0	1.0	0.2	0.2
S. chrysotaenia	0	1.1	0.2	0.8
Solea vulgaris	0.6	3.2	0.7	0.7
Important fishes (18spp.)	197.9	379.1	135.8	174.3
All fishes	608.8	1,023.0	443.1	636.0
Parapenaeus longirostris	25.2	27.4	17.0	29.4
Nephrops norvegicus	7.2	12.9	5.4	9.0
Eledone cirrhosa	6.9	55.7	1.3	5.8
Important invertebrates (3spp.)	39.3	96.0	23.7	44.2
All invertebrates	70.3	145.9	53.3	82.5
All species	679.1	1,168.9	496.4	718.5

The two species of 18 important species of fishes that demonstrated the largest stock size throughout all seasons were the same as the two species having the highest CPUA described above. The stock sizes of Atlantic horse-mackerel *Trachurus trachurus* and common pandora *Pagellus erythrinus* were also high throughout all seasons. The stock sizes for the 18 important species of fishes accounted for roughly 30% of the total stock sizes for all fishes throughout all seasons. The stock sizes of 3 species of important invertebrates accounted for 50-70% of the total stock sizes of all invertebrates throughout all seasons (Table 5-1-3-65).

Table 5-1-3-65 Estimated Stock Size by Season of 21 Important Species (tons)

Species \ Season	Spring	Summer	Autumn	Winter
Saurida undosquamis	201	699	132	508
Merluccius merluccius	2,818	6,963	2,174	2,608
Serranus cabrilla	387	341	164	290
S. scriba	6	50	0	7
Trachurus trachurus	791	1,741	845	933
Mullus barbatus	1,865	2,585	1,126	1,631
M. surmuletus	214	254	48	211
Upeneus moluccensis	154	873	126	380
Sparus aurata	39	43	27	84
Dentex macrophthalmus	192	932	176	219
Diplodus annularis	423	762	150	149
D. vulgaris	21	20	10	144
Pagellus erythrinus	896	1,241	414	224
P. acarne	257	298	418	116
P. bogaraveo	84	13	10	55
Sphyraena sphyraena	0	43	8	6
S. chrysotaenia	0	49	7	81
Solea vularis	28	136	26	34
Important fishes (18spp.)	8,375	17,044	5,862	7,677
All fishes	28,406	49,669	21,229	26,674
Parapenaeus longirostris	1,050	1,291	784	1,099
Nephrops norvegicus	783	1,094	719	1,220
Eledone cirrhosa	427	2,734	56	471
Important invertebrates (3spp.)	2,260	5,120	1,559	2,791
All invertebrates	3,991	7,777	3,114	4,745
All species	32,397	57,446	24,344	31,419

5-1-4 Biological Findings of Important Species

5-1-4 Biological Findings of Important Species

The body length composition, sex ratio, female maturity stage and age composition of important species were shown in the Tables and Figures after standardizing per unit area (1 km^2) using data obtained from each trawling station. However, only data from actual measured specimens were used for summary of the relationship between body length and body weight as well as items relating to feeding habits of important species. Furthermore, although the body length composition data of important species was mainly obtained using the hole punching method, the fish-body measurement data from biological surveys was used with respect to trawling stations at which measurement of body length using the hole punching method was not performed due to the small number of fish caught per haul.

(1) Brushtooth Lizardfish *Saurida undosquamis*

1) Size Composition

The range of the fork length of this species was 3-32 cm throughout all seasons, and the mean fork length in all areas and all strata was 22 cm in spring and autumn, and 16 and 17 cm in summer and winter, respectively (Table 5-1-4-1).

Table 5-1-4-1 Fork Length Range and Mean Fork Length of Brushtooth Lizardfish

Sub area	Stratum (m)	Range of FL (Mean FL) in cm			
		Spring	Summer	Autumn	Winter
West Mediterranean Sea	20~100			19~27 (22)	12~29 (19)
East Mediterranean Sea	20~100	10~32 (22)	3~30 (16)	10~31 (22)	7~29 (16)
	101~200	19~27 (22)			9~28 (20)
	20~200	10~32 (22)	3~30 (16)	10~31 (22)	7~29 (17)
All area	20~100	10~32 (22)	3~30 (16)	10~31 (22)	7~29 (17)
	101~200	19~27 (22)			9~28 (20)
	20~200	10~32 (22)	3~30 (16)	10~31 (22)	7~29 (17)

The type of distribution of body length composition in all areas of this species was basically mono-modal in spring and autumn (and its modes was 21-22 cm in spring and 22-23 cm in autumn), and basically bi-modal in summer and winter (and its modes was 9-10 and 17-18 cm in summer and 9-10 and 20-21 cm in winter). The two major modes in the summer and winter probably each reflect the stock size of recent spawned juvenile fish and adult fish, respectively (Fig. 5-1-4-1).

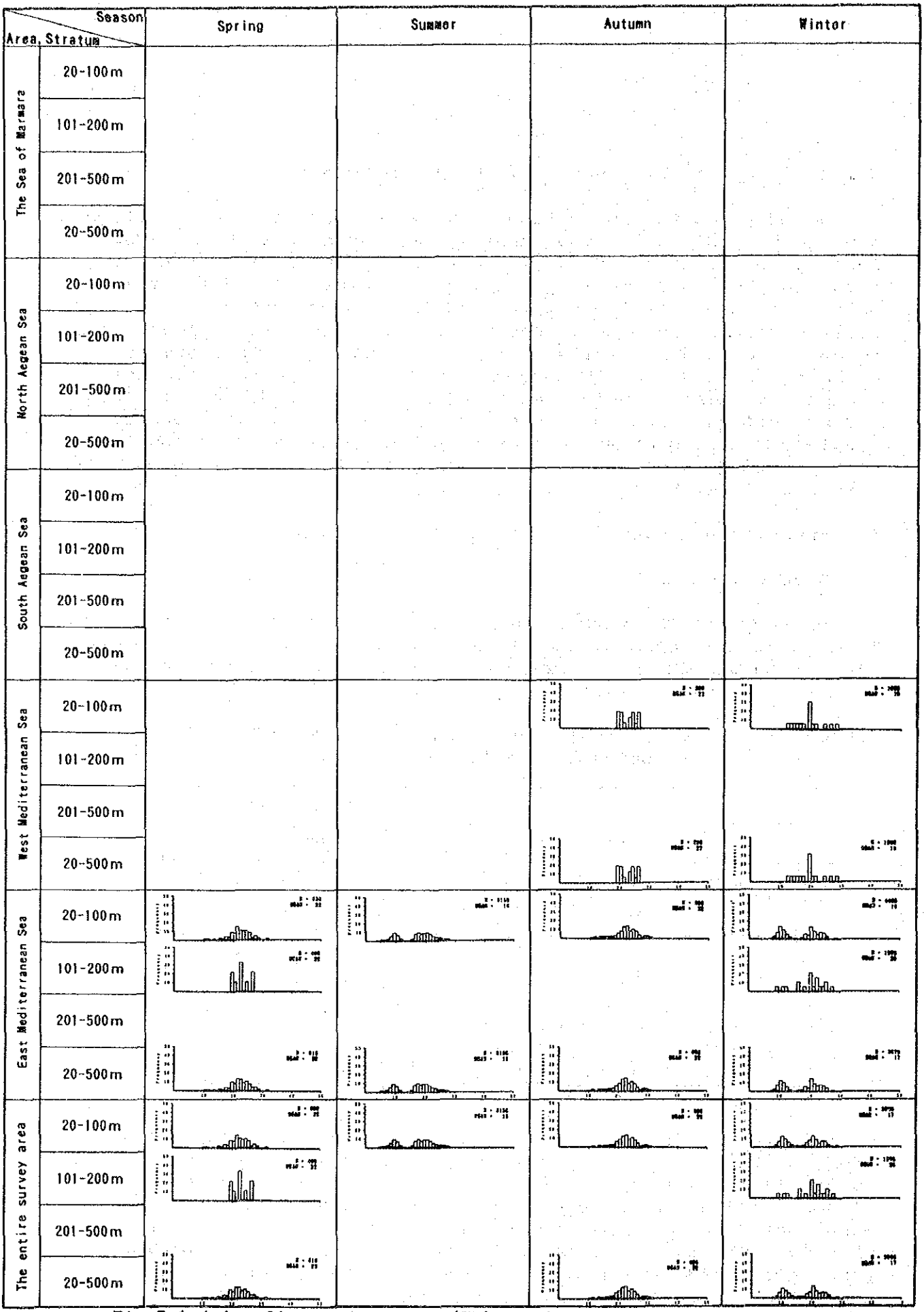


Fig. 5-1-4-1 Size composition (FL) brushtooth lizardfish *Saurida undosquamis* by sub areas, strata and seasons

2) Relationship Between Body Length and Body Weight

The relationship between fork length (X) and body weight (Y) of the total number of males and females of this species was fit to a power curve using the expression $Y=ax^b$. The coefficients a and b of the relational expression along with the correlation coefficient r are shown in Fig. 5-1-4-2.

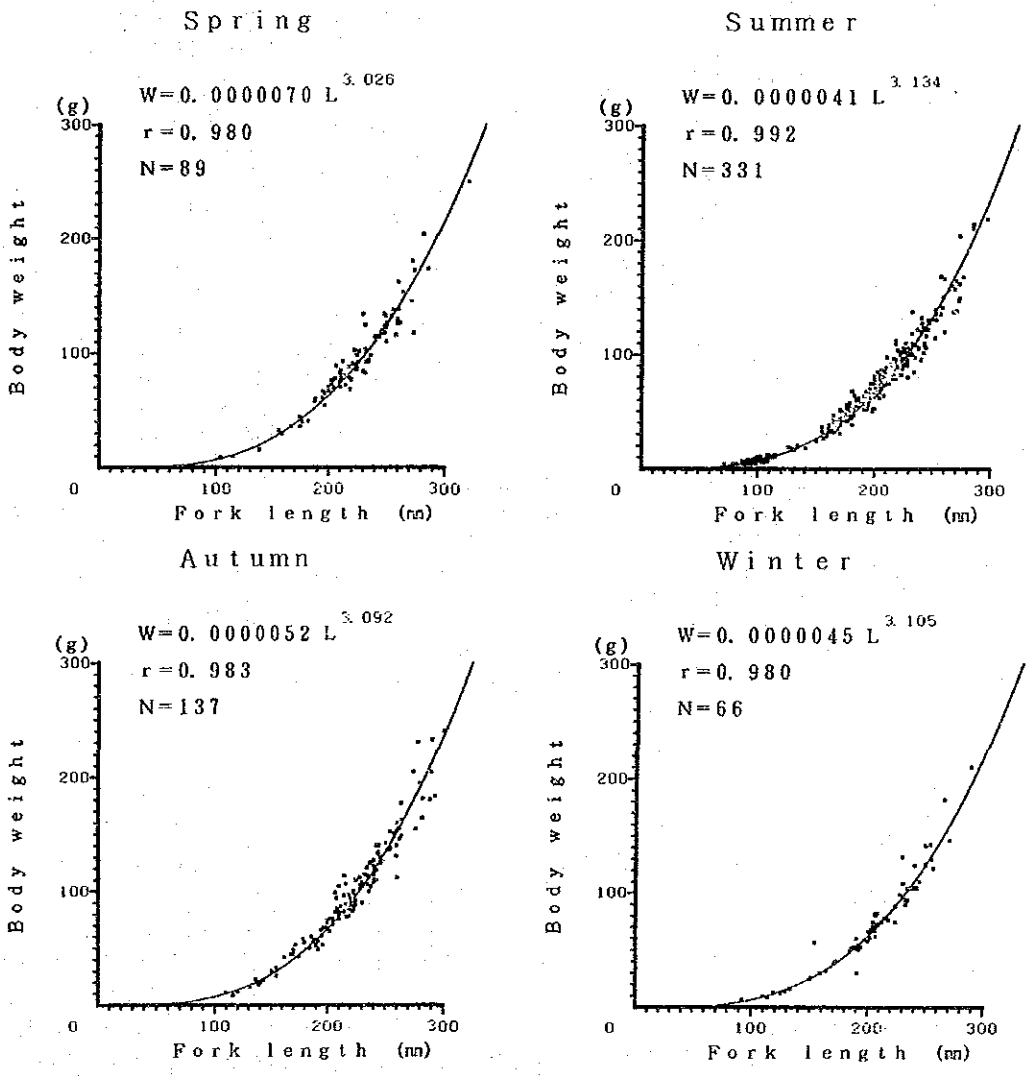


Fig. 5-1-4-2 Relationship Between Fork Length and Body Weight of Brushtooth Lizardfish

The body length and body weight for males and females of this species are shown in Table 5-1-4-2 by season and age.

There are differences observed in the growth of males and females at each age, the growth of females can be said to be faster than that of males. In addition, the sexual differentiation of this species appears to begin no later than a fork length of roughly 100 mm and body weight of roughly 10 g.

Table 5-1-4-2 Fork Length and Body Weight of Brushtooth Lizardfish by Age and Sex

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0	138~214(179)	115~222(195)	104	16~ 81(47)	10~ 90(63)	9
	1	188~235(206)	195~262(234)		58~ 93(74)	61~138(105)	
	2	203~260(222)	196~275(241)		73~126(92)	67~181(117)	
	3		251~320(278)			127~251(178)	
Summer	0	95~131(113)	88	73~126(99)	6~ 17(12)	52	4~ 19(8)
	1	128~205(167)	124~257(172)		18~ 71(39)	31~136(51)	
	2	156~227(184)	101~285(206)		27~110(56)	42~211(78)	
	3	183~270(216)	181~276(231)	103	43~ 75(61)	64~168(107)	9
	4	258	240~273(261)		142	120~204(157)	
	5		285~297(291)			214~219(217)	
Autumn	0			110~143(127)			9~ 23(16)
	1	151~197(168)	155~196(173)	140	30~ 68(45)	26~ 53(41)	20
	2	175~234(206)	172~260(216)		43~121(80)	53~140(89)	
	3	195~215(206)	221~278(246)		61~ 96(77)	90~230(130)	
	4		223~290(262)			98~232(155)	
	5		282~300(288)			164~241(198)	
	6		293			183	
Winter	0		114	93~133(118)		9	7~ 16(12)
	1	151	159~250(205)	191	26	30~126(74)	30
	2	154~215(190)	150~216(193)	164	39~ 79(58)	25~ 78(57)	32
	3	186~241(206)	208~257(229)		52~125(79)	73~125(94)	
	4		224~271(245)			89~182(125)	
	5	289			211		

3) Sex Ratios and Female Maturity Stages

The sex ratios and female maturity stages of brushtooth lizardfish by season, sub area and strata are shown in Table 5-1-4-3. In this table, the sex ratio is expressed as the ratio of the number of females in the case of taking the number of males to be 1. In addition, the total number of females includes the number of spent fish.

The number of females was large in each season, and the sex ratios in all areas were 1.67 in autumn, and 2.20-2.75 in the other seasons. In looking at the maturity stages of females in each season in terms of the proportion of the total number of fish both semi-mature (II) and mature (III) in all areas (to be referred to as the female maturity rate), the female maturity rates were 69% in spring, 69% in summer, 75% in autumn and 22% in winter.

Based on these findings, the spawning period of brushtooth lizardfish is believed to extend throughout the year. In addition, as was mentioned in section 1) describing body length composition, since a recently spawned juvenile fish population (a population having a single mode at a fork length of 10 cm) is

observed in the summer and winter, the peak spawning periods of this species are most likely in spring and autumn.

Table 5-1-4-3 Sex Ratios and Female Maturity Stages of Brushtooth Lizardfish

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios ♀/♂
			I	II	III	Total		
Spring	E. Mediterranean Sea	20~100	132	265	29	427	202	2.11
		101~200	111	276	0	387	111	3.49
		20~200	130	266	26	422	192	2.20
Summer	E. Mediterranean Sea	20~100	578	1,286	0	1,864	828	2.25
Autumn	W. Mediterranean Sea	20~100	0	34	141	177	107	1.65
	E. Mediterranean Sea	20~100	100	169	127	404	241	1.68
	All area	20~100	87	151	129	373	223	1.67
Winter	W. Mediterranean Sea	20~100	326	0	0	326	652	0.50
	E. Mediterranean Sea	20~100	2,571	753	0	3,324	908	3.66
		101~200	540	135	67	742	337	2.20
		20~200	1,894	547	22	2,463	718	3.43
	All area	20~100	1,822	502	0	2,324	823	2.82
		101~200	540	135	67	742	337	2.20
		20~200	1,502	410	16	1,929	701	2.75

* I : Immature II : Semi-mature III : Mature

The sex ratios and female maturity stages of this species by season and age are shown in Table 5-1-4-4.

The number of females was overwhelmingly dominant among older fish in each season (including those two years and older in spring, and three years and older in summer, autumn and winter). Females reach a mature age early, no later than one full year. In addition, there was no large difference observed in the female maturity rate according to age.

Table 5-1-4-4 Sex Ratios and Female Maturity Stage by Season and Age of Brushtooth Lizardfish

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	0	19	44	6	70	63	1.11
	1	39	84	12	137	107	1.28
	2	55	73	7	135	21	6.43
	3	0	45	0	45	0	—
Summer	0	3	0	0	3	17	0.18
	1	80	24	0	104	351	0.30
	2	279	644	0	924	424	2.18
	3	187	525	0	712	24	29.67
	4	17	62	0	79	10	7.90
	5	10	29	0	40	0	—
Autumn	0	8	0	0	8	13	0.62
	1	40	54	14	115	197	0.58
	2	26	61	76	164	9	18.22
	3	0	15	21	36	0	—
	4	0	7	17	25	0	—
	5	0	4	0	4	0	—
Winter	0	0	104	0	104	0	—
	1	33	16	0	50	16	3.13
	2	411	0	0	411	456	0.90
	3	499	51	16	568	207	2.74
	4	556	133	0	690	0	—
	5	0	0	0	0	20	0

* I : Immature II : Semi-mature III : Mature

4) Age Composition

The age composition of brushtooth lizardfish by season, sub area and strata is shown in Table 5-1-4-5.

The maximum age of this species throughout all seasons was 6 years. The major components of the age composition in all seasons consisted of 1 year old fish in spring, and 2 year old fish from summer to winter. There were no older fish of 4 years or older observed in spring. Three and four year old fish were frequently observed in winter. In addition, three year old fish were dominant in 101-200 m in all seasons.

Table 5-1-4-5 Age Composition of Brushtooth Lizardfish

Season	Sub area	Stratum (m)	Age 0	1	2	3	4	5	6
Spring	E. Mediterranean Sea	20~100	155	248	181	52			
		101~200	142	355					
		20~200	154	260	161	46			
Summer	E. Mediterranean Sea	20~100	238	507	1,488	799	94	40	
Autumn	W. Mediterranean Sea	20~100			90	177	16		
	E. Mediterranean Sea	20~100	34	40	360	178	42	29	5
	All area	20~100	29	35	324	178	39	25	4
Winter	W. Mediterranean Sea	20~100	163	81	652	244	81	81	
	E. Mediterranean Sea	20~100	437		1,416	1,249	1,338		
		101~200	202	270	202	472	135		
		20~200	359	90	1,011	990	937		
	All area	20~100	346	27	1,161	914	919	27	
		101~200	202	270	202	472	135		
		20~200	310	87	921	803	723	20	

5) Feeding Habits

Results of stomach contents analysis were summarized as shown below according to the occurrence method.

Spring:
No. of specimens: 89
Empty stomach rate (including eversion): 53%

Fishes: 95.3%, Crustaceans: 9.6%

Summer:
No. of specimens: 331
Empty stomach rate (including eversion): 41%

Fishes: 97.5%, Crustaceans: 2.6%, Mollusks: 1.1%

Autumn:
No. of specimens: 137
Empty stomach rate (including eversion): 43%

Fishes: 98.8%, Mollusks: 1.3%

Winter:
No. of specimens: 66
Empty stomach rate (including eversion): 68%

Fishes: 95.3%, Crustaceans: 4.8%

Based on these results, it was found that brushtooth lizardfish are fish feeders. Furthermore, those consumed fish that were identified consisted of *mullidae* species and smaller fish of that same species.

(2) Hake *Merluccius merluccius*

1) Size Composition

The range of the total length of this species was 2-78 cm throughout all seasons, and the mean total length in all areas and all strata was sequentially 25 cm, 23 cm, 18 cm and 22 cm from spring to winter. The mean total length tended to be approximately dependent on water depth, with the exception of that in the autumn, such that total length appeared to increase as water depth increased (Table 5-1-4-6).

Table 5-1-4-6 Total Length Range and Mean Total Length of Hake

Sub area	Stratum (m)	Range of TL (Mean TL) in cm			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~100	4~46 (25)	8~48 (22)	4~44 (19)	6~48 (21)
	101~200	22~44 (30)	10~42 (23)	6~54 (21)	12~52 (26)
	201~500	22~44 (31)	12~64 (26)	18~74 (34)	16~58 (32)
	20~500	4~46 (26)	8~64 (23)	4~74 (20)	6~58 (22)
North Aegean Sea	20~100	8~44 (24)	6~44 (24)	4~56 (18)	8~44 (22)
	101~200	2~42 (20)	6~68 (26)	4~46 (14)	8~44 (20)
	201~500	20~68 (48)	6~54 (27)	6~76 (13)	14~46 (34)
	20~500	2~68 (24)	6~68 (25)	4~76 (16)	8~46 (21)
South Aegean Sea	20~100	14~46 (23)		10~36 (20)	
	101~200	12~68 (32)	8~42 (25)	8~48 (19)	
	201~500		6~70 (20)	6~30 (12)	8~78 (35)
	20~500	12~68 (25)	6~70 (24)	6~48 (18)	8~78 (35)
West Mediterranean Sea	20~100	22~50 (33)			
	101~200			12~42 (29)	
	201~500	14~40 (22)	8~50 (35)	8~48 (21)	8~44 (18)
	20~500	14~50 (25)	8~50 (35)	8~48 (27)	8~44 (18)
East Mediterranean Sea	20~100	14~48 (24)		8~30 (18)	
	101~200	14~44 (24)	4~44 (18)	8~36 (21)	12~32 (21)
	201~500		6~42 (24)	8~50 (34)	26~46 (37)
	20~500	14~48 (24)	4~44 (18)	8~50 (19)	12~46 (29)
All area	20~100	4~50 (25)	6~48 (23)	4~56 (19)	6~48 (21)
	101~200	2~68 (28)	4~68 (23)	4~54 (19)	8~52 (21)
	201~500	14~68 (31)	6~70 (27)	6~76 (15)	8~78 (28)
	20~500	2~68 (25)	6~70 (23)	4~76 (18)	6~78 (22)

Although the body length composition of this species demonstrated diverse distribution patterns, consisting of mono-modal, bi-modal and poly-modal patterns, according to sub area and water depth, the distribution of body length composition in all areas was basically mono-modal in spring, summer and winter (with mode classes being observed consisting of 23-24 cm in spring and summer, and three modes, i.e. 18-19, 19-20 and 20-21 cm, in winter), and bi-modal in autumn (and the modes were 13-14 cm and 20-21 cm). In looking at the body length composition by sub area and strata, although a population of juvenile fish having a total length of roughly 10 cm was observed throughout all seasons, this population was particularly dominant in autumn (Fig. 5-1-4-3).

2) Relationship Between Body Length and Body Weight

The relationship between total length (X) and body weight (Y) of the total number of males and females of this species was fit to a power curve using the expression $Y = ax^b$. The coefficients a and b of the relational expression along with the correlation coefficient r are shown in Fig. 5-1-4-4.

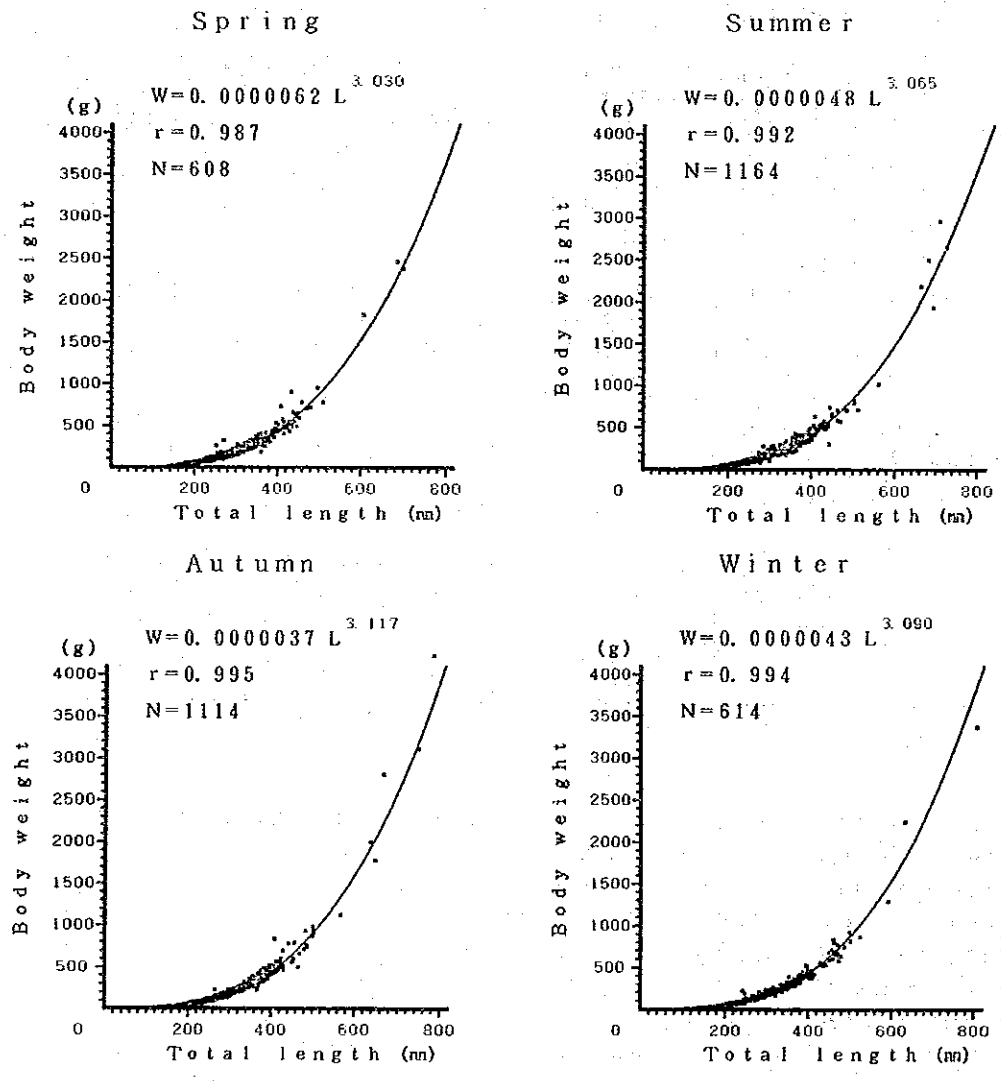


Fig. 5-1-4-4 Relationship Between Total Length and Body Weight of Hake

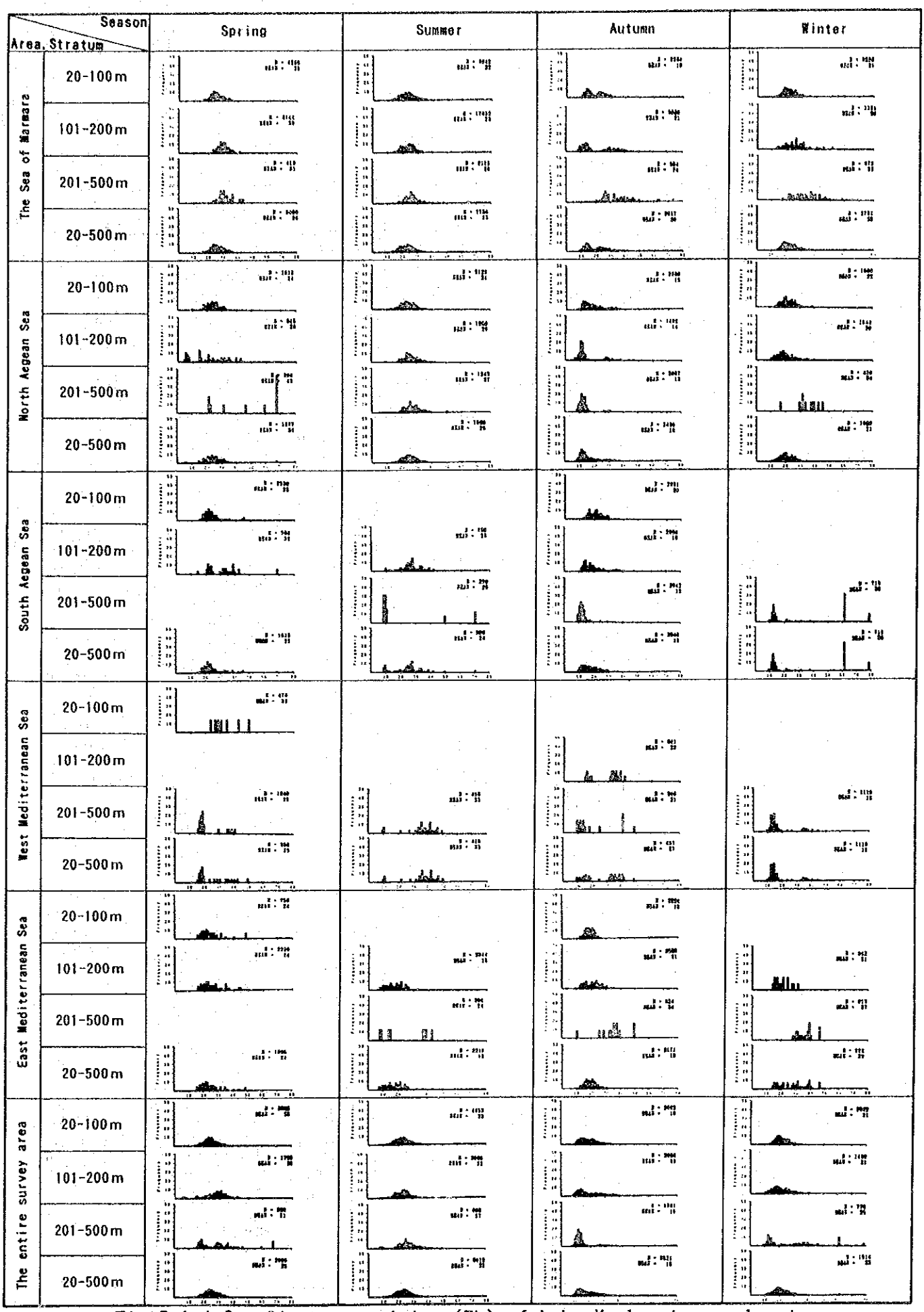


Fig. 5-1-4-3 Size composition (TL) of hake *Merluccius merluccius* by sub areas, strata and seasons

The total length and body weight of this species for males and females by season and age are shown in Table 5-1-4-7.

In looking at the growth differences between males and females at each age of this species, although there is no large difference observed in young fish, the size of females was larger than that of males in older fish. In addition, there were also large differences observed in growth between members of the same sex in each age group.

Table 5-1-4-7 Total Length and Body Weight by Age and Sex of Hake

Season	Age	Range of TL (Mean TL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0	136~237(181)	159~255(194)	97~176(135)	18~ 80(46)	30~137(59)	5~ 37(19)
	1	157~250(212)	157~267(214)	159~214(187)	27~115(70)	28~146(81)	27~ 80(47)
	2	194~303(248)	196~343(263)	66~190(128)	51~320(112)	60~293(149)	2~ 44(23)
	3	223~352(287)	237~365(305)	57~343(200)	78~320(168)	107~380(221)	1~367(184)
	4	265~423(329)	248~425(353)		140~520(294)	103~892(340)	
	5	349~439(398)	351~462(409)		267~496(404)	351~770(520)	
	6		429~471(443)			595~710(638)	
	7		594			1,790	
	8		488~671(553)			770~2,410(1,373)	
	9		685			2,320	
Summer	0	127	326	76~188(118)	12	248	4~ 53(13)
	1	158~296(199)	105~243(190)	120~226(163)	24~121(53)	20~128(52)	11~ 90(34)
	2	172~352(236)	129~398(243)	85~230(192)	32~326(91)	44~520(107)	4~ 97(52)
	3	186~384(279)	180~390(288)	190~241(215)	38~354(161)	75~487(177)	43~102(73)
	4	280~462(353)	291~427(350)	333	144~570(318)	165~629(319)	182
	5	396~433(412)	355~493(429)		400~535(477)	402~812(576)	
	6		436~550(496)			705~1,000(812)	
	7		442			660	
	8		650~695(672)			2,150~2,900(2,525)	
Autumn	0	78~252(130)	86~292(148)	70~165(113)	3~105(17)	5~165(28)	3~ 27(10)
	1	128~281(192)	121~360(192)	112~204(152)	14~166(56)	11~339(58)	9~102(26)
	2	162~365(252)	168~372(256)	101~246(187)	33~347(121)	31~378(136)	7~111(55)
	3	207~390(309)	245~492(331)	283	96~433(219)	112~920(288)	37
	4	212~414(363)	214~492(384)		69~530(365)	62~965(455)	
	5	374~476(408)	371~555(443)		380~755(512)	382~1,110(660)	
	6		355~625(478)			332~1,960(936)	
	7		635			1,750	
	8		653			2,750	
	9		767			4,150	
	10		733			3,050	
Winter	0	152~163(157)	148~169(159)	101~163(143)	27~ 30(28)	21~ 33(27)	6~ 37(21)
	1	147~243(196)	142~242(194)	150~197(174)	17~ 95(55)	17~100(52)	24~ 54(36)
	2	172~397(253)	215~316(256)	105~124(114)	68~208(117)	65~229(127)	8~ 9(9)
	3	264~381(305)	263~386(319)		120~445(205)	125~524(247)	
	4	335~375(359)	340~441(389)		259~370(309)	268~674(420)	
	5	441	390~465(426)		581	425~597(526)	
	6	448	453~470(460)		695	630~821(707)	
	7		455~790(537)			649~3,300(1,275)	
	8		581			1,270	

3) Sex Ratios and Female Maturity Stages

The sex ratios and female maturity stages of hake by season, sub area and strata are shown in Table 5-1-4-8. In this table, the sex ratio is expressed as the ratio of the number of females in the case of taking the number of males to be 1. In addition, the total number of females includes the number of spent fish.

The overall sex ratios in all areas were within a range of 0.96-1.19 throughout all seasons, indicating a nearly equal number of males and females. The female maturity rates in all areas were 61% in spring, 15% in summer, 27% in autumn and 32% in winter. These results suggest that the spawning period of this species extends throughout the year, and that the peak spawning period is in spring. In looking at the female maturity rate in all areas by strata, the rate was high at shallow depths in spring and summer, and tended to decrease as water depth increases. The opposite trend was demonstrated in winter. The following shows the results of looking at the female maturity rate for each sub area within the same season.

Spring:	a.	80%	b.	17%	c.	14%	d.	16%	e. 19%
		(-)		(0)		(4)		(0)	(0)
Summer:	a.	19%	b.	5%	c.	7%	d.	0%	e. 0%
		(0)		(0)		(0)		(0)	(0)
Autumn:	a.	57%	b.	7%	c.	1%	d.	0%	e. 0%
		(6)		(1)		(3)		(72)	(0)
Winter:	a.	38%	b.	16%	c.	63%	d.	0%	e. 50%
		(2)		(21)		(0)		(0)	(7)

Notes:
a. The Sea of Marmara, b. North Aegean Sea, c. South Aegean Sea
d. West Mediterranean Sea, e. East Mediterranean Sea,
In addition, figures in parentheses indicate the percentage of spent fish, while a hyphen indicates a percentage of less than 1%.

Based on the above findings, it was found that the female maturity rate was high in The Sea of Marmara throughout all seasons. In addition, although the spawning period of this species in terms of all areas was in the spring as was mentioned above, this is believed to be in the winter in the South Aegean Sea and East Mediterranean Sea.

Table 5-1-4-8 Sex Ratios and Female Maturity Stages of Hake (Part 1)

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios ♀/♂
			I	II	III	Total		
Spring	The Sea of Marmara	20~100	348	1,150	902	2,401	1,855	1.29
		101~200	708	547	245	1,500	1,650	0.91
		201~500	138	32	0	182	232	0.78
		20~500	375	846	627	1,851	1,532	1.21
	North Aegean Sea	20~100	727	71	14	812	543	1.50
		101~200	80	116	58	254	330	0.77
		201~500	56	156	0	212	84	2.52
		20~500	524	91	18	634	439	1.44
	South Aegean Sea	20~100	578	91	36	705	1,747	0.40
		101~200	173	0	0	214	496	0.43
		20~200	375	45	18	459	1,121	0.41
	W. Mediterranean Sea	20~100	271	135	0	406	68	5.97
		201~500	434	0	0	434	434	1.00
		20~500	352	67	0	420	251	1.67
	E. Mediterranean Sea	20~100	457	46	17	521	147	3.54
		101~200	232	232	0	464	1,857	0.25
		20~200	412	83	13	509	489	1.04
	All area	20~100	505	511	377	1,393	1,090	1.28
		101~200	358	263	106	737	1,057	0.70
		201~500	160	68	0	234	216	1.08
		20~500	425	397	269	1,096	956	1.15
Summer	The Sea of Marmara	20~100	2,551	703	47	3,303	3,003	1.10
		101~200	8,981	1,379	0	10,360	7,105	1.46
		201~500	1,282	0	0	1,282	765	1.68
		20~500	3,349	733	36	4,118	3,376	1.22
	North Aegean Sea	20~100	1,298	32	3	1,333	632	2.11
		101~200	323	34	28	386	835	0.46
		201~500	574	20	0	602	589	1.02
		20~500	804	30	11	848	695	1.22
	South Aegean Sea	101~200	295	0	13	309	386	0.80
		201~500	37	22	0	59	0	—
		101~500	209	7	9	225	257	0.88
	W. Mediterranean Sea	201~500	153	0	0	153	226	0.68
	E. Mediterranean Sea	101~200	655	0	0	655	1,093	0.60
		201~500	185	0	0	185	46	4.02
		101~500	538	0	0	538	831	0.65
	All area	20~100	1,944	378	26	2,350	1,855	1.27
		101~200	1,544	206	17	1,768	1,643	1.08
		201~500	486	12	0	503	425	1.18
		20~500	1,493	242	17	1,754	1,471	1.19

* I : Immature II : Semi-mature III : Mature

Table 5-1-4-8 Sex Ratios and Female Maturity Stages of Hake (Part 2)

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios ♀/♂
			I	II	III	Total		
Autumn	The Sea of Marmara	20~100	643	623	204	1,562	1,669	0.94
		101~200	618	1,769	374	2,789	1,380	2.02
		201~500	87	42	0	260	284	0.92
		20~500	542	655	188	1,477	1,391	1.06
	North Aegean Sea	20~100	1,075	44	36	1,168	1,126	1.04
		101~200	95	0	26	121	597	0.20
		201~500	490	17	0	507	1,201	0.42
		20~500	727	28	26	788	1,025	0.77
	South Aegean Sea	20~100	911	0	0	943	936	1.01
		101~200	626	27	0	680	1,070	0.64
		201~500	220	0	0	220	0	—
		20~500	687	8	0	720	789	0.91
	W. Mediterranean Sea	101~200	38	0	0	38	414	0.09
		201~500	0	0	0	99	0	—
		101~500	19	0	0	68	207	0.33
	E. Mediterranean Sea	20~100	985	0	0	985	695	1.42
		101~200	712	0	0	712	879	0.81
		201~500	243	0	0	243	54	4.50
		20~500	832	0	0	832	703	1.18
	All area	20~100	880	232	83	1,236	1,201	1.03
		101~200	456	258	60	785	878	0.89
		201~500	264	18	0	326	519	0.63
		20~500	664	198	62	959	997	0.96
Winter	The Sea of Marmara	20~100	952	482	133	1,568	1,859	0.84
		101~200	211	180	37	448	614	0.73
		201~500	196	21	34	352	327	1.08
		20~500	653	329	94	1,101	1,304	0.84
	North Aegean Sea	20~100	660	69	5	1,012	552	1.83
		101~200	322	162	54	550	947	0.58
		201~500	101	34	34	168	168	1.00
		20~500	499	99	24	787	665	1.18
	South Aegean Sea	201~500	171	0	294	465	106	4.39
	W. Mediterranean Sea	201~500	155	0	0	155	187	0.83
	E. Mediterranean Sea	101~200	135	0	0	135	540	0.25
		201~500	46	183	274	548	365	1.50
		101~500	90	91	137	341	452	0.75
	All area	20~100	815	288	73	1,306	1,244	1.05
		101~200	264	150	42	470	790	0.60
		201~500	157	25	144	358	210	1.71
		20~500	485	176	86	821	826	0.99

* I : Immature II : Semi-mature III : Mature

The sex ratios and female maturity stages of this species by season and age are shown in Table 5-1-4-9.

As mentioned previously, although the sex ratio in all areas for each season was approximately 1, differences were observed in the sex ratio by age, with the number of males tending to be larger than the number of females in the case of 0 - 3 year old fish, while the number of females was dominant in the case of 4 year old fish and older. The female maturity rates by age as indicated by looking at the example of spring, considered to be the peak spawning period of this species, were 0%, 16%, 40%, 77%, 70%, 85%, 80%, 100% and 100% from the ages of 0 to 8 years. It appears that the older the females, the higher the maturity rate. In addition, the age of female maturity was as early as 1 year, and 2 years in the majority of fish.

Table 5-1-4-9 Sex Ratios and Female Maturity Stage by Season and Age of Hake

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	0	39	0	0	39	58	0.67
	1	92	0	18	111	188	0.59
	2	117	34	46	199	293	0.68
	3	92	177	140	410	280	1.46
	4	52	79	45	178	60	2.97
	5	5	29	4	39	12	3.25
	6	2	12	0	15	0	—
	7	0	1	0	1	0	—
	8	0	12	0	12	0	—
	9	0	0	0	2	0	—
Summer	0	1	0	0	1	0	—
	1	275	0	0	275	242	1.14
	2	549	51	0	602	823	0.73
	3	444	136	6	586	304	1.93
	4	144	45	8	198	58	3.41
	5	17	4	1	23	6	3.83
	6	3	0	0	4	0	—
	7	0	0	0	0	0	—
	8	2	0	0	2	0	—
Autumn	0	41	8	0	52	48	1.08
	1	264	2	1	268	361	0.74
	2	209	29	36	276	379	0.73
	3	101	79	20	218	171	1.28
	4	28	70	0	111	25	4.44
	5	3	0	3	9	4	2.25
	6	0	7	0	8	0	—
	7	0	0	0	0	0	—
	8	3	0	0	3	0	—
	9	3	0	0	3	0	—
	10	0	0	0	0	0	—
Winter	0	10	0	0	10	17	0.59
	1	250	2	0	259	389	0.67
	2	169	50	10	235	280	0.84
	3	32	76	20	163	110	1.48
	4	8	34	3	53	9	5.89
	5	0	6	4	12	0	—
	6	0	2	8	11	1	11.00
	7	0	0	39	41	0	—
	8	0	0	0	0	0	—

* I : Immature II : Semi-mature III : Mature

4) Age Composition

The age composition of hake by season, sub area and strata is shown in Table 5-1-4-10.

The age composition of all areas consisted of primarily of 2 and 3 year old fish in spring and summer, and 1 and 2 year old fish in autumn and winter. Although there were little differences observed in age composition due to differences in water depth and geographical differences, older fish aged 6 years and over tended to be present in large numbers in the deepest stratum (201-500 m) throughout all seasons and in all areas. Furthermore, the maximum age of specimens of this species was 10 years.

5) Feeding Habits

Results of stomach contents analysis were summarized as shown below according to the occurrence method.

Spring:
No. of specimens: 609
Empty stomach rate (including eversion): 66%

Fishes: 81.2%, Crustaceans: 28.6%
Mollusks: 1.0%, Others: 0.5%

Summer:
No. of specimens: 1,164
Empty stomach rate (including eversion): 74%

Fishes: 63.1%, Crustaceans: 37.3%
Mollusks: 2.4%, Unknown 2.7%, Others: 0.4%

Autumn:
No. of specimens: 1,114
Empty stomach rate (including eversion): 71%

Fishes: 74.9%, Crustaceans: 28.4%
Mollusks: 1.9%

Winter:
No. of specimens: 614
Empty stomach rate (including eversion): 74%

Fishes: 85.5%, Crustaceans: 14.6%
Mollusks: 3.2%

Based on these results, this species was mainly fish feeders, consuming relatively large amounts of benthic crustaceans (such as shrimps and crabs).

Table 5-1-4-10 Age Composition of Hake (Part 1)

Season	Sub area	Stratum (m)	Age 0	1	2	3	4	5	6	7	8	9
Spring	The Sea of Marmara	20~100	259	514	966	1,940	575	39	15			
		101~200		198	490	1,779	471	212				
		201~500			40	252	90	32				
		20~500	167	368	718	1,613	471	68	9			
	North Aegean Sea	20~100	131	308	563	275	88	36	19			
		101~200	29	80	196	138	196					
		201~500		28	56	28		28		28	128	
		20~500	95	230	428	215	91	29	13	4	19	
	South Aegean Sea	20~100	235	689	1,020	381	91	127				
		101~200		165	96	138	244	24				41
		20~200	117	427	558	259	167	75				20
	West Mediterranean Sea	20~100			158	158			79		79	
		201~500		757	138	69	207	69				
		20~500		378	148	113	103	34	39		39	
	East Mediterranean Sea	20~100	65	360	211	46	32				46	
		101~200	116	464	813	232	232	232	232			
		20~200	75	381	331	83	72	46	46		37	
	All area	20~100	176	417	694	923	275	37	15		9	
		101~200	21	193	358	765	315	114	29			10
		201~500		135	61	146	79	37		9	42	
		20~500	120	332	536	778	254	52	15	1	12	2
Summer	The Sea of Marmara	20~100	142	1,162	2,896	1,544	436	37				
		101~200		4,351	8,099	4,271	917					
		201~500		207	553	819	250	217			72	
		20~500	108	1,526	3,416	1,864	487	49			6	
	North Aegean Sea	20~100	33	358	778	728	214	24		4		
		101~200	21	145	572	370	145	15				
		201~500	13	75	583	416	140	6	13		6	
		20~500	25	225	665	537	175	17	2	1	1	
	South Aegean Sea	101~200	55	27	386	187	66	26				
		201~500						243				
		101~500	36	18	257	125	44	98				
	W. Mediterranean Sea	201~500			26	63	121	40				
	East Mediterranean Sea	101~200	188	396	975	961	264		66			
		201~500	139	46			46	139				
		101~500	176	308	731	721	210	34	49			
	All area	20~100	89	773	1,871	1,149	328	31		2		
		101~200	47	731	1,619	949	252	13	9			
		201~500	15	66	351	316	126	81	6		12	
		20~500	59	603	1,454	901	259	36	4		2	

Table 5-1-4-10 Age Composition of Hake (Part 2)

Season	Sub area	Stratum (m)	Age 0	1	2	3	4	5	6	7	8	9	10
Autumn	The Sea of Marmara	20~100	254	1,162	1,138	676	188		35				
		101~200	434	369	868	1,146	1,495						
		201~500			200	174	127	11	8	11			11
		20~500	230	864	940	642	331	2	26	2			2
	North Aegean Sea	20~100	372	1,004	799	248	37	53					
		101~200	792	244	235	124		13					
		201~500	576	966	252	464	166				55	55	
		20~500	511	827	552	268	57	32			12	12	
	South Aegean Sea	20~100	7	700	747	519	64						
		101~200		959	496	496	113	35					
		201~500	640	1,329	164	28							
		20~500	131	904	555	414	66	10					
	West Mediterranean Sea	101~200		200		280	160						
		201~500	80	133	27			80	27				
		101~500	40	166	13	140	80	40	13				
	East Mediterranean Sea	20~100	45	1,507	738	91							
		101~200	20	715	900	582	126						
		201~500	27		27	135	81	27	27				
		20~500	35	1,117	733	258	48	2	2				
	All area	20~100	209	1,119	898	406	86	15	12				
		101~200	294	546	554	492	285	11					
		201~500	335	605	180	233	102	12	7	3	20	20	3
		20~500	253	887	683	394	136	14	8		3	3	—
Winter	The Sea of Marmara	20~100	97	1,701	1,209	431	33	21		15			
		101~200	75	271	230	402	80	21		37			
		201~500		66	164	241	116	22	22	35	11		
		20~500	73	1,088	804	387	59	21	4	23	2		
	North Aegean Sea	20~100	143	540	661	286	73						
		101~200	288	783	354	299	75		54				
		201~500		37		149	112	37					
		20~500	185	591	504	280	76	2	19				
	South Aegean Sea	201~500	28	56	85	28				294			
	W. Mediterranean Sea	201~500		62	62	190	97		35				
	East Mediterranean Sea	101~200	202	270	337	135							
		201~500			91	365	228	137	91				
		101~500	101	135	214	250	114	68	45				
	All area	20~100	119	1,155	951	362	52	11		8			
		101~200	207	555	311	315	68	7	30	12			
		201~500	10	53	95	157	80	21	20	116	3		
		20~500	108	681	541	290	64	13	13	41	—		

(3) Comber *Serranus cabrilla*

1) Size Composition

The fork length range of this species was 6-32 cm throughout all seasons, and the mean fork length in all areas and at all strata was 14 cm in spring and autumn, and 16 cm in summer and winter (Table 5-1-4-11).

Table 5-1-4-11 Fork Length Range and Mean Fork Length of Comber

Sub area	Stratum (m)	Range of FL (Mean FL) in cm			
		Spring	Summer	Autumn	Winter
North Aegean Sea	20~100 101~200	12~21 (15)	6~32 (15) 16~21 (17)	9~21 (14) 12~21 (16)	11~18 (14)
	20~200	12~21 (15)	6~32 (15)	9~21 (14)	11~18 (14)
South Aegean Sea	20~100 101~200	9~20 (14) 8~20 (13)	10~23 (17)		16~20 (17)
	20~200	8~20 (14)	10~23 (17)		16~20 (17)
East Mediterranean Sea	20~100	12~17 (14)			
All area	20~100 101~200	9~21 (14) 8~20 (13)	6~32 (16) 16~21 (17)	9~21 (14) 12~21 (16)	11~20 (16)
	20~200	8~21 (14)	6~32 (16)	9~21 (14)	11~20 (16)

The overall body length composition of this species in each season demonstrated a mono-modal distribution with the exception of that in winter. The mode consisted of 14-15 cm in spring, 18-19 cm in summer and 13-14 cm in autumn. The body length distribution of this species in winter demonstrated a bi-modal distribution pattern, with the modes consisting of 14-15 cm and 17-18 cm. The two major modes in winter reflected the body length composition in the North Aegean Sea (mono-modal pattern having a single mode at 14-15 cm), and that in the South Aegean Sea (mono-modal pattern having a single mode at 17-18 cm) (Fig. 5-1-4-5).

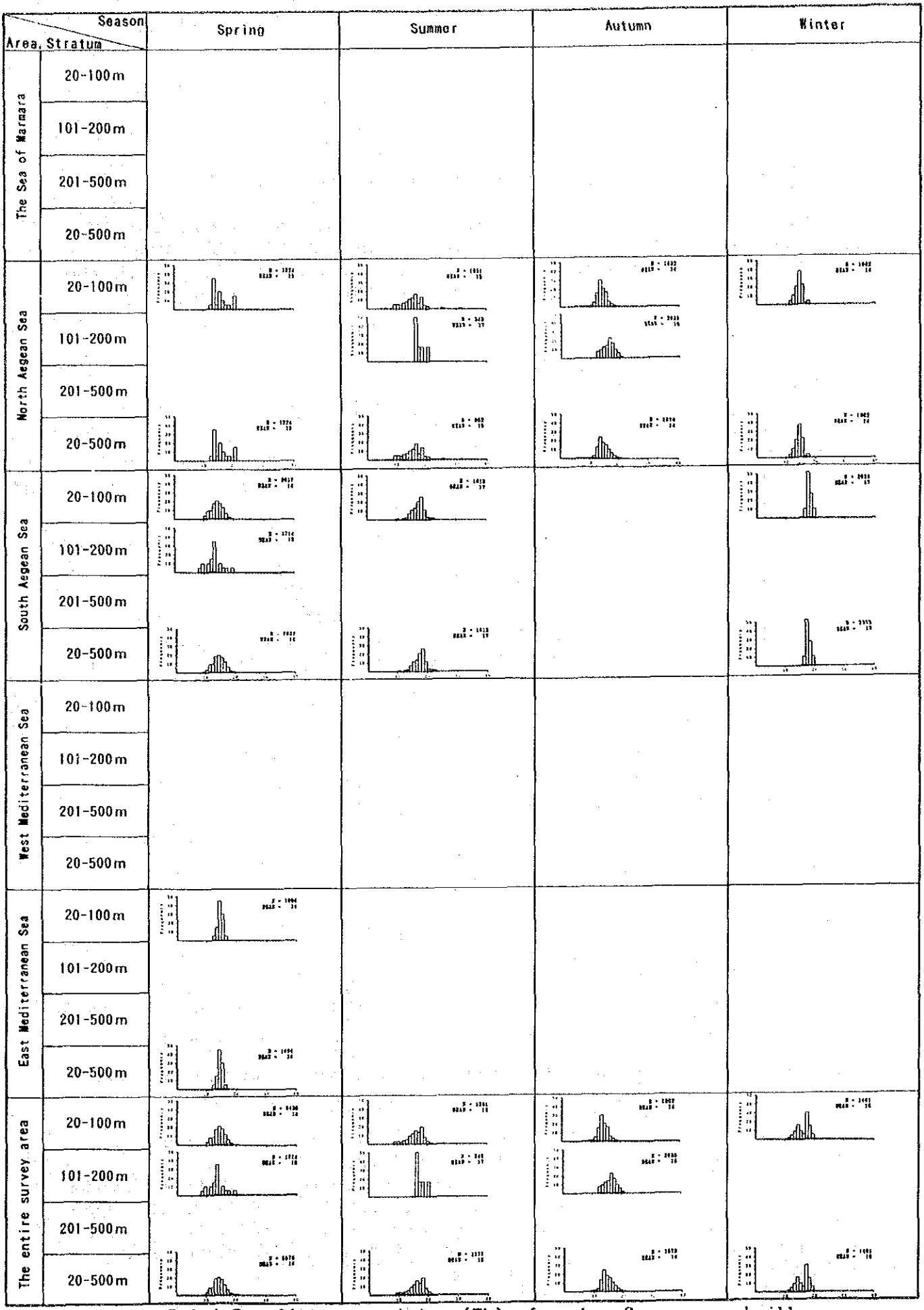


Fig. 5-1-4-5 Size composition (FL) of comber *Serranus cabrilla* by sub areas, strata and seasons

2) Relationship Between Body Length and Body Weight

The relationship between fork length (X) and body weight (Y) was fit to a power curve using the expression $Y = aX^b$. The coefficients a and b of the relational expression along with the correlation coefficient r are shown in Fig. 5-1-4-6.

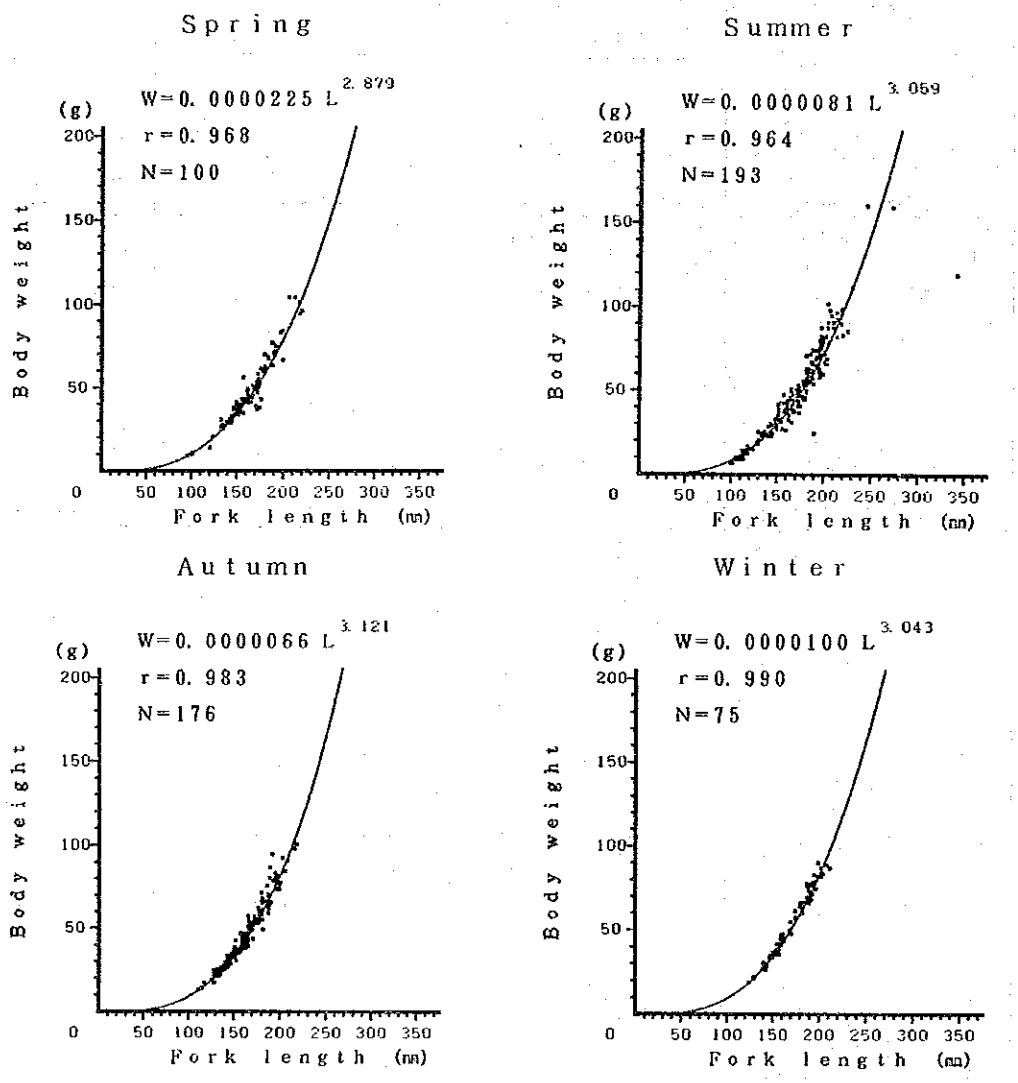


Fig. 5-1-4-6 Relationship Between Fork Length and Body Weight of Comber

The body length and body weight of this species by sex are shown by season and age in Table 5-1-4-12.

As well be described later, since the majority of this species is hermaphroditic, growth differences cannot be observed between males and females. The gonads of this species appear to develop in individuals having a fork length of roughly 10 cm and body weight of roughly 10 g or more.

Table 5-1-4-12 Fork Length and Body Weight by Age and Sex of Comber

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0		94~ 95(94)			10~ 11(11)	
	1		116~134(128)			20~ 30(27)	
	2		130~173(144)			28~ 66(38)	
	3		144~203(160)			34~ 92(50)	
	4		158~206(181)			48~102(75)	
	5		185			81	
Summer	0		94~120(104)	103		7~ 18(11)	10
	1		70~184(132)			14~ 75(29)	
	2		109~210(166)			14~ 97(54)	
	3		171~319(189)			54~117(76)	
	4		200~255(222)			88~157(124)	
Autumn	0		104~108(106)			13~ 14(14)	
	1	110	118~155(133)		17	17~ 50(29)	
	2	150	128~178(153)		41	24~ 70(44)	
	3		170~203(181)			58~ 99(76)	
	4		192			83	
Winter	1		116~138(129)			19~ 34(27)	
	2		131~180(150)			28~ 70(43)	
	3		151~184(166)			43~ 76(59)	
	4		164~175(172)			56~ 76(66)	

3) Sex Ratios and Female Maturity Stages

The sex ratios and female maturity stages of comber by season and sub area are shown in Table 5-1-4-13. The majority of specimens of this species demonstrated hermaphrodicity. Only a very small number of specimens were observed to have male gonads only in autumn. Specimens demonstrating hermaphrodicity were treated as females in the table. In addition, the number of spent fish were included in the total number of females.

The female maturity rates in all areas were 12% in spring, 7% in summer and 0% in autumn and winter. In addition, in looking at the female maturity rates in spring and summer geographically, in spring, the female maturity rates were 90% in the North Aegean Sea, 0% in the South Aegean Sea and 100% in the East Mediterranean Sea, while in summer, the female maturity rates was 9% in the North Aegean Sea and 10% in the South Aegean Sea.

These results suggest that this species is hermaphroditic protogynous, the spawning period is from spring to summer, the peak spawning period is in spring, and that there are geographical differences in the spawning periods.

Table 5-1-4-13 Sex Ratios and Female Maturity Stages of Comber

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios ♀/♂
			I	II	III	Total		
Spring	North Aegean Sea	20~100	122	61	1,041	1,225	0	—
	South Aegean Sea	20~100	9,240			9,240	0	—
		101~200	1,714			1,714	0	—
		20~200	6,731			6,731	0	—
	E. Mediterranean Sea	20~100		593	1,101	1,694	0	—
	All area	20~100	4,650	163	535	5,350	0	—
		101~200	1,714			1,714	0	—
		20~200	4,063	130	428	4,622	0	—
Summer	North Aegean Sea	20~100	949	71	28	1,048	0	—
		101~200	290	58		348	0	—
		20~200	866	69	24	960	0	—
	South Aegean Sea	20~100	1,549	49		1,619	0	—
	All area	20~100	1,167	63	17	1,255	0	—
		101~200	290	58		348	0	—
		20~200	1,094	62	16	1,180	0	—
Autumn	North Aegean Sea	20~100	935			1,559	26	59.96
		101~200	2,636			2,636	0	—
		20~200	1,313			1,798	20	89.90
Winter	North Aegean Sea	20~100	1,084			1,084	0	—
	South Aegean Sea	20~100	2,034			2,034	0	—
	All area	20~100	1,464			1,464	0	—

* I : Immature II : Semi-mature III : Mature

The sex ratios and female maturity stages of this species by season and age are shown in Table 5-1-4-14.

When the maturity rate by age of female gonads (ovaries) are indicated using the example of spring, considered to be the peak spawning season of this species, the maturity rates were 0%, 24%, 18%, 11% and 7% from 0 to 4 years of age.

Table 5-1-4-14 Sex Ratios and Female Maturity Stages by Season and Age of Comber

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	0	34	0	0	34	—	—
	1	115	0	36	151	—	—
	2	1,101	29	216	1,347	—	—
	3	1,646	101	104	1,853	—	—
	4	930	0	70	1,000	—	—
	5	108	0	0	108	—	—
Summer	0	69	0	0	69	—	—
	1	113	14	5	133	—	—
	2	419	43	10	473	—	—
	3	272	5	0	277	—	—
	4	36	0	0	36	—	—
Autumn	0	8	0	0	19	—	—
	1	346	0	0	593	10	59.30
	2	591	0	0	763	10	76.30
	3	327	0	0	371	—	—
	4	7	0	0	7	—	—
Winter	1	160	0	0	160	—	—
	2	505	0	0	505	—	—
	3	173	0	0	173	—	—
	4	56	0	0	56	—	—

* I : Immature II : Semi-mature III : Mature

4) Age Composition

The age composition of comber by season, sub area and strata is shown in Table 5-1-4-15.

The maximum age of specimens of this species throughout all seasons was 5 years. The modes of age composition in all areas for each season were 3 years in spring and 2 years in the other seasons.

5) Feeding Habits

Results of stomach contents analysis were summarized as shown below according to the occurrence method.

Spring:
No. of specimens: 100
Empty stomach rate (including eversion): 71%

Crustaceans: 58.7%, Fishes: 41.4%, Mollusks: 3.5%

Summer:
No. of specimens: 193
Empty stomach rate (including eversion): 89%

Crustaceans: 81.9%, Fishes: 13.7%, Sea algae: 9.1%, Polychaetes: 4.6%, Echinoderms: 4.6%

Autumn:
No. of specimens: 176
Empty stomach rate (including eversion): 84%

Crustaceans: 78.6%, Fishes: 32.2%, Mollusks: 10.8%, Polychaetes: 7.2%, Echinoderms: 7.2%

Winter:
No. of specimens: 75
Empty stomach rate (including eversion): 79%

Crustaceans: 56.3%, Fishes: 25%, Mollusks: 18.8%, Polychaetes: 18.8%

Based on these results, this species was found to demonstrate benthic animal feeder focusing primarily on crustaceans.

Table 5-1-4-15 Age Composition of Comber

Season	Sub area	Stratum (m)	Age 0	1	2	3	4	5
Spring	North Aegean Sea	20~100		245	551	245	184	
	South Aegean Sea	20~100			2,632	4,035	2,302	271
		101~200	202	605	403	403	101	
		20~200	67	201	1,889	2,824	1,568	181
	E. Mediterranean Sea	20~100			678	847	169	
	All area	20~100		61	1,623	2,290	1,239	135
		101~200	202	605	403	403	101	
		20~200	40	170	1,379	1,913	1,011	108
Summer	North Aegean Sea	20~100	128	171	468	166	23	
		101~200			290	58		
		20~200	112	149	446	152	20	
	South Aegean Sea	20~100		100	526	528	70	
	All area	20~100	81	145	489	297	40	
		101~200			290	58		
		20~200	74	133	473	277	36	
Autumn	North Aegean Sea	20~100	26	778	674	105		
		101~200		73	1,189	1,336	37	
		20~200	20	621	788	379	8	
Winter	North Aegean Sea	20~100		267	597	124	94	
	South Aegean Sea	20~100			368	245		
	All area	20~100		160	505	173	56	

(4) **Painted Comber *Serranus scriba***

1) Size Composition

The total length range of this species at strata of 20-100 m in the North Aegean Sea in summer was 8-24 cm, and the mean total length was 13 cm. The body length composition demonstrated two prominent modes, consisting of one mode of 12-13 cm and another mode of 15-16 cm, with the former being dominant (Fig. 5-1-4-7).

2) Relationship Between Body Length and Body Weight

The relationship between total length (X) and body weight (Y) was fit to a power curve using the expression $Y = aX^b$. The coefficients a and b of the relational expression along with the correlation coefficient r are shown in Fig. 5-1-4-8.

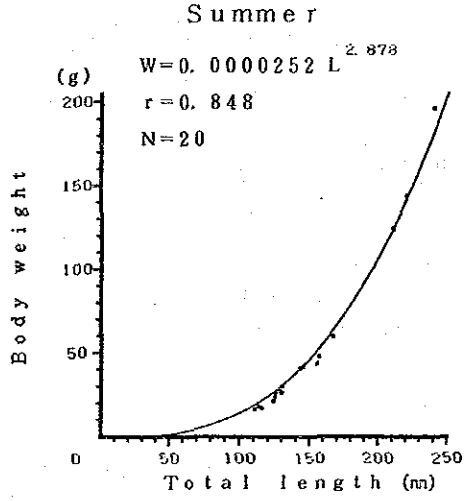


Fig. 5-1-4-8 Relationship Between Total Length and Body Weight of Painted Comber

3) Sex Ratios and Female Maturity Stages

The sex of all specimens in summer was unable to be determined.

4) Age Composition

The age composition of this species in the North Aegean Sea in summer is shown in Table 5-1-4-16.

Ages 0-4 years were observed, with two year old fish being the dominant age group. As was previously described in section 3), the sex of all specimens of this species was unable to be determined. In addition, it is known that the spawning period of this species in the Mediterranean Sea is from April to August. Based on these factors, whether the mature age of this species is

5 years and older cannot be concluded due to the lack of data.

Table 5-1-4-16 Age Composition of Painted Comber

Season	Sub area	Stratum (m)	Age				
			0	1	2	3	4
Summer	North Aegean Sea	20~100	249	1,496	1,745	1,246	249

5) Feeding Habits

Results of stomach contents analysis were summarized as shown below according to the occurrence method.

Summer:
No. of specimens: 20
Empty stomach rate (including eversion): 70%

Crustaceans: 100%, Fishes: 33.4%

Based on these results, this species was found to feed primarily on benthic animals, and be dependent primarily on benthic crustaceans in summer to say at least.

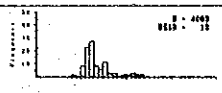
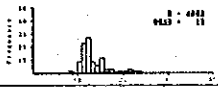
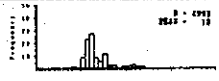
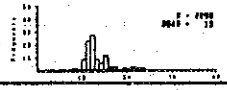
Area, Stratum \ Season	Spring	Summer	Autumn	Winter
The Sea of Marmara 20-100m				
The Sea of Marmara 101-200m				
The Sea of Marmara 201-500m				
The Sea of Marmara 20-500m				
North Aegean Sea 20-100m				
North Aegean Sea 101-200m				
North Aegean Sea 201-500m				
North Aegean Sea 20-500m				
South Aegean Sea 20-100m				
South Aegean Sea 101-200m				
South Aegean Sea 201-500m				
South Aegean Sea 20-500m				
West Mediterranean Sea 20-100m				
West Mediterranean Sea 101-200m				
West Mediterranean Sea 201-500m				
West Mediterranean Sea 20-500m				
East Mediterranean Sea 20-100m				
East Mediterranean Sea 101-200m				
East Mediterranean Sea 201-500m				
East Mediterranean Sea 20-500m				
The entire survey area 20-100m				
The entire survey area 101-200m				
The entire survey area 201-500m				
The entire survey area 20-500m				

Fig.5-1-4-7 Size composition (TL) of painted comber *Serranus scriba* by sub areas, strata and seasons

(5) Atlantic Horse-Mackerel *Trachurus trachurus*

Since this species was not treated as an important species at the outset of this survey, the size composition and biological measurements were not made in the initial round of this survey conducted in summer. Thus, the data presented here indicates a summary of data collected in the second round of the survey and beyond (winter survey).

1) Size Composition

The fork length range of this species was 6-39 cm, and the mean fork length range in all areas and at all strata was 11-13 cm. The mean fork length tended to be dependent on water depth in that fork length to increase as water depth increased (Table 5-1-4-17).

Table 5-1-4-17 Fork Length Range and Mean Fork Length of Atlantic Horse-Mackerel

Sub area	Stratum (m)	Range of FL (Mean FL) in cm		
		Spring	Autumn	Winter
The Sea of Marmara	20~100	8~23 (12)	11~19 (12)	7~19 (12)
	101~200	12~20 (17)	11~19 (13)	12~19 (14)
	20~200	8~23 (12)	11~19 (13)	7~19 (12)
North Aegean Sea	20~100	12~20 (13)	7~20 (11)	10~16 (12)
	101~200		7~22 (12)	9~29 (15)
	201~500	7~30 (24)	11~39 (13)	17~27 (21)
	20~500	7~30 (14)	7~39 (12)	9~29 (14)
South Aegean Sea	20~100	19~27 (22)	8~24 (11)	
	101~200		7~17 (9)	
	201~500	6~25 (16)	8~21 (11)	
	20~500	6~27 (18)	7~24 (11)	
West Mediterranean Sea	201~500		11~16 (13)	13~25 (19)
East Mediterranean Sea	20~100	14~21 (16)		
	101~200		7~19 (10)	
	201~500		11~19 (15)	18~25 (20)
	20~500	14~21 (16)	7~19 (10)	18~25 (20)
All area	20~100	8~27 (13)	7~24 (11)	7~19 (12)
	101~200	12~20 (17)	7~22 (11)	9~29 (15)
	201~500	6~30 (18)	8~39 (11)	13~27 (20)
	20~500	6~30 (13)	7~39 (11)	7~29 (13)

The body length composition of this species in all areas and at all strata basically demonstrated a mono-modal distribution in each season. Those modes consisted of 12-13 cm in spring, 11-12 cm in autumn and 10-11 cm in winter, and a population of smaller fish having a single mode in these classes was dominant for each season. As previously mentioned, the body length composition in all areas by strata tended to be dependent on water depth, with this trend observed particularly strongly in spring and autumn. In other words, as water depth increased, the proportion of smaller fish having a fork length of 15 cm or less decreased, while the proportion of medium-sized fish of 15-20 cm and large fish of 20 cm or more tended to increase relative to the smaller population. In addition, there were hardly any large fish having a fork length of 20 cm or more observed in The Sea of Marmara (Fig. 5-1-4-9).

2) Relationship Between Body Length and Body Weight

The relationship between fork length (X) and body weight (Y) was fit to a power curve using the expression $Y = Ax^b$. The coefficients a and b of the relational expression along with the correlation coefficient r are shown in Fig. 5-1-4-10.

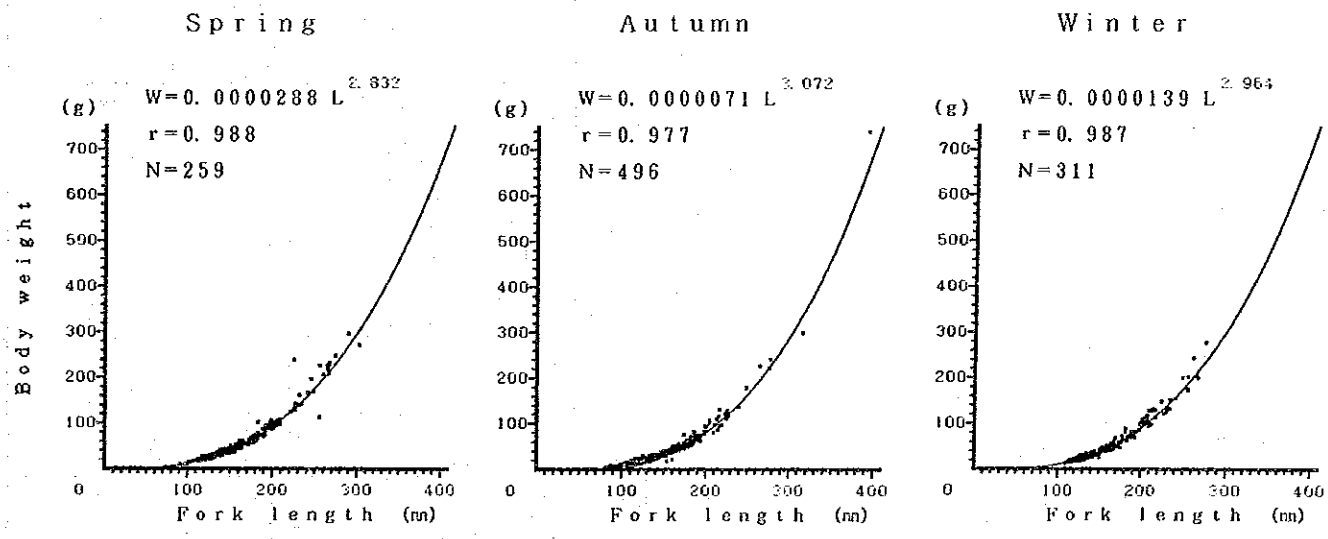


Fig. 5-1-4-10 Relationship Between Fork Length and Body Weight of Atlantic Horse-Mackerel

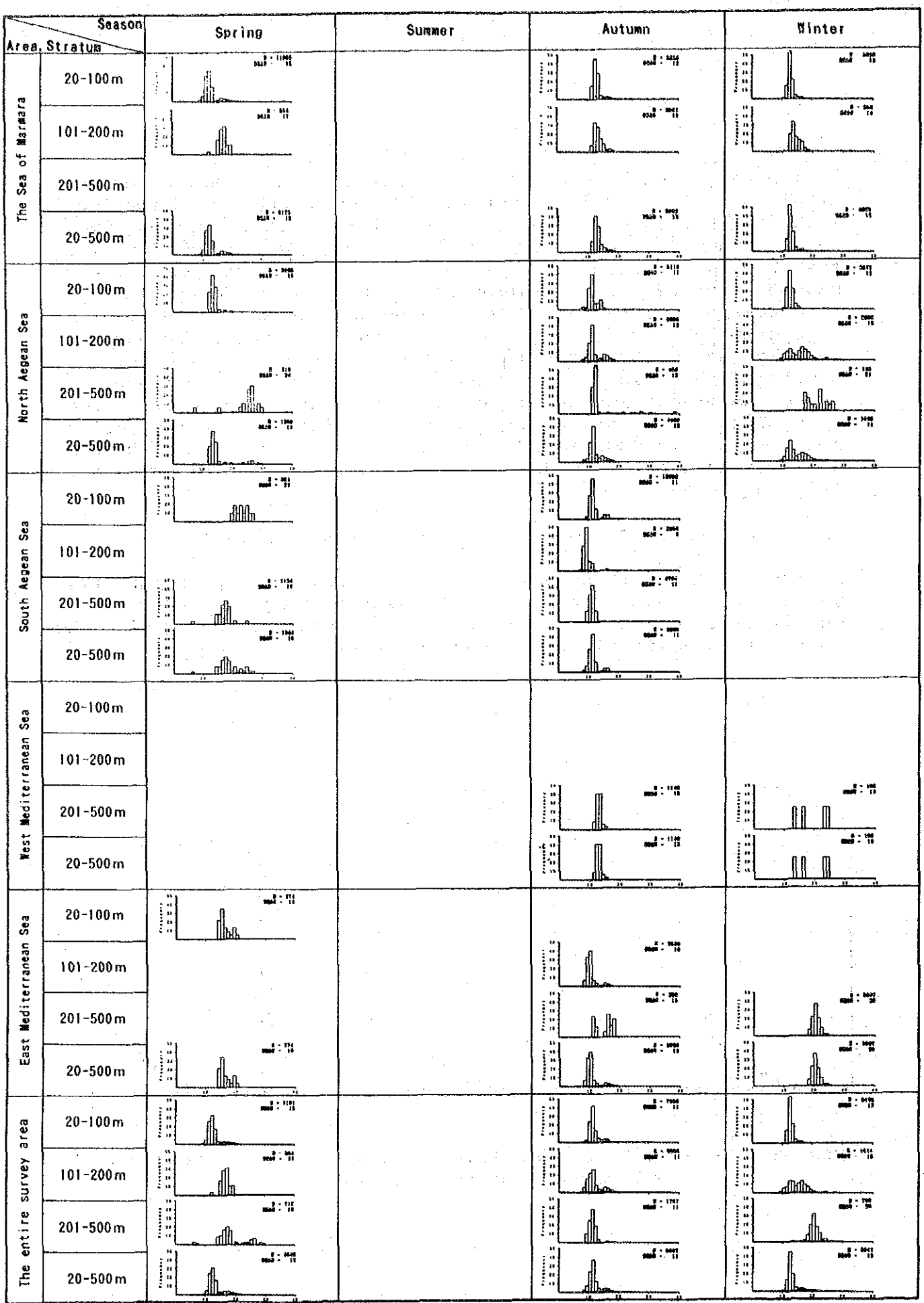


Fig. 5-1-4-9 Size composition (FL) of Atlantic horse-mackerel *Trachurus trachurus* by sub areas, strata and seasons

The body length and body weight of Atlantic horse-mackerel for each sex are shown in Table 5-1-4-18 by season and age.

There was large difference between males and females at each age, there appears to be a difference between the growth of males and females among older fish. In age 5 and over in spring, and age 4 and over in winter, the size of males tended to be larger than that of females. In addition, the sexual differentiation of this species appears to begin at a fork length of roughly 10 cm and body weight of roughly 20 g.

Table 5-1-4-18 Fork Length and Body Weight by Age and Sex of Atlantic Horse-Mackerel

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0	98~105(101)		90~ 96(93)	12~ 16(14)		10~ 11(11)
	1	100~142(121)	109~145(122)		14~ 36(24)	16~ 36(24)	
	2	120~158(143)	120~171(143)		22~ 55(38)	21~ 58(38)	
	3	151~198(175)	154~187(169)		43~ 98(65)	41~ 95(59)	
	4	102~217(187)	169~198(187)		62~117(87)	58~ 94(80)	
	5	221~262(243)	185~269(225)		131~225(182)	67~232(141)	
	6	222~284(253)	262		106~278(186)	213	
	7		296			255	
Autumn	0	110	95~115(103)	81~119(101)	16	7~ 15(11)	6~ 17(11)
	1	107~155(126)	110~145(125)	101~129(114)	10~ 40(22)	9~ 36(21)	10~ 22(15)
	2	126~209(161)	123~188(157)	157	22~104(47)	18~ 73(41)	21
	3	119~212(173)	141~221(189)		25~109(62)	27~123(78)	
	4	164~223(185)	162~235(184)		48~110(69)	46~128(66)	
	5	180	166~244(205)		62	46~169(108)	
	6	185~272(228)	260~271(265)		65~226(146)	208~213(211)	
	7	310			280		
	8		385			693	
Winter	0		107			13	
	1	112~133(124)	112~150(124)	110~127(119)	16~ 33(23)	14~ 38(23)	15~ 24(19)
	2	130~184(142)	130~180(145)		24~ 68(34)	21~ 61(35)	
	3	151~250(173)	154~249(178)		39~162(65)	38~165(68)	
	4	180~262(222)	173~236(196)		67~192(138)	56~145(87)	
	5	200~271(242)	194~208(199)		96~260(195)	81~ 93(89)	

3) Sex Ratios and Female Maturity Stages

The sex ratios and female maturity stages of Atlantic horse-mackerel by season, sub area and strata are shown in Table 5-1-4-19. The sex ratio is expressed as the ratio of the number of females in the case of taking the number of males to be 1. In addition, the total number of females includes the number of spent fish.

The sex ratios in all areas were 0.73 in spring, 1.18 in autumn and 0.64 in winter. The female maturity rates for each season were 97% in spring, 19% in autumn and 69% in winter. In looking at the female maturity rates by strata in terms of all

areas by season, that in spring at depths of 200 m or less was 90% or more and 0% at depths of 201 m or more, that in autumn at depths of 200 m or less was roughly 20-30% and 0% at depths of 201 m or more, while that in water at depths of 20-100 m was 79%, that a depths of 101-200 m was 31% and that at depths of 201-500 m was 72%. In addition, female maturity rates by sub area were summarized as shown below.

Spring:	a.	74%	b.	86%	c.	24%	e.	89%
Autumn:	a.	92%	b.	11%	c.	-	e.	0%
Winter:	a.	81%	b.	19%	d.	67%	e.	80%

where a. The Sea of Marmara, b. North Aegean Sea,
c. South Aegean Sea, d. West Mediterranean Sea,
e. East Mediterranean Sea

Based on these findings, the spawning period of this species is considered to extend throughout the year, and the peak spawning period is believed to have geographical differences. The spawning fish school of this species may also be divided into several sub populations.

Table 5-1-4-19 Sex Ratios and Female Maturity Stages of Atlantic Horse-Mackerel

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios ♀/♂
			I	II	III	Total		
Spring	The Sea of Marmara	20~100	0	2,091	2,946	5,037	6,894	0.73
		101~200	19	126	215	361	194	1.86
		20~200	6	1,436	2,036	3,478	4,661	0.75
	North Aegean Sea	20~100	78	524	389	991	1,417	0.70
		201~500	70	0	0	70	230	0.30
		20~500	74	262	194	530	824	0.64
	South Aegean Sea	20~100	0	0	244	244	650	0.38
		201~500	387	0	0	387	738	0.52
		20~500	258	0	81	339	708	0.48
	E. Mediterranean Sea	20~100	34	237	33	304	472	0.64
	All area	20~100	20	1,278	1,706	3,005	4,163	0.72
		101~200	19	126	215	361	194	1.86
		201~500	228	0	0	228	484	0.47
		20~500	66	802	1,078	1,947	2,684	0.73
Autumn	The Sea of Marmara	20~100	88	331	698	1,117	2,121	0.53
		101~200	112	693	586	1,393	1,137	1.23
		20~200	98	486	650	1,235	1,699	0.73
	North Aegean Sea	20~100	722	319	156	1,303	1,255	1.04
		101~200	1,419	0	0	1,419	986	1.44
		201~500	154	0	0	154	307	0.50
		20~500	869	73	36	1,003	839	1.20
	South Aegean Sea	20~100	7,820	0	0	7,820	5,490	1.42
		201~500	1,930	0	0	1,930	0	—
		20~500	6,348	0	0	6,348	4,118	1.54
	W. Mediterranean Sea	201~500	570	0	0	570	399	1.43
	E. Mediterranean Sea	101~200	191	0	0	191	435	0.44
		201~500	73	0	0	73	75	0.97
		101~500	132	0	0	132	255	0.52
	All area	20~100	2,598	228	326	3,184	2,872	1.11
		101~200	839	189	160	1,188	927	1.28
		201~500	407	0	0	407	222	1.83
		20~500	1,326	150	173	1,661	1,403	1.18
Winter	The Sea of Marmara	20~100	421	1,859	349	2,678	4,794	0.56
		101~200	195	199	160	567	292	1.94
		20~200	353	1,361	292	2,045	3,443	0.59
	North Aegean Sea	20~100	802	229	0	1,031	802	1.29
		101~200	999	200	0	1,217	1,114	1.09
		201~500	35	27	0	62	66	0.94
		20~500	558	130	0	695	620	1.12
	W. Mediterranean Sea	201~500	42	42	42	126	42	3.00
	E. Mediterranean Sea	201~500	0	0	601	752	2,255	0.33
	All area	20~100	469	1,656	305	2,472	4,295	0.58
		101~200	597	200	80	892	703	1.27
		201~500	29	24	128	212	499	0.43
		20~500	394	766	187	1,378	2,161	0.64

* I : Immature II : Semi-mature III : Mature

The sex ratios and female maturity stages of Atlantic horse-mackerel by season and age are shown in Table 5-1-4-20.

The number of males was dominant in many age groups throughout all seasons. There appears to be no large differences in female maturity rates according to age. In addition, the mature age of this species is probably no later than 1 full year.

Table 5-1-4-20 Sex Ratios and Female Maturity Stages by Season and Age of Atlantic Horse-Mackerel

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	0	0	0	0	0	49	0
	1	3	563	383	950	1,541	0.62
	2	23	213	463	700	692	1.01
	3	28	25	80	134	188	0.71
	4	3	0	73	76	119	0.64
	5	5	0	72	78	52	1.50
	6	0	0	4	4	40	0.10
	7	2	0	0	2	0	—
Autumn	0	150	0	0	150	2	75.00
	1	854	71	123	1,057	763	1.39
	2	218	39	27	289	317	0.91
	3	78	16	8	102	227	0.45
	4	3	5	7	16	31	0.52
	5	0	16	0	17	1	17.00
	6	1	0	0	1	17	0.06
	7	0	0	6	6	0	—
	8	1	0	0	1	0	—
Winter	0	0	2	0	2	0	—
	1	191	623	70	902	1,303	0.69
	2	130	40	41	212	310	0.68
	3	62	91	65	219	429	0.51
	4	1	3	10	27	94	0.29
	5	2	5	0	8	23	0.35

* I : Immature II : Semi-mature III : Mature

4) Age Composition

The age composition of this species by season, sub area and strata is shown in Table 5-1-4-21.

The maximum age of this species was 8 years throughout the entire survey. The major age group within the age composition in all areas for each season consisted of 1 year old fish. The dominant age groups by strata in all areas consisted of 1 year old fish at depths of 100 m or less throughout all seasons, and three year old fish in the two strata from 101-500 m except in autumn. The dominant age groups in autumn were 1 year old fish at depths of 200 m or less, and 0 year old fish at depths of 201 m or more. The majority of smaller fish that were dominant in body length composition in each season were most likely 1 year

old fish.

5) Feeding Habits

Results of stomach contents analysis were summarized as shown below according to the occurrence method.

Spring:
No. of specimens: 259
Empty stomach rate: 52%

Crustaceans: 95.2%	Mollusks: 14.4%	Fishes: 8.0%
Polychaetes: 1.6%	Echinoderms: 1.6%	Unknown: 0.9%

Autumn:
No. of specimens: 496
Empty stomach rate: 60%

Crustaceans: 73.0%	Mollusks: 27.6%	Fishes: 4.1%
Polychaetes: 4.1%	Unknown: 4.6%	

Winter:
No. of specimens: 311
Empty stomach rate: 55%

Crustaceans: 80.9%	Fishes: 21.3%	Mollusks: 2.9%

Based on these results, Atlantic horse-mackerel was found to feed mainly on planktonic crustaceans (such as opposum shrimp and copepods).

Table 5-1-4-21 Age Composition of Atlantic Horse-Mackerel

Season	Sub area	Stratum (m)	Age 0	1	2	3	4	5	6	7	8
Spring	The Sea of Marmara	20~100	210	7,229	3,427	362	445	254	63		
		101~200		18	108	292	137				
		20~200	140	4,825	2,320	338	342	169	42		
	North Aegean Sea	20~100		679	1,530	198					
		201~500				24		216	56	24	
		20~500		339	765	111		108	28	12	
	South Aegean Sea	20~100				81	244	325	244		
		201~500			259	754	37	37	37		
		20~500			173	530	106	133	106		
	East Mediterranean Sea	20~100		34	304	370	67				
	All area	20~100	114	4,072	2,202	308	277	168	56		
		101~200		18	108	292	137				
		201~500			129	389	18	126	46	12	
		20~500	70	2,492	1,393	323	196	131	45	2	
Autumn	The Sea of Marmara	20~100		2,264	759	113	89	12			
		101~200		1,471	829	115	115				
		20~200		1,924	789	114	100	7			
	North Aegean Sea	20~100	1,346	1,699	1,147	539		159	159	61	
		101~200	345	2,538	1,167	517	105				
		201~500						5	17	6	11
		20~500	470	1,563	803	363	48	38	42	16	3
	South Aegean Sea	20~100	5,552	14,727	54	1,239	27				
		201~500	6,113			322					
		20~500	5,692	11,045	40	1,010	20				
	W. Mediterranean Sea	201~500		1,083	57						
	East Mediterranean Sea	101~200	287	192	583						
		201~500		81	148						
		101~500	143	136	366						
	All area	20~100	2,069	5,833	664	579	43	53	47	18	
		101~200	240	1,820	969	313	88				
		201~500	764	155	44	40		2	8	3	5
		20~500	1,015	2,745	608	329	48	19	18	7	1
Winter	The Sea of Marmara	20~100	7	5,715	968	875	48				
		101~200		304	350	173	31				
		20~200	5	4,091	783	664	43				
	North Aegean Sea	20~100		1,688	482	121					
		101~200		284	512	1,118	229	187			
		201~500			22	57	31	17			
		20~500		363	297	521	111	87			
	W. Mediterranean Sea	201~500			42	84	42				
	E. Mediterranean Sea	201~500				1,954	1,052				
	All area	20~100	6	5,211	907	781	42				
		101~200		294	431	645	130	93			
		201~500			21	442	237	10			
		20~500	2	2,287	524	649	121	32			

(6) Red Mullet *Mullus barbatus*

1) Size Composition

The fork length range of this species was 4-23 cm, and the mean fork length in all areas was 12-13 cm without any differences between seasons. The mean fork length was dependent on water depth in that fork length increased as water depth increased. In addition, the mean fork length of this species in The Sea of Marmara was larger in comparison with other sub areas (Table 5-1-4-22).

Table 5-1-4-22 Fork Length Range and Mean Fork Length of Red Mullet

Sub area	Stratum (m)	Range of FL (Mean FL) in cm			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~100 101~200	12~20 (15)	10~20 (14) 12~19 (15)	11~21 (15)	11~21 (15)
	20~200	12~20 (15)	10~20 (14)	11~21 (15)	11~21 (15)
North Aegean Sea	20~100 101~200	7~21 (12) 9~17 (12)	8~22 (13) 10~20 (14)	5~20 (12) 10~19 (14)	8~20 (12) 8~20 (13)
	20~200	7~21 (12)	8~22 (13)	5~20 (13)	8~20 (13)
South Aegean Sea	20~100 101~200 201~500	7~21 (13) 10~19 (14) 10~21 (14)	4~22 (13) 12~19 (15)	7~21 (13) 10~23 (14) 12~22 (15)	8~19 (10) 9~20 (12)
	20~500	7~21 (13)	4~22 (13)	7~23 (13)	8~20 (11)
West Mediterrancan Sea	20~100 101~200 201~500	8~20 (13) 12~22 (18) 10~22 (15)	5~19 (12) 9~23 (14)	8~22 (14) 10~23 (15)	6~18 (11) 7~21 (12)
	20~500	8~22 (13)	5~23 (12)	8~23 (14)	6~21 (11)
East Mediterrancan Sea	20~100 101~200 201~500	9~21 (13) 10~22 (14) 10~23 (15)	4~21 (9) 9~21 (15) 16~19 (17)	7~21 (12) 7~22 (12) 13~22 (17)	9~21 (14) 11~19 (14) 12~19 (15)
	20~500	9~23 (14)	4~21 (10)	7~22 (12)	9~21 (14)
All area	20~100 101~200 201~500	7~21 (13) 9~22 (13) 10~23 (15)	4~22 (11) 9~23 (15) 16~19 (17)	5~21 (13) 7~23 (13) 12~22 (16)	6~21 (12) 7~21 (13) 12~19 (15)
	20~500	7~23 (13)	4~23 (12)	5~23 (13)	6~21 (12)

The distribution of body length composition of this species in all areas and at all strata demonstrated a mono-modal pattern except in summer. The mode consisted of 13-14 cm in spring and autumn, and 10-11 cm in winter. The body length composition in summer demonstrated a bi-modal distribution pattern having two

modes at 6-7 cm and 13-14 cm. The population of juvenile fish having a mode of 6-7 cm in summer most likely reflects a population of fish that have just entered a demersal life after completing their planktonic life. The distribution of these juvenile fish population in summer was remarkable at depths of 100 m or less in the South Aegean Sea and East, West Mediterranean Sea. This suggests that these sub areas serve as important nursery grounds for juvenile fish of this species (Fig. 5-1-4-11).

2) Relationship Between Body Length and Body Weight

The relationship between fork length (X) and body weight (Y) was fit to a power curve using the expression $Y = aX^b$. The coefficients a and b of the relational expression along with the correlation coefficient r are shown in Fig. 5-1-4-12.

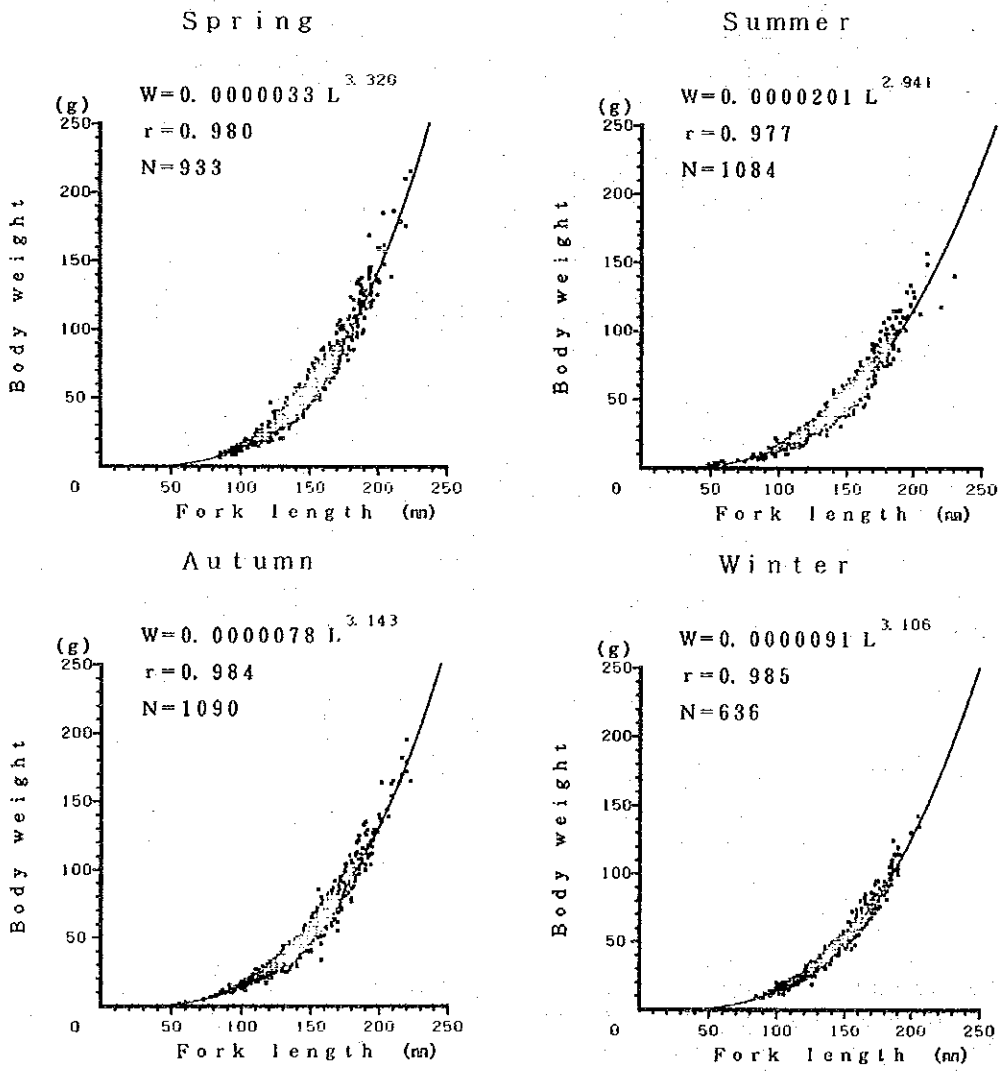


Fig. 5-1-4-12 Relationship Between Fork Length and Body Weight of Red Mullet

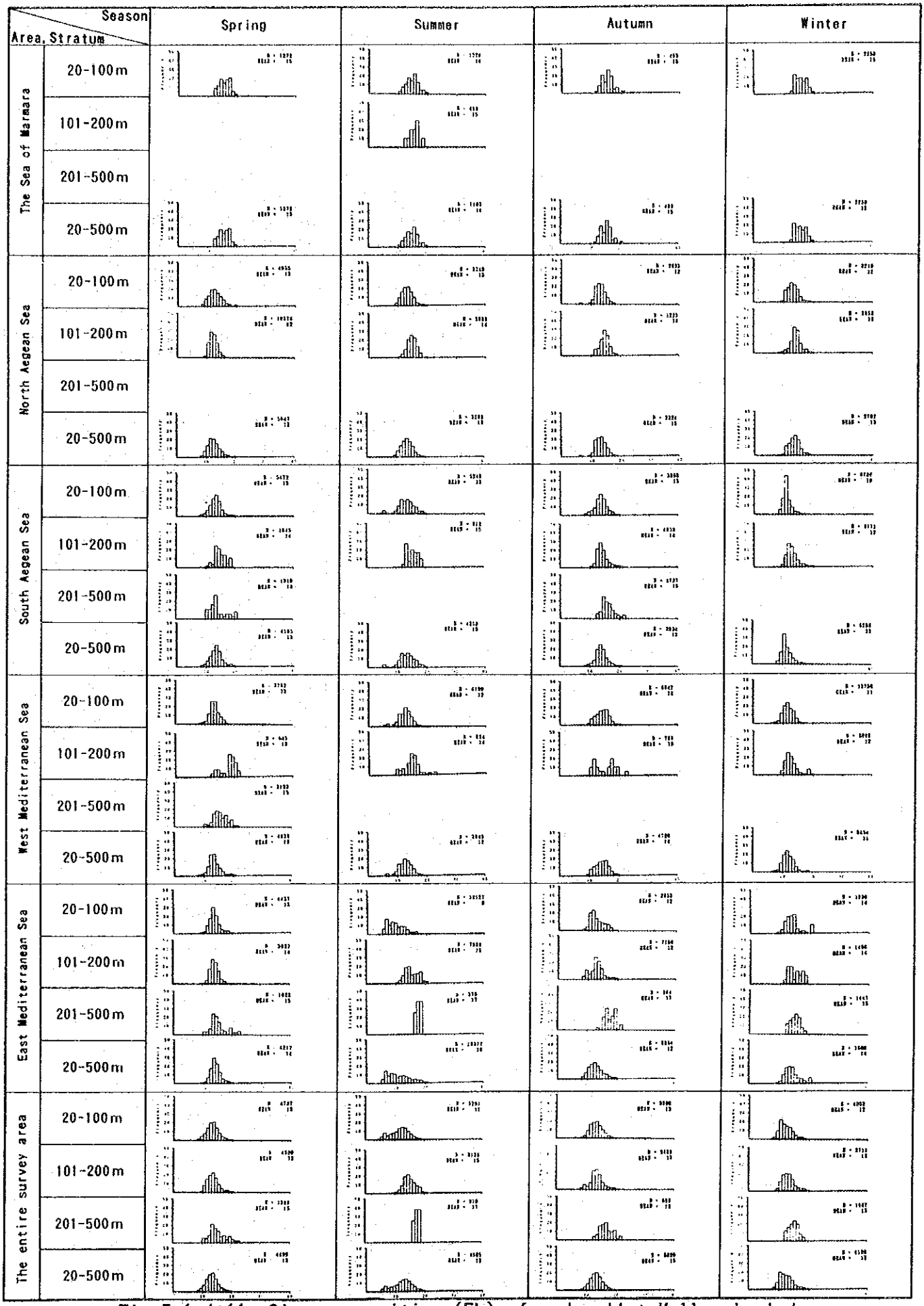


Fig. 5-1-4-11 Size composition (FL) of red mullet *Mullus barbatus* by sub areas, strata and seasons

The body length and body weight for males and females of this species by season and age are shown in Table 5-1-4-23.

It appears that remarkable differences in growth between males and females in each age group occur bordering around the age of 2 years. Although there is no difference in growth between males and females at the age of less than 1 year, at the age of 2 years and older, the growth of females can be said to be faster than that of males. The sexual differentiation of this species appears to begin at roughly a fork length of 90 cm and body weight of 10 g.

Table 5-1-4-23 Fork Length and Body Weight by Age and Sex of Red Mullet

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0	85~119(96)	86~125(101)		7~ 22(13)	9~ 28(16)	
	1	95~169(120)	100~154(121)		12~ 43(26)	14~ 49(28)	
	2	122~159(138)	122~172(145)		24~ 72(42)	24~ 90(52)	
	3	133~173(155)	143~189(168)		36~ 88(63)	46~137(82)	
	4		155~205(190)			66~185(125)	
	5		199~217(207)			126~187(154)	
	6		220~224(221)			176~216(201)	
Summer	0	97~123(107)	85~115(103)	60~107(88)	11~ 26(17)	7~ 22(15)	3~ 19(11)
	1	93~146(117)	100~170(123)	103~138(115)	12~ 40(24)	14~ 69(29)	14~ 33(20)
	2	106~164(134)	96~180(145)	128~147(137)	19~ 59(38)	21~ 81(47)	35~ 47(39)
	3	136~166(149)	133~195(166)		35~ 71(53)	40~115(73)	
	4	125	101~230(189)		28	75~157(110)	
	5		201~210(205)			125~149(137)	
Autumn	0	92~144(104)	88~117(100)	56~103(88)	13~ 51(18)	10~ 24(16)	2~ 18(11)
	1	100~143(122)	100~176(128)		13~ 71(29)	16~ 96(34)	
	2	120~162(139)	121~176(150)		21~ 86(43)	29~ 92(54)	
	3	135~180(162)	152~215(172)		31~106(68)	40~165(85)	
	4	190	175~223(195)		135	81~195(129)	
	5		220			172	
Winter	0	90~107(100)	95	85~ 98(93)	9~ 18(14)	11	10~ 14(12)
	1	99~143(121)	95~151(120)		15~ 43(28)	14~ 48(27)	
	2	125~161(138)	122~187(144)		26~ 59(41)	28~125(48)	
	3	158	150~185(165)		67	47~ 97(71)	
	4		173~190(184)			75~120(98)	
	5		188~200(193)			115~131(120)	
	6						
	7		205			143	

3) Sex Ratios and Female Maturity Stages

The sex ratios and female maturity stages of this species by season, sub area and strata are shown in Table 5-1-4-24. The sex ratio is expressed as the ratio of the number of females in the case of taking the number of males to be 1. In addition, the

total number of females includes the number of individual fish that released eggs.

The number of females was large in each season, the sex ratios for all areas were within a range of 1.66-2.61. The female maturity rates in all areas for each season were 91% in spring, 26% in summer and 0% in autumn and winter. Furthermore, all females in winter were immature. The female maturity rates in each sub area were summarized by season as shown below.

Spring:	a.	100	(0)%	b.	80	(0)%	c.	98 (0)%
	d.	99.8	(0)%	e.	99	(0)%		
Summer:	a.	99	(0)%	b.	54	(0)%	c.	20 (0)%
	d.	6	(0)%	e.	0.5	(9)%		
Autumn:	a.	0	(100)%	b.	0	(100)%		
	d.	0	(100)%	e.	0	(84)%		
Winter:	a.	0	(0)%	b.	0	(0)%	c.	0 (0)%
	d.	0	(0)%	e.	0	(0)%		

Note:
a. The Sea of Marmara, b. North Aegean Sea, c. South Aegean Sea, d. West Mediterranean Sea, e. East Mediterranean Sea
In addition, figures in parentheses indicate the percentage of spent females.

Based on these findings, the spawning season of this species is believed to extend from spring to summer, and the peak spawning period is believed to be in the spring in all areas. In addition, spawning is believed to be entirely completed by the end of summer (beginning of autumn). In the East Mediterranean Sea, the percentage of spent females demonstrating a value of 9% in summer (despite being 0% in other sub areas) and the female immaturity rate demonstrating a value of 16% in autumn (also being 0% in other sub areas) suggests that spawning in this sub area begins earlier and ends sooner than in other sub areas.

Table 5-1-4-24 Sex Ratios and Female Maturity Stages of Red Mullet (Part 1)

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios ♀/♂
			I	II	III	Total		
Spring	The Sea of Marmara	20~100		28	919	947	328	2.89
	North Aegean Sea	20~100	897	511	2,007	3,416	1,772	1.93
		101~200	0	6,968	1,440	8,408	2,469	3.41
		20~200	791	1,271	1,940	4,003	1,854	2.16
	South Aegean Sea	20~100	55	3,448	571	4,074	1,405	2.90
		101~200	30	561	338	929	715	1.30
		201~500	0	66	459	524	786	0.67
		20~500	44	2,444	503	2,992	1,181	2.53
	W. Mediterranean Sea	20~100	0	543	4,670	5,214	2,551	2.04
		101~200	26	317	172	516	132	3.91
		201~500	0	212	850	1,062	1,062	1.00
		20~500	7	431	2,839	3,278	1,647	1.99
	E. Mediterranean Sea	20~100	83	437	2,313	2,834	1,507	1.88
		101~200	0	108	3,884	3,993	1,648	2.42
		201~500	0	82	230	312	716	0.44
		20~500	41	268	2,490	2,800	1,422	1.97
	All area	20~100	379	1,058	1,890	3,327	1,545	2.15
		101~200	13	1,517	1,798	3,328	1,267	2.63
		201~500	0	110	442	552	820	0.67
		20~500	274	1,081	1,761	3,118	1,432	2.18
Summer	The Sea of Marmara	20~100	12	811	129	953	280	3.40
		101~200	0	48	192	240	240	1.00
		20~200	10	684	139	834	273	3.06
	North Aegean Sea	20~100	1,001	351	775	2,128	1,066	2.00
		101~200	868	799	341	2,010	1,067	1.88
		20~200	969	459	671	2,099	1,066	1.97
	South Aegean Sea	20~100	3,041	392	234	3,667	1,411	2.60
		101~200	27	293	166	487	326	1.49
		20~200	2,438	372	220	3,031	1,194	2.54
	W. Mediterranean Sea	20~100	4,331	235	55	4,623	1,329	3.48
		101~200	611	20	0	632	176	3.59
		20~200	2,471	128	27	2,627	752	3.49
	E. Mediterranean Sea	20~100	6,687	47	0	7,644	1,220	6.27
		101~200	4,772	0	0	4,772	3,222	1.48
		201~500	369	0	0	369	0	—
		20~500	5,481	28	0	6,055	1,699	3.56
	All area	20~100	2,262	361	448	3,196	1,078	2.97
		101~200	1,392	393	182	1,968	1,160	1.70
		201~500	369	0	0	369	0	—
		20~500	2,003	364	371	2,828	1,082	2.61

* I : Immature II : Semi-mature III : Mature

Table 5-1-4-24 Sex Ratios and Female Maturity Stages of Red Mullet (Part 2)

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios ♀/♂
			I	II	III	Total		
Autumn	The Sea of Marmara	20~100	0	0	0	323	173	1.87
	North Aegean Sea	20~100	0	0	0	1,533	1,061	1.45
		101~200	0	0	0	753	474	1.59
		20~200	0	0	0	1,329	908	1.46
	South Aegean Sea	20~100	0	0	0	2,788	1,268	2.20
		101~200	0	0	0	3,661	1,002	3.65
		201~500	0	0	0	1,123	604	1.86
		20~500	0	0	0	2,919	1,144	2.55
	W. Mediterranean Sea	20~100	0	0	0	4,330	1,600	2.71
		101~200	0	0	0	553	237	2.33
		20~200	0	0	0	3,385	1,259	2.69
	E. Mediterranean Sea	20~100	440	0	0	2,322	1,057	2.20
		101~200	265	0	0	2,451	3,815	0.64
		201~500	0	0	0	225	81	2.78
		20~500	314	0	0	1,961	1,564	1.25
	All area	20~100	94	0	0	2,056	1,059	1.94
		101~200	70	0	0	1,968	1,490	1.32
		201~500	0	0	0	449	211	2.13
		20~500	82	0	0	1,929	1,109	1.74
Winter	The Sea of Marmara	20~100	1,215	0	0	1,215	1,038	1.17
	North Aegean Sea	20~100	2,510	0	0	2,510	715	3.51
		101~200	1,291	0	0	1,291	650	1.99
		20~200	2,053	0	0	2,053	691	2.97
	South Aegean Sea	20~100	4,609	0	0	4,609	3,648	1.26
		101~200	1,745	0	0	1,745	2,029	0.86
		20~200	2,972	0	0	2,972	2,723	1.09
	W. Mediterranean Sea	20~100	8,920	0	0	8,920	4,663	1.91
		101~200	1,515	0	0	1,515	1,581	0.96
		20~200	5,217	0	0	5,217	3,122	1.67
	E. Mediterranean Sea	20~100	940	0	0	940	899	1.05
		101~200	843	0	0	843	562	1.50
		201~500	1,013	0	0	1,013	434	2.33
		20~500	935	0	0	935	739	1.27
	All area	20~100	3,108	0	0	3,108	1,665	1.87
		101~200	1,437	0	0	1,437	1,237	1.16
		201~500	1,013	0	0	1,013	434	2.33
		20~500	2,454	0	0	2,454	1,480	1.66

* I : Immature II : Semi-mature III : Mature

The sex ratios and female maturity stages of this species by season and age are shown in Table 5-1-4-25.

The number of females was overwhelmingly dominant among 3 years and older in each season. In looking at the female maturity rate according to each age in the case of spring, considered to be the peak spawning period of this species, the female maturity rates were 61% at 0 years old and 80-100% at 1-6 years old. The mature age of this species is as early as 0 years old and no later than 1 full year.

Table 5-1-4-25 Sex Ratios and Female Maturity Stages by Season and Age of Red Mullet

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	0	22	3	32	57	164	0.35
	1	111	181	387	680	680	1.00
	2	92	575	920	1,588	526	3.02
	3	7	203	325	536	29	18.48
	4	34	95	45	175	0	—
	5	0	2	16	18	0	—
	6	0	2	1	3	0	—
Summer	0	40	0	0	59	33	1.79
	1	323	16	27	386	382	1.01
	2	703	205	143	1,053	554	1.90
	3	421	96	108	626	32	19.56
	4	145	9	19	174	16	10.88
	5	0	0	11	11	0	—
Autumn	0	35	0	0	59	84	0.70
	1	27	0	0	351	550	0.64
	2	2	0	0	856	329	2.60
	3	6	0	0	421	8	52.63
	4	0	0	0	124	0	—
	5				—	0	—
Winter	0	15	0	0	15	124	0.12
	1	472	0	0	472	674	0.70
	2	573	0	0	573	241	2.38
	3	433	0	0	433	3	144.33
	4	93	0	0	93	0	—
	5	6	0	0	6	0	—
	6	0	0	0	0	0	—
	7	13	0	0	13	0	—

* I : Immature II : Semi-mature III : Mature

4) Age Composition

The age composition of this species by season, sub area and strata is shown in Table 5-1-4-26.

The maximum age of this species throughout all seasons was 7 years. Age composition in each season consisted mainly of 1 and

2 year old fish, while the dominant age group in winter was 1 year old fish, and that in the other three seasons was 2 year old fish. In addition, the composite ratio of older fish age 3 years and older tended to be higher when moving from shallow to deeper depths.

5) Feeding Habits

Results of stomach contents analysis were summarized as shown below according to the occurrence method.

Spring:
No. of specimens: 933
Empty stomach rate: 16%

Crustaceans: 83.7%, Polychaetes: 54.7%, Mollusks: 40.2%, Echinoderms: 2.2%, Others: 0.4%

Summer:
No. of specimens: 1,084
Empty stomach rate: 24%

Crustaceans: 78.6%, Polychaetes: 51.6%, Mollusks: 38.4%, Echinoderms: 3.9% Unknown: 3.0% Fishes: 1.5% Others: 0.2%

Autumn:
No. of specimens: 1,090
Empty stomach rate: 16%

Crustaceans: 82.2%, Polychaetes: 46.3%, Mollusks: 29.1%, Echinoderms: 3.3%, Fishes: 1.5%, Unknown: 0.4%

Winter:
No. of specimens: 636
Empty stomach rate: 32%

Crustaceans: 77.7%, Polychaetes: 61.9%, Mollusks: 36.6%, Echinoderms: 7.5%, Others: 1.4%, Fishes: 0.5%, Unknown: 0.3%

Based on these results, this species was found to feed on small benthic invertebrates, and primarily crustaceans, polychaetes and mollusks, throughout all seasons.

Table 5-1-4-26 Age Composition of Red Mullet (Part 1)

Season	Sub area	Stratum (m)	Age 0	1	2	3	4	5	6	7
Spring	The Sea of Marmara	20~100		26	482	725	40			
	North Aegean Sea	20~100	515	2,058	1,829	578	200	5		
		101~200	216	4,302	6,143	216				
		20~200	480	2,322	2,336	536	176	4		
	South Aegean Sea	20~100	244	1,106	3,028	719	381			
		101~200	30	263	722	585	44			
		201~500		393	524	131	262			
		20~500	170	836	2,243	637	287			
	West Mediterrancan Sea	20~100	286	3,199	3,529	615	134			
		101~200		26	105	122	324	69		
		201~500	106	106	744	744	425			
		20~500	178	1,850	2,153	492	230	19		
	East Mediterrancan Sea	20~100	101	1,123	2,473	544	68			
		101~200		1,036	3,528	748	134	179	14	
		201~500		139	489	189	91	56	63	
		20~200	50	930	2,494	553	94	69	15	
	All area	20~100	301	1,563	2,185	626	189	2		
		101~200	47	1,235	2,616	493	119	77	5	
		201~500	26	194	561	313	217	28	31	
		20~500	227	1,391	2,152	575	177	19	3	
Summer	The Sea of Marmara	20~100	30	207	746	228	20			
		101~200			288	144	48			
		20~500	25	173	670	214	25			
	North Aegean Sea	20~100	110	1,084	1,195	279	23			
		101~200	17	125	2,393	507	42			
		20~200	87	853	1,484	334	28			
	South Aegean Sea	20~100	123	1,308	2,214	1,435	81	91		
		101~200		27	570	215				
		20~200	98	1,052	1,885	1,191	65	72		
	West Mediterranean Sea	20~100	568	1,457	3,285	992	189			
		101~200		152	441	176	38			
		20~200	284	804	1,863	584	113			
	East Mediterrancan Sea	20~100	823	1,688	2,930	1,308	57			
		101~200		35	2,405	2,456	3,097			
		201~500				231	139			
		101~500	494	1,023	2,480	1,545	977			
	All area	20~100	231	1,133	1,708	673	49	16		
		101~200	7	93	1,670	751	609			
		201~500				231	139			
		20~500	169	842	1,670	686	198	11		

Table 5-1-4-26 Age Composition of Red Mullet (Part 2)

Season	Sub area	Stratum (m)	Age 0	1	2	3	4	5	6	7
Autumn	The Sea of Marmara	20~100		10	269	184	31			
	North Aegean Sea	20~100	146	1,463	865	158	10			
		101~200		554	620	53				
		20~200	108	1,226	801	130	7			
	South Aegean Sea	20~100	460	746	2,425	416	199			
		101~200		871	1,493	1,681	618			
		201~500		86	691	777	173			
		20~500	295	735	2,035	803	316			
	West Mediterranean Sea	20~100	116	1,346	3,096	1,034	453			
		101~200	83	208	42	374	83			
		20~200	108	1,061	2,333	869	361			
	East Mediterranean Sea	20~100	765	1,071	1,036	586	24			
		101~200	877	2,005	2,835	1,152	273	11		
		201~500			60	153	93			
		20~200	649	1,104	1,303	646	99	2		
	All area	20~100	330	1,079	1,339	370	87			
		101~200	239	1,002	1,405	801	243	3		
		201~500		21	218	309	113			
		20~500	286	990	1,281	472	127	—		
Winter	The Sea of Marmara	20~100		232	1,128	757	134			
	North Aegean Sea	20~100	187	724	1,277	900	136			
		101~200	94	442	1,068	378	65	6		
		20~200	152	618	1,198	704	109	2		
	South Aegean Sea	20~100	951	5,307	88	346	29			
		101~200	321	2,176	955		286	34		
		20~200	591	3,518	584	148	176	19		
	West Mediterranean Sea	20~100	131	2,108	395					
	East Mediterranean Sea	20~100	17	890	572	185				174
		101~200		562	422	351		70		
		201~500		145	796	434	72			
		20~500	10	675	587	268	14	14		104
	All area	20~100	215	1,388	899	599	88			21
		101~200	132	851	761	187	109	17		
		201~500		145	796	434	72			
		20~500	180	1,163	846	447	95	6		13

(7) **Striped Red Mullet *Mullus surmuletus***

1) Size Composition

The fork length range of this species throughout all seasons was 7-33 cm, and the mean fork length in all areas and at all strata was 13-15 cm. The mean fork length tended to depend on water depth, with those fish at shallow depths having small fork lengths, and fork length increasing as depth increased (Table 5-1-4-27).

Table 5-1-4-27 Fork Length Range and Mean Fork Length of Striped Red Mullet

Sub area	Stratum (m)	Range of FL (Mean FL) in cm			
		Spring	Summer	Autumn	Winter
North Aegean Sea	20~100	12~15 (13)	12~19 (14)	14~18 (16)	17~22 (19)
	101~200	11~23 (15)	12~21 (15)		
	201~500			22~25 (23)	
	20~500	11~23 (14)	12~21 (15)	14~25 (17)	17~22 (19)
South Aegean Sea	20~100	11~25 (14)	13~21 (16)		9~17 (13)
	101~200	32~33 (32)	12~21 (15)	14~21 (18)	
	201~500	13~22 (16)			
	20~500	11~33 (15)	12~21 (16)	14~21 (18)	9~17 (13)
West Mediterranean Sea	20~100	13~21 (16)	7~15 (12)	9~15 (12)	
	101~200				14~26 (18)
	201~500	13~17 (15)			
	20~500	13~21 (16)	7~15 (12)	9~15 (12)	14~26 (18)
East Mediterranean Sea	20~100	12~25 (14)		8~24 (14)	
	101~200	13~21 (15)		16~20 (17)	
	201~500	21~22 (21)			
	20~500	12~25 (14)		8~24 (14)	
All area	20~100	11~25 (14)	7~21 (14)	8~24 (13)	9~22 (14)
	101~200	11~33 (15)	12~21 (15)	14~21 (17)	14~26 (18)
	201~500	13~22 (16)		22~25 (23)	
	20~500	11~33 (15)	7~21 (15)	8~25 (14)	9~26 (14)

The distribution pattern of body length composition of this species in all areas and at all strata was mono-modal with the exception of autumn. The mode consisted of 13-14 cm in spring, 14-15 cm in summer and 12-14 cm in winter (two consecutive classes). The distribution in autumn demonstrated a bi-modal pattern having modes at 10-11 cm and 17-18 cm. The population of smaller fish having a mode at 10-11 cm probably reflects juvenile fish that have recently spawned in the East and West Mediterranean Sea (Fig. 5-1-4-13).

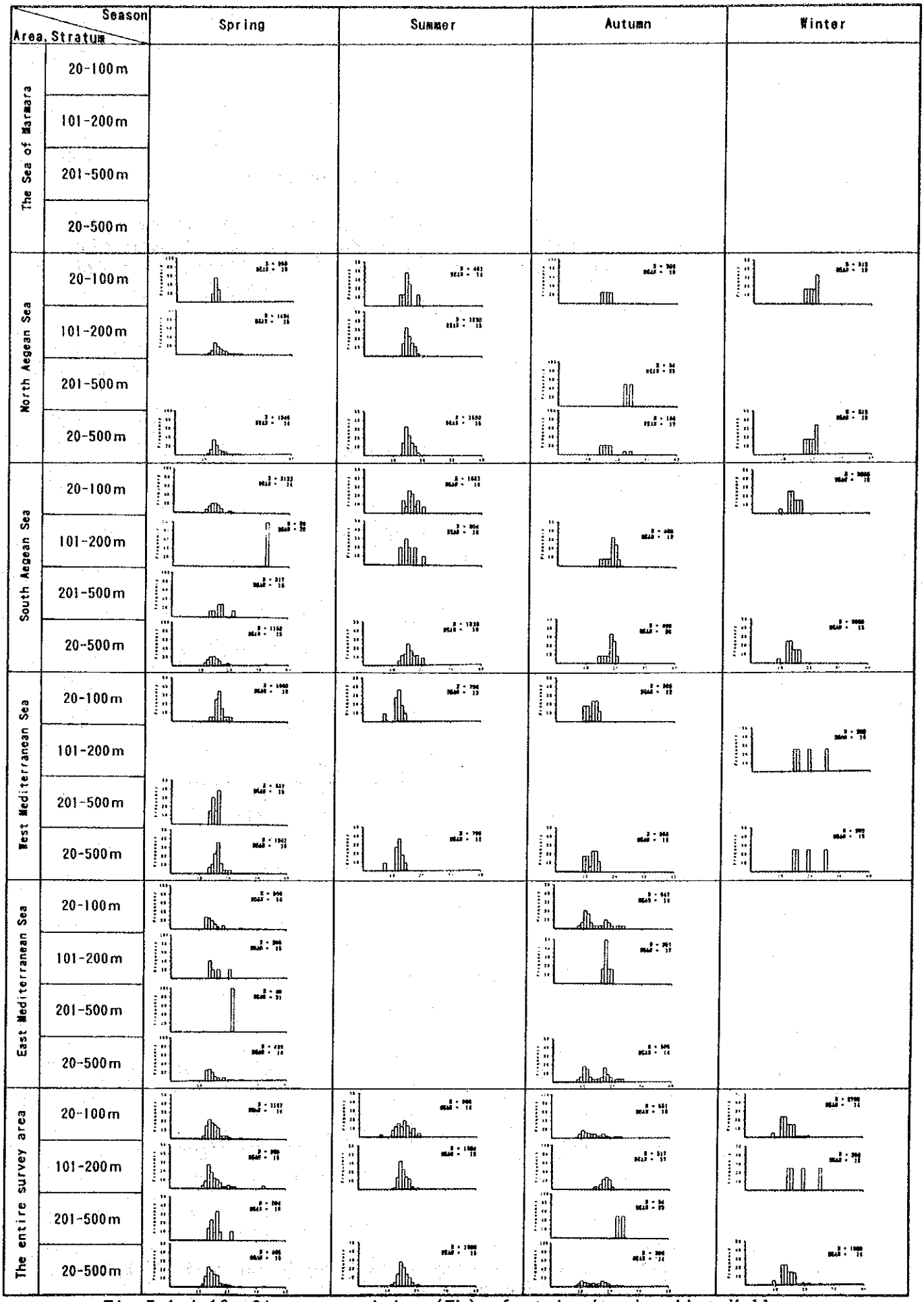


Fig. 5-1-4-13 Size composition (FL) of striped red mullet *Mullus surmuletus* by sub areas, strata and seasons

2) Relationship Between Body Length and Body Weight

The relationship between fork length (X) and body weight (Y) of the total number of males and females of this species was fit to a power curve using the expression $Y = aX^b$. Coefficients a and b of the relational expression along with the correlation coefficient r are shown in Fig. 5-1-4-14.

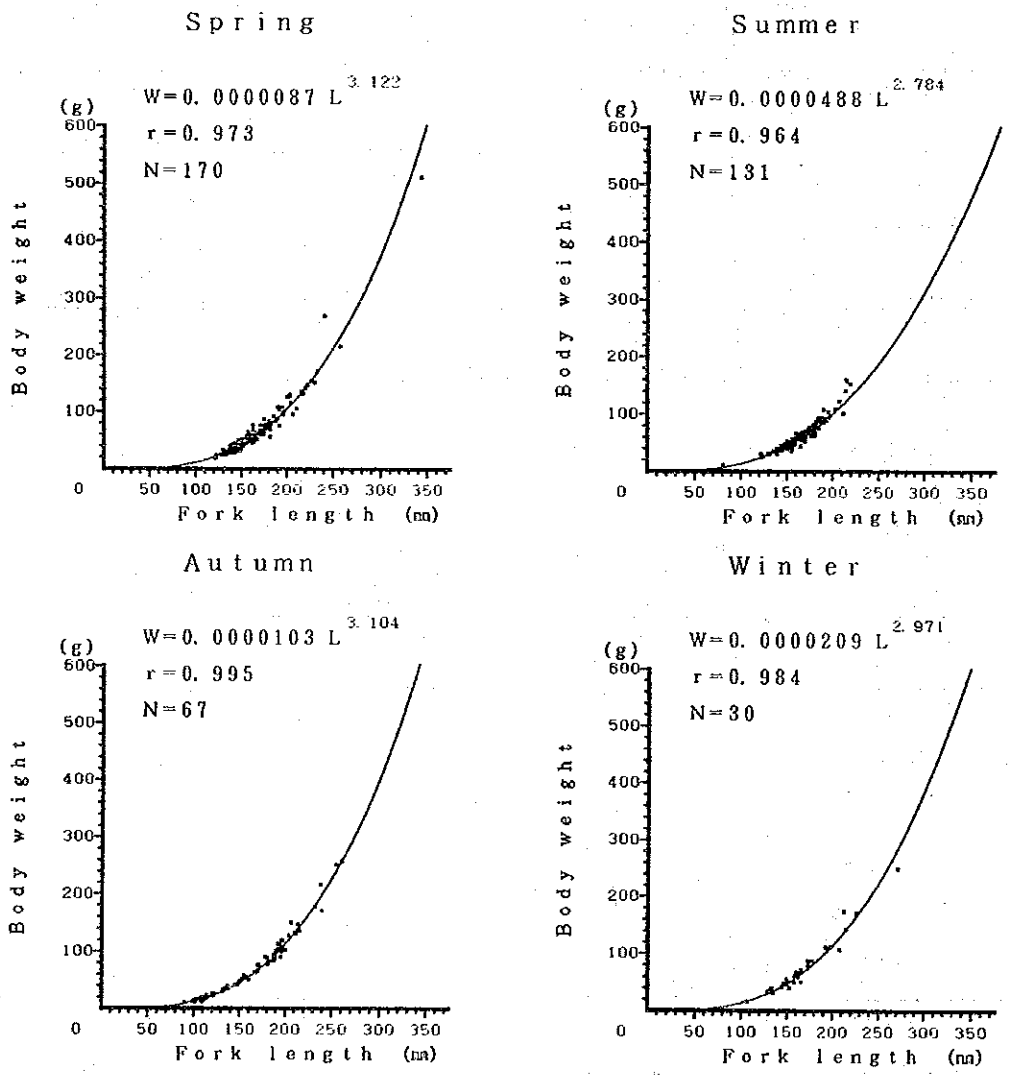


Fig. 5-1-4-14 Relationship Between Fork Length and Body Weight of Striped Red Mullet

The body length and body weight for males and females of this species by season and age are shown in Table 5-1-4-28.

Although differences between the growth of males and females were not so large at ages of 3 years and under, in older fish age 4 years and older, the size of females was larger than that of males. The sexual differentiation of this species begins at a fork length of about 90 mm and a body weight of roughly 10 g, and the sexual differentiation in females is thought to occur earlier than that in males.

Table 5-1-4-28 Fork Length and Body Weight by Age and Sex of Striped Red Mullet

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	1	115~130(123)	115~130(125)		23~ 39(30)	21~ 42(35)	
	2	122~157(140)	128~154(140)		25~ 56(43)	33~ 76(47)	
	3	138~179(161)	140~179(163)		31~105(68)	49~ 93(72)	
	4	178~190(182)	170~206(189)		109~129(114)	70~143(109)	
	5	191~202(196)	208~225(215)		117~136(127)	149~270(180)	
	6		241			216	
	10		321			513	
Summer	0			76			11
	1		114~123(117)			26~ 31(29)	
	2	130~166(146)	122~165(140)	143~154(148)	31~ 72(51)	32~ 63(47)	41~ 45(43)
	3	134~178(157)	153~198(172)		40~109(66)	56~102(83)	
	4	177~181(179)	175~205(193)		89~ 93(91)	95~154(130)	
	5	194			123		
Autumn	0		97~102(99)	84~103(96)		12~ 16(14)	11~ 19(15)
	1	123~138(129)	105~139(117)	104	32~ 43(37)	18~ 45(28)	18
	2	125~147(140)	140~159(150)		34~ 59(51)	48~ 76(59)	
	3	160~183(173)	183~184(183)		78~120(91)	100~106(103)	
	4	182~202(192)	200~223(211)		112~151(131)	149~218(184)	
	5		224~244(234)			173~259(216)	
	6		238			252	
Winter	1	126	100		33	16	
	2	122~154(137)	121~147(131)		34~ 61(45)	34~ 51(42)	
	3	140~185(155)	138~180(152)		56~114(75)	49~112(69)	
	4	162	162~199(180)		88	81~175(114)	
	5	201~211(206)	211		144~168(156)	172	
	6		253			251	

3) Sex Ratios and Female Maturity Stages

The sex ratios and female maturity stages of this species by season, sub area and strata are shown in Table 5-1-4-29. The sex ratio is expressed as the ratio of the number of females in the case of taking the number of males to be 1. In addition, the total number of females includes the number of spent fish.

The sex ratios in all areas were 0.87 in spring, 0.39 in summer, 1.33 in autumn and 0.83 in winter. Although the number

of males was overwhelmingly dominant in summer, the number of males and females was generally equal in other seasons.

The female maturity rates of each season were 75% in spring, 4% in summer, and 0% in autumn and winter. Furthermore, all females in winter were immature. The female maturity rates in each sub area were summarized by season as shown below.

Spring: a. 72% b. 80% c. 40% d. 100%
Winter: a. 7% b. 0% c. 0%

Where, a. North Aegean Sea, b. South Aegean Sea,
c. West Mediterranean Sea, d. East Mediterranean Sea

Based on these results, the spawning period of this species is predicted to extend from spring to summer, the peak spawning period is in spring in each sub area, and spawning occurs earlier in the south and later in the north.

The sex ratios and female maturity stages of this species by season and age are shown in Table 5-1-4-30.

The number of females tended to be higher among older fish age 4 years and older. The female maturity rates by age in spring were 63% among 1 year old fish and 75% or more among fish age 2 years and older. In addition, the mature age of females was one full year.

Table 5-1-4-30 Sex Ratios and Female Maturity Stages by Season and Age of Striped Red Mullet

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	1	6	8	4	19	60	0.32
	2	43	51	93	188	233	0.81
	3	25	22	57	106	129	0.82
	4	21	17	25	64	25	2.56
	5	6	3	18	28	10	2.80
	6	0	0	4	4	0	–
	10	0	0	6	6	0	–
Summer	1	39	0	0	39	0	–
	2	75	0	0	75	260	0.29
	3	111	11	0	122	217	0.56
	4	26	0	0	26	18	1.44
	5	0	0	0	0	9	0
Autumn	0	0	0	0	9	0	–
	1	44	0	0	70	19	3.68
	2	11	0	0	28	24	1.17
	3	9	0	0	9	56	0.16
	4	3	0	0	9	39	0.23
	5	10	0	0	10	0	–
	6	6	0	0	6	0	–
Winter	1	87	0	0	87	87	1.00
	2	262	0	0	262	476	0.55
	3	280	0	0	280	367	0.76
	4	212	0	0	212	87	2.44
	5	17	0	0	17	34	0.50
	6	19	0	0	19	0	–

* I : Immature II : Semi-mature III : Mature

Table 5-1-4-29 Sex Ratios and Female Maturity Stages of Striped Red Mullet

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios ♀/♂
			I	II	III	Total		
Spring	North Aegean Sea	20~100	345	259	173	777	173	4.49
		101~200	132	109	449	690	805	0.86
		20~200	203	159	357	719	594	1.21
	South Aegean Sea	20~100	147	0	596	743	1,381	0.54
		101~200	0	0	99	99	0	—
		201~500	45	0	45	91	227	0.40
		20~500	84	0	334	419	747	0.56
	W. Mediterranean Sea	20~100	580	290	0	870	1,064	0.82
		201~500	42	127	0	169	381	0.44
		20~500	311	208	0	519	722	0.72
	E. Mediterranean Sea	20~100	0	157	172	329	234	1.41
		101~200	0	59	59	118	177	0.67
		201~500	0	49	0	49	0	—
		20~500	0	122	124	247	185	1.34
	All area	20~100	152	147	256	556	617	0.90
		101~200	66	69	264	399	446	0.90
		201~500	29	58	15	103	202	0.51
		20~500	104	108	210	423	488	0.87
Summer	North Aegean Sea	20~100	100	0	0	100	301	0.33
		101~200	383	29	0	413	1,391	0.30
		20~200	336	24	0	360	1,209	0.30
	South Aegean Sea	20~100	327	0	0	327	1,310	0.25
		101~200	333	0	0	333	222	1.50
		20~200	330	0	0	330	766	0.43
	W. Mediterranean Sea	20~100	644	0	0	644	72	8.94
	All area	20~100	357	0	0	357	561	0.64
		101~200	374	24	0	399	1,196	0.33
		20~200	368	16	0	385	984	0.39
Autumn	North Aegean Sea	20~100	70	0	0	70	209	0.34
		201~500	53	0	0	53	0	—
		20~500	61	0	0	61	104	0.59
	South Aegean Sea	101~200	102	0	0	102	306	0.33
	W. Mediterranean Sea	20~100	0	0	0	266	199	1.34
	E. Mediterranean Sea	20~100	346	0	0	424	100	4.24
		101~200	0	0	0	76	151	0.50
		20~200	231	0	0	308	117	2.63
	All area	20~100	190	0	0	296	152	1.95
		101~200	51	0	0	89	228	0.39
		201~500	53	0	0	53	0	—
		20~500	131	0	0	202	152	1.33
Winter	North Aegean Sea	20~100	156	0	0	156	156	1.00
	South Aegean Sea	20~100	2,365	0	0	2,365	2,891	0.82
	W. Mediterranean Sea	101~200	115	0	0	115	115	1.00
	All area	20~100	1,260	0	0	1,260	1,523	0.83
		101~200	115	0	0	115	115	1.00
		20~200	878	0	0	878	1,054	0.83

* I : Immature II : Semi-mature III : Mature

4) Age Composition

The age composition of this species by season, sub area and strata is shown in Table 5-1-4-31.

The maximum age of specimens of this species was 10 years. The dominant age groups of age composition in each season consisted of 2 year old fish in spring, summer and winter, and 1 year old fish in autumn. In addition, there were numerous 3 year old fish in each season. Since 0 year old fish were only observed in the Mediterranean Sea in summer and autumn, this sub area is predicted to be an important nursery ground for juvenile fish of this species.

5) Feeding Habits

Results of stomach contents analysis were summarized as shown below according to the occurrence method.

Spring:
No. of specimens: 170
Empty stomach rate: 19%

Crustaceans: 90.6%, Mollusks: 27.8%, Polychaetes: 23.4%
Fishes: 8.8%, Echinoderms: 7.3%

Summer:
No. of specimens: 132
Empty stomach rate: 31%

Crustaceans: 95.7%, Polychaetes: 23.1%, Mollusks: 22.0%
Echinoderms: 13.2%, Fishes: 5.5%, Unknown: 1.1%

Autumn:
No. of specimens: 67
Empty stomach rate: 19%

Crustaceans: 77.8%, Polychaetes: 50.0%, Echinoderms: 26.0% Mollusks: 18.6% Fishes: 9.3%

Winter:
No. of specimens: 30
Empty stomach rate: 17%

Crustaceans: 100.0% Fishes: 32.0% Polychaetes: 20.0%
Mollusks: 4.0%

Based on these results, this species was found to feed on small benthic animals, and primarily crustaceans.

Table 5-1-4-31 Age Composition of Striped Red Mullet

Season	Sub area	Stratum (m)	Age 0	1	2	3	4	5	6	10
Spring	North Aegean Sea	20~100			950					
		101~200		57	771	493	115	57		
		20~200		38	830	329	76	38		
	South Aegean Sea	20~100		301	1,137	370	247	69		
		101~200								99
		201~500			91	182		45		
		20~500		150	591	230	123	45		24
	West Mediterranean Sea	20~100			193	1,064	484	193		
		201~500			296	254				
		20~500			244	659	242	96		
	East Mediterranean Sea	20~100		125	282	93	46		15	
		101~200			177	59		59		
		201~500						49		
		20~500		83	217	72	31	18	10	
	All area	20~100		138	568	272	145	41	7	
		101~200		28	429	261	57	43		24
		201~500			129	145		31		
		20~500		81	443	244	93	39	4	6
Summer	North Aegean Sea	20~100			301	100				
		101~200			341	420	19			
		20~200			334	366	16			
	South Aegean Sea	20~100			573	737	246	82		
		101~200			333	166	55			
		20~200			453	451	150	41		
	W. Mediterranean Sea	20~100	72	358	358					
	All area	20~100	24	119	410	279	82	27		
		101~200			339	377	25			
		20~200	8	39	363	344	44	9		
Autumn	North Aegean Sea	20~100			93	186				
		201~500					27	27		
		20~500			46	93	13	13		
	South Aegean Sea	101~200			68	204	136			
	W. Mediterranean Sea	20~100	166	266	133					
	East Mediterranean Sea	20~100	138	276	68	34	69	34	34	
		101~200				113	113			
		20~200	92	184	45	60	83	22	22	
	All area	20~100	110	204	90	63	34	17	17	
		101~200			34	158	124			
		201~500					27	27		
		20~500	63	116	61	81	59	13	9	
Winter	North Aegean Sea	20~100				104	52	156		
	South Aegean Sea	20~100		526	2,102	1,839	788			
	W. Mediterranean Sea	101~200			115		58		58	
	All area	20~100		263	1,051	971	420	78		
		101~200			115		58		58	
		20~200		175	739	647	299	52	19	

(8) Golden-Banded Goatfish *Upeneus moluccensis*

1) Size Composition

The fork length range of golden-banded goatfish was 5 - 19 cm throughout all seasons, and the mean fork length in all areas was 10 cm in spring and summer and 13 cm in autumn and winter.

Table 5-1-4-32 Fork Length Range and Mean Fork Length of Golden-Banded Goatfish

Sub area	Stratum (m)	Range of FL (Mean FL) in cm			
		Spring	Summer	Autumn	Winter
South Aegean Sea	20~100		13~16 (14)	10~16 (14)	
West Mediterranean Sea	20~100	9~17 (13)	6~17 (12)	10~17 (13)	9~17 (13)
	101~200		13~16 (14)		9~18 (13)
	20~200	9~17 (13)	6~17 (12)	10~17 (13)	9~18 (13)
East Mediterrancan Sea	20~100	7~17 (10)	5~18 (10)	7~19 (13)	8~16 (11)
	101~200	8~14 (10)	9~18 (12)	11~17 (15)	10~17 (13)
	20~200	7~17 (10)	5~18 (10)	7~19 (13)	8~17 (13)
All area	20~100	7~17 (11)	5~18 (10)	7~19 (13)	8~17 (12)
	101~200	8~14 (10)	9~18 (12)	11~17 (15)	9~18 (13)
	20~200	7~17 (10)	5~18 (10)	7~19 (13)	8~18 (13)

The distribution of body length composition of golden-banded goatfish in all areas demonstrated a mono-modal pattern in all seasons except summer, with those modes consisting of 9-10 cm in spring, 14-15 cm in autumn and 13-14 cm in winter. The distribution patten of body length composition of this species in summer had two modes consisting of 6-7 cm and 13-14 cm. The two dominant modes in summer probably reflect a population of recently spawned juvenile fish and adult fish, respectively. The size composition at depths of 100 m or less in the East and West Mediterranean Sea demonstrated bi-modal distribution, representing the respective stock sizes of juvenile fish and adult fish in all seasons except autumn. These findings indicate that recruitment to the stock of juvenile fish occurs over an extended period of time, and that peak is in summer (Fig. 5-1-4-15).

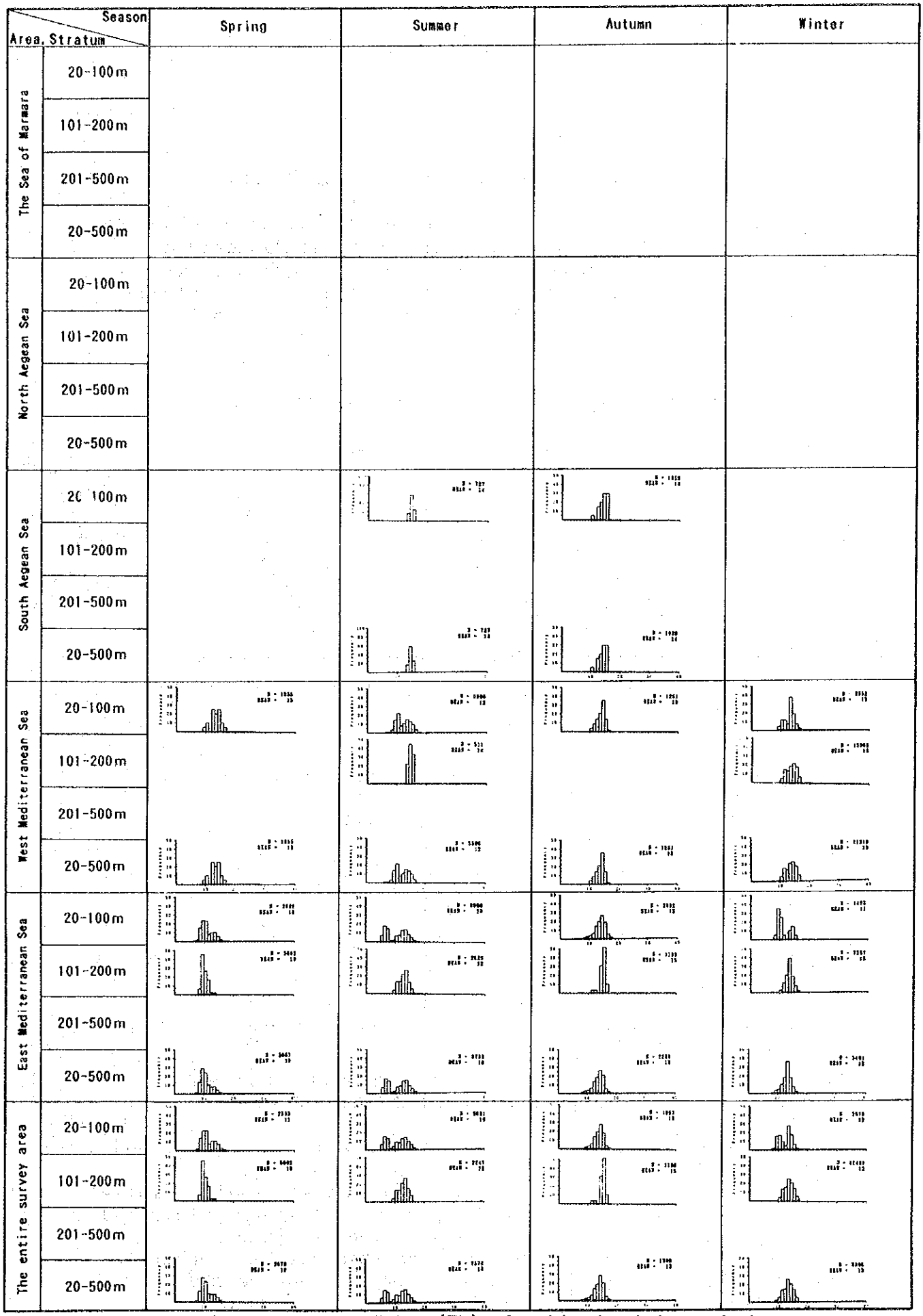


Fig. 5-1-4-15 Size composition (FL) of golden-banded goatfish *Upeneus moluccensis* by sub areas, strata and seasons

2) Relationship Between Body Length and Body Weight

The relationship between fork length (X) and body weight (Y) of the total number of males and females of golden-banded goatfish was fit to a power curve using the expression $Y = aX^b$. The coefficients a and b of the relational expression along with the correlation coefficient r are shown in Fig. 5-1-4-16.

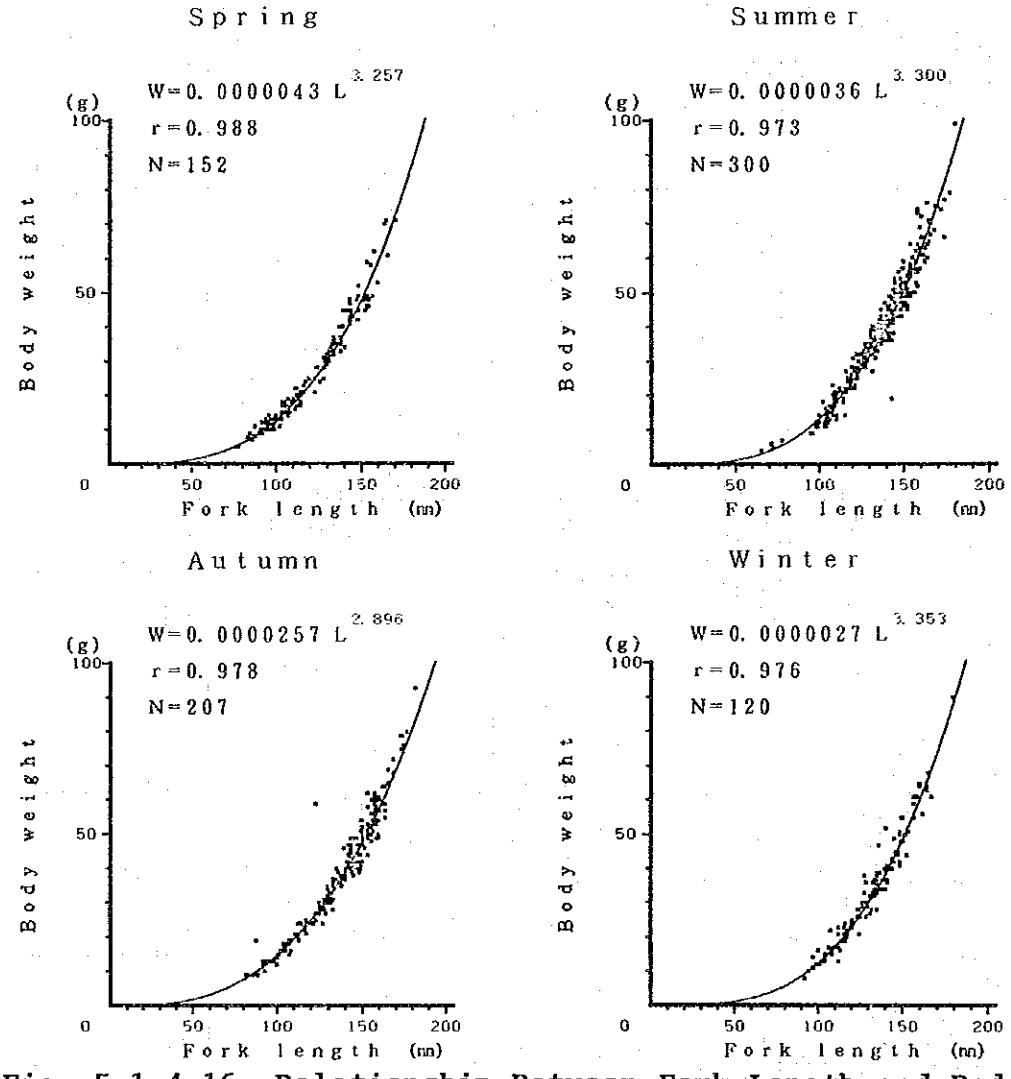


Fig. 5-1-4-16 Relationship Between Fork Length and Body Weight of Golden-Banded Goatfish

The body length and body weight of this species by age and sex are shown in Table 5-1-4-33.

There were differences observed between the growth of males and females at all ages, with the growth of females considered to be faster than that of males. In addition, the sexual differentiation (gonad development) of this species appears to begin at a fork length of roughly 80 mm and body weight of roughly 7 g.

Table 5-1-4-33 Fork Length and Body Weight by Age and Sex of Golden-Banded Goatfish

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0	85~102(92)	81~104(94)	75~ 89(83)	8~ 15(11)	7~ 15(12)	5~ 11(8)
	1	93~128(107)	91~131(111)		10~ 32(18)	12~ 36(21)	
	2	108~140(126)	103~156(137)		18~ 45(31)	18~ 62(40)	
	3	127	112~167(149)		29	21~ 71(52)	
Summer	1	93~140(107)	102~134(118)		9~ 36(17)	14~ 45(27)	
	2	107~146(122)	106~159(137)		20~ 47(28)	23~ 66(43)	
	3		138~173(153)			46~ 79(60)	
	4		168~176(171)			74~ 99(83)	
Autumn	0	93~108(101)	86~103(98)	80~109(90)	13~ 21(17)	12~ 19(16)	9~ 20(12)
	1	98~128(113)	111~128(120)		14~ 32(23)	19~ 59(30)	
	2	124~143(132)	126~157(141)		24~ 40(33)	27~ 62(44)	
	3	154	127~178(156)		59	30~ 93(59)	
Winter	0	90~110(99)	99~111(104)	92~110(100)	8~ 17(13)	12~ 17(15)	10~ 16(13)
	1	102~126(115)	105~150(129)		13~ 30(23)	19~ 51(33)	
	2	142~161(151)	113~160(143)		49~ 68(59)	21~ 65(47)	
	3	118	163~175(169)		24	61~ 90(76)	

3) Sex Ratios and Female Maturity Stages

The sex ratios and female maturity stages by season, sub area and strata of golden-banded goatfish are shown in Table 5-1-4-34. The sex ratio is expressed as the ratio of the number of females in the case of taking the number of males to be 1. In addition, the total number of females includes the number of individual fish that released eggs.

The number of females was large in all seasons, and the sex ratios in all areas were 1.43 in spring, 5.36 in summer, 4.11 in autumn and 3.91 in winter. The female maturity rates for each season were 87% in summer (consisting of 81% semi-mature females and 6% mature females), 12% in autumn (all semi-mature females) and 0% in spring and winter. All females in spring and winter were immature. The female maturity rates in summer by strata were 86% at strata of 20-100 m (with a mature fish rate of 4%), and 97% at strata of 101-200 m (with a mature fish rate of 27%). The following provides a summary of female maturity rates in summer and autumn for each sub area.

Summer: a. 100% b. 96% c. 85%
Autumn: a. 11 (89)% b. 55 (28)% c. 6 (57)%

where, a. South Aegean Sea, b. West Mediterranean Sea,
c. East Mediterranean Sea
Figures in parentheses indicate the percentage of spent females.

Based on these results, the spawning period of this species is predicted to extend from summer to autumn, and the peak spawning period is around the end of summer. In addition, the finding that female maturity rates were high at depths of 101 m or more rather than in shallow areas of 100 m or less suggests that this species either move to deeper strata as they mature, or that those members living in deeper strata mature faster than those in shallow strata. The presence of dependency on water depth by maturity is expected to become clear when the spawning grounds of this species are identified in the future.

The sex ratios and female maturity stages of this species by season and age are shown in Table 5-1-4-35.

In the age group of 2 years and older, it appears that the number of females is overwhelmingly large. When looking at the female maturity rates by age for summer, that from 1 year to 4 years of age increased sequentially in the manner of 58%, 86%, 100% and 100%, thus indicating that the greater the age of the fish, the higher the female maturity rate. In addition, the mature age of this species is most likely 1 full year.

Table 5-1-4-35 Sex Ratios and Female Maturity Stages by Season and Age of Golden-Banded Goatfish

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	0	321	0	0	321	283	1.13
	1	502	0	0	502	627	0.80
	2	470	0	0	470	176	2.67
	3	193	0	0	193	7	27.57
Summer	1	168	220	22	411	637	0.65
	2	423	2,412	185	3,020	211	14.31
	3	0	982	47	1,029	0	—
	4	0	62	18	80	0	—
Autumn	0	23	0	0	23	15	1.53
	1	72	0	0	164	224	0.73
	2	272	82	0	783	121	6.47
	3	99	104	0	501	5	100.20
Winter	0	87	0	0	87	176	0.49
	1	2,943	0	0	2,943	1,227	2.40
	2	2,940	0	0	2,940	114	25.79
	3	218	0	0	218	57	3.83

* I : Immature II : Semi-mature III : Mature

Table 5-1-4-34 Sex Ratios and Female Maturity Stages of Golden-Banded Goatfish

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios ♀/♂
			I	II	III	Total		
Spring	W. Mediterranean Sea	20~100	948	0	0	948	406	2.34
	E. Mediterranean Sea	20~100	1,505	0	0	1,505	893	1.69
		101~200	2,611	0	0	2,611	3,191	0.82
		20~200	1,643	0	0	1,643	1,180	1.39
	All area	20~100	1,435	0	0	1,435	832	1.73
		101~200	2,611	0	0	2,611	3,191	0.82
		20~200	1,566	0	0	1,566	1,094	1.43
Summer	South Aegean Sea	20~100	0	546	182	728	0	—
	W. Mediterranean Sea	20~100	241	4,730	315	5,287	241	21.94
		101~200	0	511	0	511	0	—
		20~200	161	3,324	210	3,695	161	22.95
	E. Mediterranean Sea	20~100	978	4,912	194	6,084	1,189	5.12
		101~200	60	1,369	602	2,032	797	2.55
		20~200	748	4,026	296	5,071	1,091	4.65
	All area	20~100	774	4,518	213	5,505	932	5.91
		101~200	45	1,155	452	1,652	598	2.76
		20~200	591	3,677	273	4,542	848	5.36
Autumn	South Aegean Sea	20~100	0	103	0	977	51	19.16
	W. Mediterranean Sea	20~100	182	596	0	1,082	0	—
	E. Mediterranean Sea	20~100	716	108	0	1,783	536	3.33
		101~200	0	0	0	906	227	3.99
		20~200	626	94	0	1,674	497	3.37
	All area	20~100	537	205	0	1,562	380	4.11
		101~200	0	0	0	906	227	3.99
		20~200	488	186	0	1,503	366	4.11
Winter	W. Mediterranean Sea	20~100	2,255	0	0	2,255	133	16.96
		101~200	11,628	0	0	11,628	3,286	3.54
		20~200	8,504	0	0	8,504	2,235	3.81
	E. Mediterranean Sea	20~100	969	0	0	969	373	2.60
		101~200	5,985	0	0	5,985	1,374	4.36
		20~200	4,313	0	0	4,313	1,040	4.15
	All area	20~100	1,612	0	0	1,612	253	6.37
		101~200	8,806	0	0	8,806	2,330	3.78
		20~200	6,408	0	0	6,408	1,638	3.91

* I : Immature II : Semi-mature III : Mature

4) Age Composition

The age composition of golden-banded goatfish by season, sub area and strata is shown in Table 5-1-4-36.

The maximum age of specimens of this species throughout the entire survey was 4 years. The major components of age composition in all areas consisted of 1 year old fish in spring and winter, and 2 year old fish in summer and autumn. There were no 0 year old fish observed in summer.

The fact that 0 year old fish accounted for the major component of age composition at depths of 100 m or less in the East Mediterranean Sea probably suggests that this area is an important nursery ground for the recruitment to the stock of this species.

5) Feeding Habits

Results of stomach contents analysis were summarized as shown below according to the occurrence method.

Spring:
No. of specimens: 152
Empty stomach rate: 29%

Crustaceans: 91.7%, Fishes: 25.0%, Polychaetes: 4.7%
Echinoderms: 3.8% Mollusks: 1.9%

Summer:
No. of specimens: 300
Empty stomach rate: 13%

Crustaceans: 95.5%, Polychaetes: 16.9%, Fishes: 15.4%
Mollusks: 5.0%, Echinoderms: 0.8%, Unknown: 0.8%

Autumn:
No. of specimens: 207
Empty stomach rate: 20%

Crustaceans: 86.1%, Polychaetes: 38.2%, Fishes: 9.1%
Echinoderms: 5.5% Mollusks: 1.9%

Winter:
No. of specimens: 120
Empty stomach rate: 19%

Crustaceans: 88.7%, Fishes: 21.7%, Polychaetes: 15.5%
Echinoderms: 7.3% Mollusks: 4.2%

Based on these results, golden-banded goatfish was found to feed on benthic animals, and primarily small crustaceans such as opposum shrimp, shrimps and crabs.

Table 5-1-4-36 Age Composition of Golden-Banded Goatfish

Season	Sub area	Stratum (m)	Age 0	1	2	3	4
Spring	W. Mediterranean Sea	20~100		203	812	339	
	E. Mediterranean Sea	20~100	961	903	579	227	
		101~200	870	3,772	1,161		
		20~200	949	1,261	652	199	
	All area	20~100	841	815	608	241	
		101~200	870	3,772	1,161		
		20~200	844	1,144	670	214	
Summer	South Aegean Sea	20~100			728		
	W. Mediterranean Sea	20~100		965	3,387	1,175	
		101~200			511		
		20~200		643	2,428	783	
	E. Mediterranean Sea	20~100		1,307	4,479	1,525	142
		101~200		1,138	1,510	181	
		20~200		1,265	3,737	1,189	107
	All area	20~100		1,141	3,984	1,340	107
		101~200		853	1,260	136	
		20~200		1,069	3,303	1,039	80
Autumn	South Aegean Sea	20~100		51	411	566	
	W. Mediterranean Sea	20~100		16	745	319	
	E. Mediterranean Sea	20~100	144	610	1,088	552	
		101~200		57	566	510	
		20~200	126	541	1,023	547	
	All area	20~100	101	436	952	507	
		101~200		57	566	510	
		20~200	92	401	917	507	
Winter	W. Mediterranean Sea	20~100	279	1,675	558	140	
		101~200	620	7,930	6,333	620	
		20~200	506	5,845	4,408	460	
	E. Mediterranean Sea	20~100	1,044	224	224		
		101~200	343	4,072	2,772	172	
		20~200	577	2,789	1,922	114	
	All area	20~100	661	949	391	70	
		101~200	482	6,001	4,552	396	
		20~200	541	4,317	3,165	287	

(9) Gilt-Head Sea Bream *Sparus aurata*

1) Size Composition

The fork length range of this species throughout all seasons was 11-25 cm, and the mean fork length range was 15-19 cm. The size of this species in the South Aegean Sea throughout this entire survey was greater than that observed in the East Mediterranean Sea (Table 5-1-4-37).

Table 5-1-4-37 Fork Length Range and Mean Fork Length of Gilt-Head Sea Bream

Sub area	Stratum (m)	Range of FL (Mean FL) in cm			
		Spring	Summer	Autumn	Winter
South Aegean Sea	20~100	19~25 (21)	21~23 (21)	22~23 (22)	
East Mediterranean Sea	20~100	15~20 (17)	15~18 (16)	11~19 (15)	15~20 (17)
All area	20~100	15~25 (19)	15~23 (18)	11~23 (15)	15~20 (17)

The distribution of size composition of this species in all areas demonstrated a bi-modal pattern in all seasons except winter, with those modes consisting of 17-18 cm and 21-22 cm in spring, 16-17 cm and 21-22 cm in summer, and 11-12 cm and 15-16 cm in autumn. With respect to the two modes observed in spring and summer, the mode at smaller body length reflects the dominant class in the East Mediterranean Sea, while the mode at larger body length reflects the dominant class in the South Aegean Sea. Body length composition in winter (body length composition in the East Mediterranean Sea) demonstrated mono-modal distribution having a single mode at a 17-18 cm (Fig. 5-1-4-17).

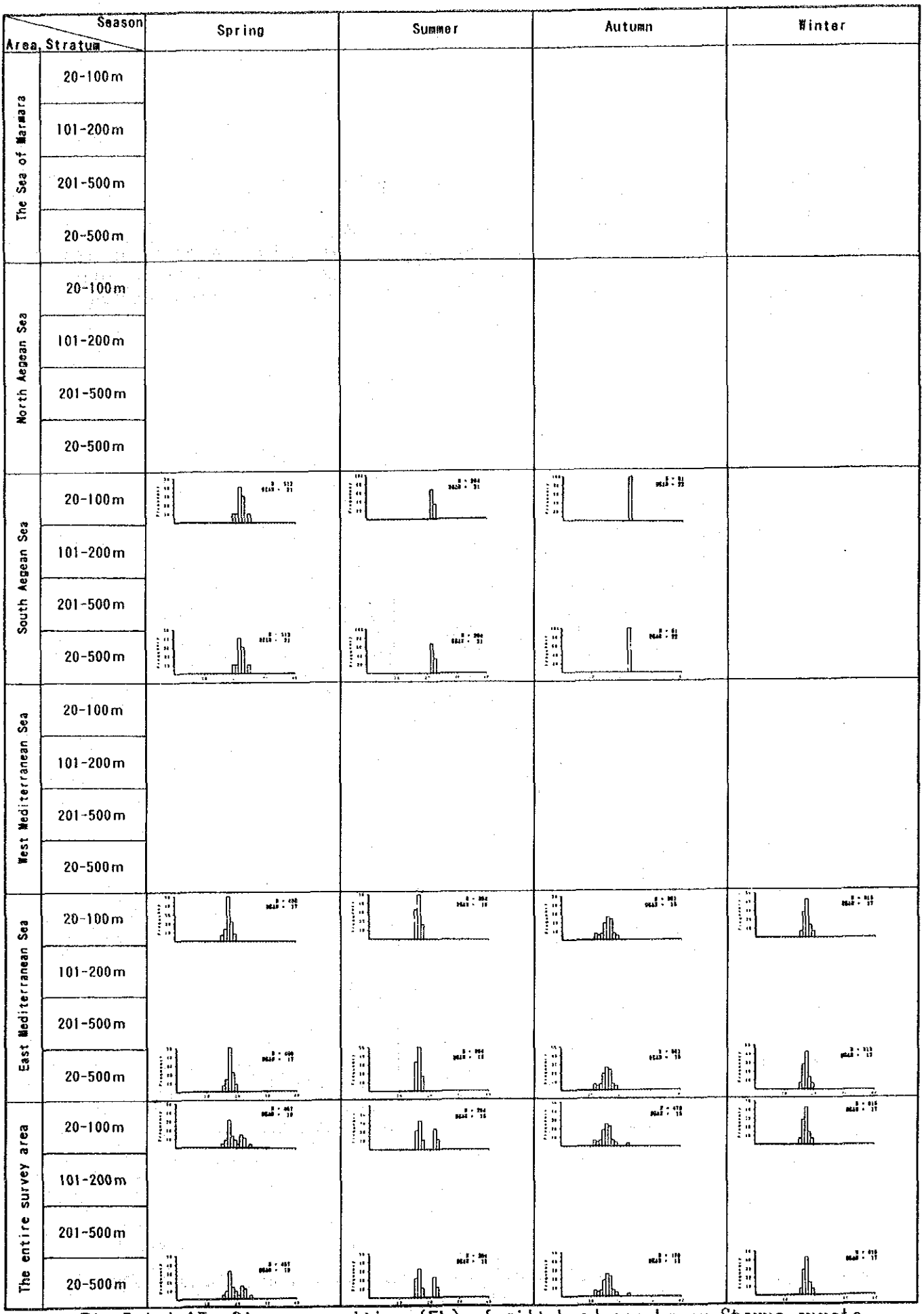


Fig.5-1-4-17 Size composition (FL) of gilt-head sea bream *Sparus aurata* by sub areas, strata and seasons

2) Relationship Between Body Length and Body Weight

The relationship between fork length (X) and body weight (Y) for the total number of males and females of this species was fit to a power curve using the expression $Y = aX^b$. The coefficients a and b of the relational expression along with the correlation coefficient r are shown in Fig. 5-1-4-18.

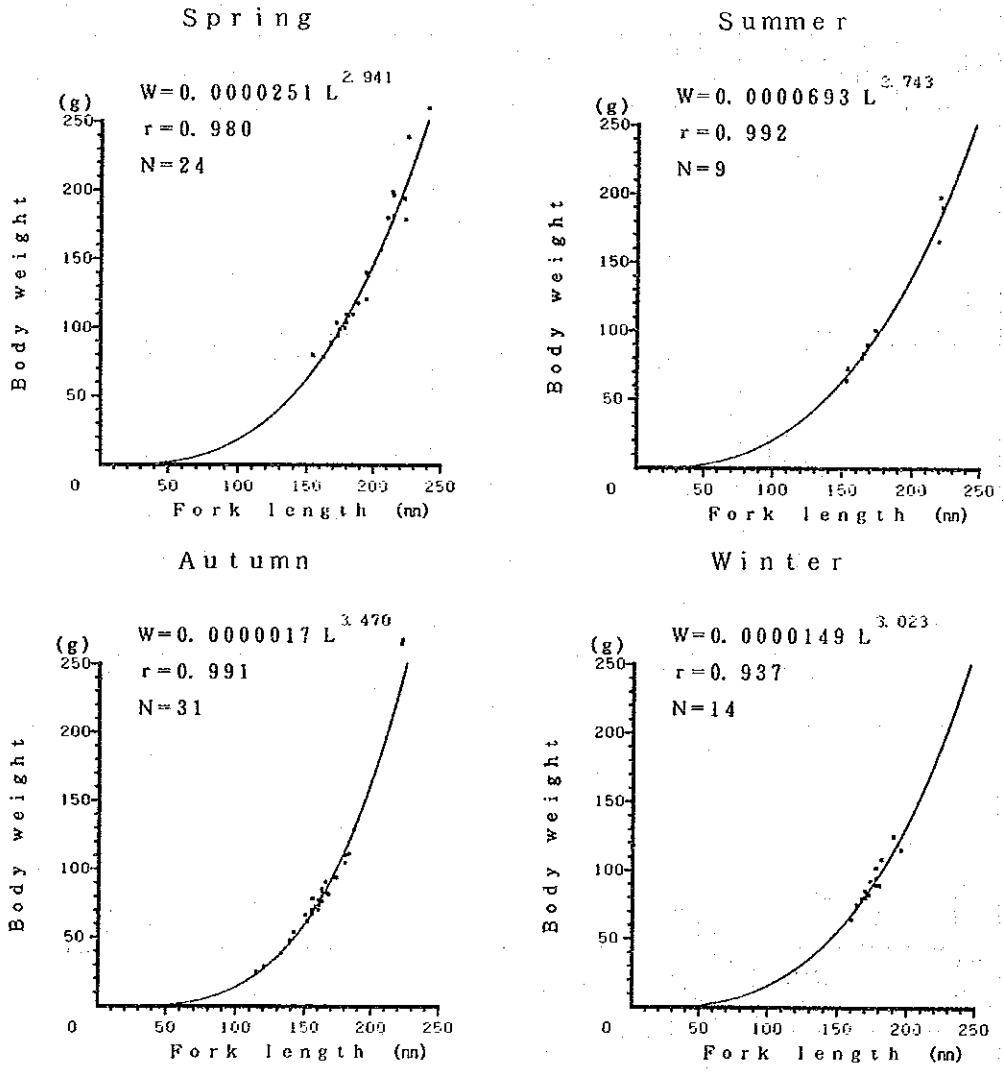


Fig. 5-1-4-18 Relationship Between Fork Length and Body Weight of Gilt-Head Sea Bream

The body length and body weight ranges (the mean values of each) of this species by season, age and sex are shown in Table 5-1-4-38.

The differences in growth between males and females by age within the same season were unable to be verified due to the small number of specimens, and the majority of the specimens being hermaphroditic as will be mentioned later. The sexual differentiation of this species (gonad development) appears to occur early in males and late in females.

Table 5-1-4-38 Fork Length and Body Weight by Age and Sex of Gilt-Head Sea Bream

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	2		155~223(184)			79~199(117)	
	3		211~241(222)			179~260(206)	
Summer	1			153~154(153)			64~ 73(69)
	2			164~174(168)			81~101(89)
	3		219~222(220)			166~198(185)	
Autumn	0	142~180(159)		121~139(130)	54~111(78)		29~ 48(39)
	1	151~183(167)	187		67~112(87)	129	
	2	222~223(222)			265~268(267)		
Winter	1	160~180(172)			65~ 90(83)		
	2	164~178(172)	170~182(176)		76~103(89)	81~109(95)	
	3		190~196(193)			116~126(121)	

3) Sex Ratios and Female Maturity Stages

The sex ratios and female maturity stages of this species by season, sub area and strata are shown in Table 5-1-4-39. The majority of the specimens of this species were hermaphroditic in spring and summer. These hermaphroditic specimens are treated as females in the table. The sexual differentiation of specimens occurred in the autumn and winter.

The sex ratios in all areas in autumn and winter were 0.02 in autumn and 0.40 in winter, with the number of males appearing to be dominant. The female maturity rates in both seasons were 100% in both cases (all semi-mature). In addition, all specimens in the East Mediterranean Sea in summer were immature, while all specimens in the South Aegean Sea in autumn were male.

Based on these results, this species is predicted to be hermaphroditic protandrous, and the spawning period of this species is predicted to extend from autumn to winter, with the peak spawning period being in winter.

Table 5-1-4-39 Sex Ratios and Female Maturity Stages of Gilt-Head Sea Bream

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios ♀/♂
			I	II	III	Total		
Spring	South Aegean Sea	20~100	514	0	0	514	—	—
	E. Mediterranean Sea	20~100	433	0	0	433	—	—
	All area	20~100	460	0	0	460	—	—
Summer	South Aegean Sea	20~100	204	0	0	204	—	—
Autumn	South Aegean Sea	20~100	0	0	0	0	81	0
	E. Mediterranean Sea	20~100	0	9	0	9	481	0.02
	All area	20~100	0	7	0	7	401	0.02
Winter	E. Mediterranean Sea	20~100	0	262	0	262	654	0.40

* : Immature II : Semi-mature III : Mature

The sex ratios and female maturity stages of this species by season and age are shown in Table 5-1-4-40.

The males of this species mature at an age of as early as 0 years, and the majority mature in 1 year. Females mature in 1 year at the earliest, while the majority mature in 2 years.

Table 5-1-4-40 Sex Ratios and Female Maturity Stages by Season and Age of Gilt-Head Sea Bream

Season	Age	* Maturity stage of ♀				♂	Sex ratios ♀/♂
		I	II	III	Total		
Spring	2	357	0	0	357	—	—
	3	102	0	0	102	—	—
Summer	3	102	0	0	102	—	—
Autumn	0	0	0	0	0	185	0
	1	0	7	0	7	84	0.08
	2	0	0	0	0	16	0
Winter	1	0	0	0	0	262	0
	2	0	131	0	131	393	0.33
	3	0	131	0	131	0	—

* I : Immature II : Semi-mature III : Mature

4) Age Composition

The age composition of this species by season, sub area and strata is shown in Table 5-1-4-41.

The maximum age of specimens of this species throughout all seasons was 3 years. The dominant age group in each season consisted of 2 year old fish in all seasons except autumn. The major component of age composition in autumn consisted of 0 year old fish. The dominant age group in the South Aegean Sea consisted of fish that were older than that in the East Mediterranean Sea.

Table 5-1-4-41 Age Composition of Gilt-Head Sea Bream

Season	Sub area	Stratum (m)	Age			
			0	1	2	3
Spring	South Aegean Sea	20~100			206	308
	E. Mediterranean Sea	20~100			433	
	All area	20~100			357	102
Summer	South Aegean Sea	20~100				204
	E. Mediterranean Sea	20~100		128	256	
	All area	20~100		64	128	102
Autumn	South Aegean Sea	20~100			81	
	E. Mediterranean Sea	20~100	418	164		
	All area	20~100	334	131	16	
Winter	E. Mediterranean Sea	20~100		262	524	131

5) Feeding habits

Results of stomach contents analysis were summarized as shown below according to the occurrence method.

Spring:
No. of specimens: 24
Empty stomach rate: 13%

Crustaceans: 81.0%, Mollusks: 33.4%, Polychaetes: 14.3%
Echinoderms: 9.6%, Sea algae: 9.6%

Summer:
No. of specimens: 9
Empty stomach rate: 89%

Crustaceans and mollusks: 100%

Autumn:
No. of specimens: 31
Empty stomach rate: 52%

Crustaceans: 86.7%, Fishes: 13.4%

Winter:
No. of specimens: 14
Empty stomach rate: 71%

Polychaetes: 75.0% Crustaceans: 50.0%

Based on these results, this species was found to feed on small benthic animals consisting primarily of crustaceans, while also being herbivorous depending on the season.

(10) Large-Eye Dentex *Dentex macrophthalmus*

1) Size composition

The fork length range of this species throughout all seasons was 6-22 cm. The mean fork length of this species was 13 cm in each season (Table 5-1-4-42).