Table 5-1-4-42 Fork Length Range and Mean Fork Length of Large-Eye Dentex

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

The distribution pattern of size composition of this species in all areas varied according to the season, demonstrating a poly-modal pattern in spring, a mono-modal pattern in summer and autumn, and a bi-modal pattern in winter. The modes having the largest peaks in each season were each observed within a range of a fork length of 12-15 cm (Fig. 5-1-4-19).

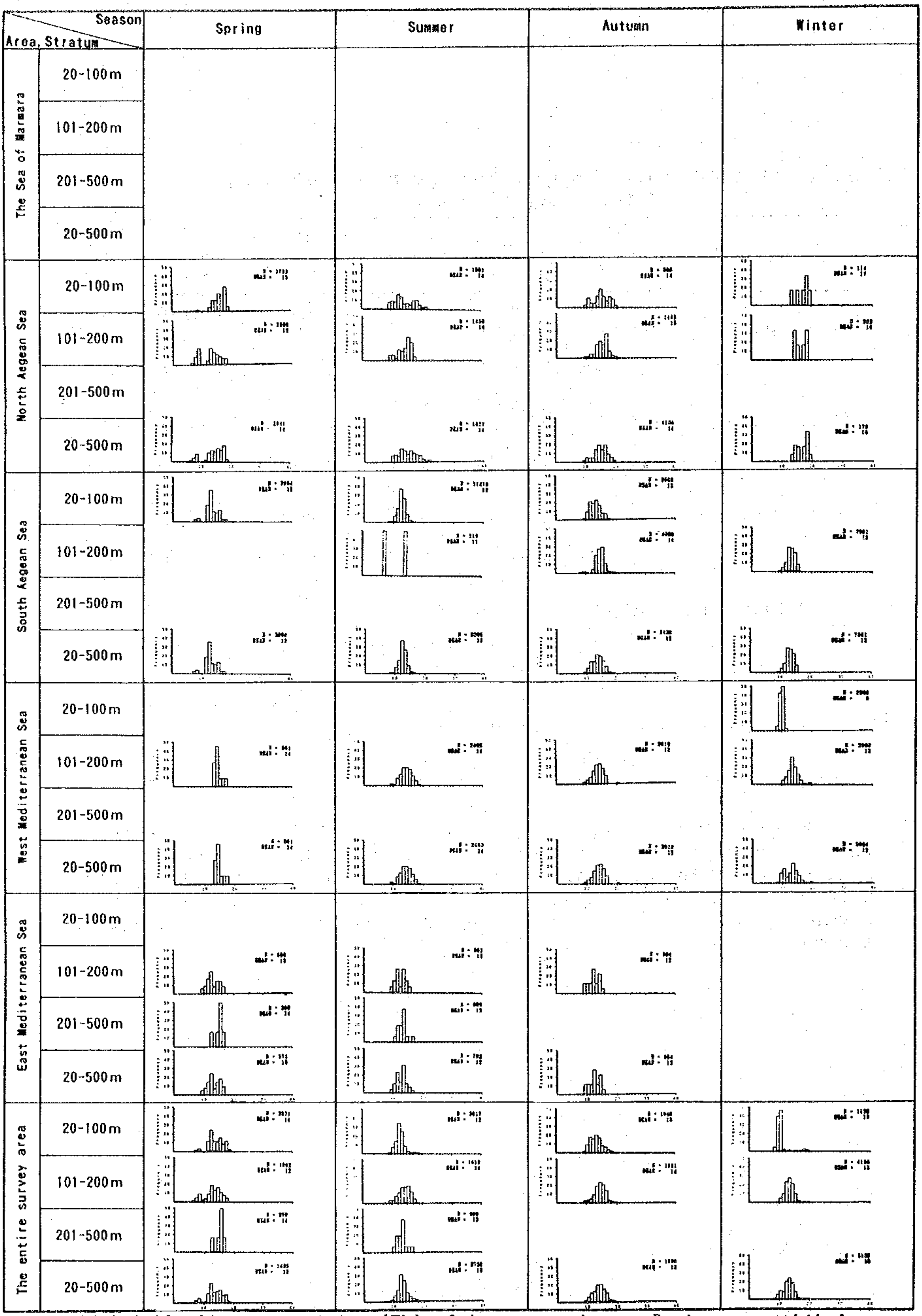


Fig.5-1-4-19 Size composition (FL) of large-eye dentex *Dentex macrophthalmus* by sub areas, strata and seasons

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. 5-1-4-20.

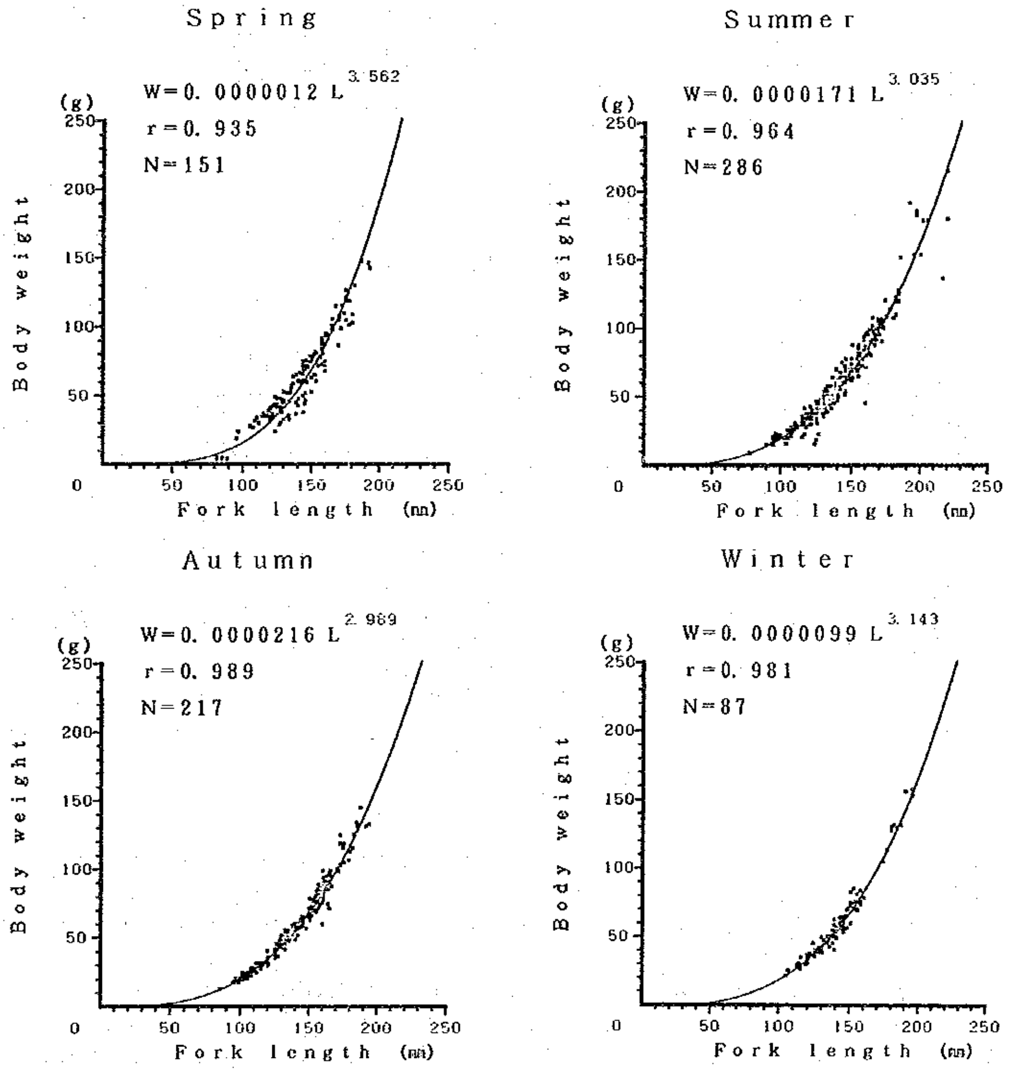


Fig. 5-1-4-20 Relationship Between Fork Length and Body Weight of Large-Eye Dentex

The fork length and body weight ranges of this species by season, age and sex, along with their means, are shown in Table 5-1-4-43.

There were no large differences observed in the sizes of males and females for each age. Gonad development for both males and females appears to begin at a fork length of roughly 8 cm and body weight of roughly 5 g.

Table 5-1-4-43 Fork Length and Body Weight by Age and Sex of Large-Eye Dentex

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0	82~ 89(85)	82~ 85(83)		4~ 5(4)	4~ 5(5)	
	1	114~128(122)	97~130(119)	96	31~ 43(37)	24~ 53(37)	19
	2	129~159(144)	117~150(137)	135	36~ 88(62)	33~ 76(55)	53
	3	147~166(154)	144~176(155)		53~ 99(77)	38~105(75)	
	4	160~178(166)	155~171(163)		75~119(100)	68~108(89)	
	5	170~193(178)	173~187(179)		99~143(115)	109~148(124)	
	6	176	174~192(183)		127	110~147(129)	
Summer	0	95~ 98(96)	97	78~ 99(90)	15~ 22(19)	23	9~ 21(17)
	1	95~125(116)	90~129(113)	103~117(108)	16~ 40(31)	15~ 47(31)	20~ 23(21)
	2	105~166(135)	104~158(133)	115~149(132)	19~ 98(50)	16~ 78(51)	21~ 63(42)
	3	130~184(162)	126~195(161)		42~125(89)	47~154(94)	
	4	205	200		179	154	
Autumn	0	95~117(104)	86~119(103)		18~ 31(23)	13~ 33(23)	
	1	111~148(125)	100~162(127)		26~ 57(38)	20~ 92(44)	
	2	120~172(153)	102~165(144)		36~ 99(73)	22~ 95(63)	
	3	135~171(157)	125~176(147)		49~101(81)	40~116(71)	
	4	144~192(174)	140~194(163)		64~145(110)	59~133(93)	
	5	154~165(159)	151~163(159)		79~ 98(89)	79~ 99(91)	
	6		173~183(178)			125~126(126)	
Winter	1	107~120(115)	113~143(124)		26~ 37(32)	27~ 63(41)	
	2	138~160(148)	119~155(135)		46~ 79(65)	30~ 75(48)	
	3	115~187(146)	120~180(144)	105	29~132(64)	31~131(67)	22
	4	140~190(153)	122~195(162)		54~157(77)	38~158(100)	
	5	137~195(156)			51~154(83)		
	6	151	174~177(175)		73	106~114(110)	

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 5-1-4-44. 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 0.86 in winter, and within a range of 1.11-1.94 in other seasons. The female maturity stages were summarized as shown below by season and sub area.

Spring:	All areas	11%	a. 4%	b. 39%	c. 17%	d. 10%
Summer:	All areas	86%	a. 88%	b. 91%	c. 72%	d. 59%
		(0.2)	(3)		(0)	(0)
Autumn:	All areas	79%	a. 75%	b. 82%	c. 82%	d. 45%
		(4)	(18)	(0)	(0)	(0)
Winter:	All areas	0.3%	a. 11%	b. 0%	c. 0%	
		(2)	(63)	(0)	(0)	

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

Figures in parentheses indicate the percentage of spent fish.

Based on these results, although the spawning period of this species extends throughout the entire year, that peak period is considered to extend from summer to autumn. In addition, there appear to be geographical differences in the peak spawning period.

Although this species is known to be dioecious, there was a small number of specimens observed to be hermaphroditic in the South Aegean Sea during the spring portion of this survey.

The sex ratios and female maturity stages of this species by season and age are shown in Table 5-1-4-45.

The number of females was dominant in many age groups throughout all seasons. When looking at the female maturity rates by age in summer and autumn, predicted to be the peak spawning periods of this species, that for 0 year old fish was 0-6%, that for 1-3 year old fish was roughly 70-90%, and that for 4 year old fish and older was 100%. Thus, older fish tended to demonstrate high female maturity rates. In addition, females appeared to mature rapidly, with some maturing at 0 years old (in the first year), and the majority maturing at 1 year old (in the second year).

Table 5-1-4-45 Sex Ratios and Female Maturity Stages by Season and Age of Large-Eye Dentex

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	0	19	0	0	19	39	0.49
	1	241	23	0	297	59	5.03
	2	327	46	0	393	168	2.34
	3	54	10	8	73	90	0.81
	4	87	0	0	87	83	1.05
	5	36	13	0	49	92	0.53
	6	24	0	0	24	12	2.00
Summer	0	12	0	0	12	12	1.00
	1	40	234	84	359	207	1.73
	2	133	620	590	1,344	1,123	1.20
	3	73	139	34	247	300	0.82
	4	0	0	3	3	3	1.00
Autumn	0	91	0	3	95	50	1.90
	1	34	242	25	302	25	12.08
	2	75	243	43	395	324	1.22
	3	0	179	6	197	98	2.01
	4	0	72	17	89	79	1.13
	5	0	68	0	68	34	2.00
	6	0	34	0	34	0	—
Winter	1	57	0	0	63	27	2.33
	2	232	0	0	232	35	6.63
	3	361	4	0	372	322	1.16
	4	186	0	0	202	404	0.50
	5	0	0	0	0	516	0
	6	186	0	0	186	93	2.00

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

Table 5-1-4-44 Sex Ratios and Female Maturity Stages of Large-Eye Dentex

Season	Sub area	Stratum (m)	* Maturity stage of ♀ I	II	III	Total	♂	Sex ratios ♀/♂
Spring	North Aegean Sea	20~100	973	0	0	973	790	1.23
		101~200	1,435	130	0	1,565	1,043	1.50
		20~200	1,127	43	0	1,170	874	1.34
	South Aegean Sea	20~100	1,483	352	0	2,092	896	2.34
	W. Mediterranean Sea	101~200	264	53	0	317	211	1.50
	E. Mediterranean Sea	101~200	416	18	0	434	227	1.91
		201~500	45	0	89	134	134	1.00
		101~500	323	13	22	359	204	1.76
	All area	20~100	1,228	176	0	1,532	843	1.82
		101~200	589	47	0	637	387	1.65
		201~500	45	0	89	134	134	1.00
		20~500	790	94	8	945	544	1.74
Summer	North Aegean Sea	20~100	73	249	123	466	745	0.63
		101~200	0	0	790	790	628	1.26
		20~200	52	177	313	558	712	0.78
	South Aegean Sea	20~100	556	2,975	2,525	6,057	5,426	1.12
		101~200	0	0	0	0	55	0
		20~200	444	2,380	2,020	4,845	4,351	1.11
	W. Mediterranean Sea	101~200	483	1,029	216	1,729	737	2.35
	E. Mediterranean Sea	101~200	59	773	0	832	0	—
		201~500	479	0	0	479	131	3.66
		101~500	269	386	0	655	65	10.08
	All area	20~100	288	1,460	1,191	2,951	2,825	1.05
		101~200	215	551	318	1,085	503	2.16
		201~500	479	0	0	479	131	3.66
		20~500	269	1,000	761	2,037	1,711	1.19
Autumn	North Aegean Sea	20~100	93	279	139	512	380	1.35
		101~200	0	629	19	910	535	1.70
		20~200	46	454	79	711	457	1.56
	South Aegean Sea	20~100	339	937	160	1,436	597	2.41
		101~200	204	2,657	204	3,066	1,022	3.00
		20~200	312	1,281	169	1,762	682	2.58
	W. Mediterranean Sea	101~200	171	799	0	970	1,050	0.92
	E. Mediterranean Sea	101~200	330	264	0	593	0	—
	All area	20~100	257	717	153	1,128	524	2.15
		101~200	146	962	40	1,236	699	1.77
		20~200	201	840	96	1,182	611	1.94
Winter	North Aegean Sea	20~100	19	19	0	77	38	2.03
		101~200	47	0	0	188	94	2.00
		20~200	28	13	0	114	57	2.00
	South Aegean Sea	101~200	2,862	0	0	2,862	4,618	0.62
	W. Mediterranean Sea	101~200	1,756	0	0	1,756	1,237	1.42
	All area	20~100	19	19	0	77	38	2.03
		101~200	1,840	0	0	1,863	2,173	0.86
		20~200	1,384	4	0	1,416	1,639	0.86

* 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 5-1-4-46.

The maximum age of specimens of this species throughout all seasons was 6 years. The dominant age groups in each season consisted of 2 year old fish in spring, summer and autumn, and 3 year old fish in winter. There were no 0 year old fish observed in winter. In addition, a large number of fish age 4 years and older were observed at strata of 101-200 m in the South Aegean Sea in autumn and winter.

5) Feeding habits

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

Spring:
No. of specimens: 151
Empty stomach rate: 50%

Crustaceans: 86.7%, Fishes: 24.0%, Echinoderms: 16.0%
Polychaetes: 12.0%, Mollusks: 8.0%

Summer:
No. of specimens: 286
Empty stomach rate: 62%

Crustaceans: 72.5%, Mollusks: 22.1%, Polychaetes: 17.5%
Fishes: 9.2%, Echinoderms: 6.5%, Others: 1.9%
Unknown: 4.6%

Autumn:
No. of specimens: 217
Empty stomach rate: 60%

Crustaceans: 80.3%, Fishes: 30.3%, Polychaetes: 17.5%
Mollusks: 8.2%, Echinoderms: 7.0%

Winter:
No. of specimens: 87
Empty stomach rate: 71%

Crustaceans: 96.0%, Mollusks: 16.0%, Polychaetes: 8.0%
Fishes: 4.0%

Based on these results, this species was found to feed on small benthic animals and be dependent primarily on benthic crustaceans (such as opposum shrimp, shrimps and crabs).

Table 5-1-4-46 Age Composition of Large-Eye Dentex

Season	Sub area	Stratum (m)	Age 0	1	2	3	4	5	6
Spring	North Aegean Sea	20~100	30	91	334	243	304	577	182
		101~200	522	261	913	130	522	261	
		20~200	194	148	527	205	376	472	121
	South Aegean Sea	20~100		1,110	1,461	149	266		
	W. Mediterranean Sea	101~200			370	211			
	E. Mediterranean Sea	101~200		304	265	112			
		201~500		45		179	45		
		101~500		239	199	129	11		
	All area	20~100	15	600	898	196	285	288	91
		101~200	104	234	416	135	104	52	
		201~500		45		179	45		
		20~500	58	362	567	164	170	141	36
Summer	North Aegean Sea	20~100	69	241	304	440	25		
		101~200	43		476	346			
		20~200	62	172	353	413	18		
	South Aegean Sea	20~100		1,895	8,811	776			
		101~200	55		55				
		20~200	11	1,516	7,060	620			
	W. Mediterranean Sea	101~200	69	224	1,123	1,049			
	E. Mediterranean Sea	101~200		416	357	119			
		201~500		87	566	44			
		101~500		251	461	81			
	All area	20~100	38	976	4,085	589	14		
		101~200	49	155	676	565			
		201~500		87	566	44			
		20~500	40	586	2,474	547	7		
Autumn	North Aegean Sea	20~100	161	89	300	128	214		
		101~200	216	413	554	197	65		
		20~200	188	251	427	162	139		
	South Aegean Sea	20~100	113	423	1,021	413	62		
		101~200	204		204	818	1,227	1,227	409
		20~200	131	338	857	494	295	245	81
	W. Mediterranean Sea	101~200	101	486	1,222	211			
	E. Mediterranean Sea	101~200	132	264	198				
	All area	20~100	129	312	780	318	112		
		101~200	161	343	659	272	226	204	68
		20~200	145	327	720	295	169	102	34
Winter	North Aegean Sea	20~100		19	19	38	38		
		101~200		47	94	47	94		
		20~200		28	44	41	57		
	South Aegean Sea	101~200		221	110	2,295	2,240	1,866	1,120
	W. Mediterranean Sea	101~200		66	596	530	66	132	
	All area	20~100		19	19	38	38		
		101~200		114	350	1,038	795	688	373
		20~200		91	267	788	606	516	280

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

(11) **Annular Sea Bream** *Diplodus annularis*

1) Size composition

The fork length range of this species throughout all seasons was 7-18 cm. The mean fork length was within a range of 10-13 cm, with little differences observed according to the season and sub area (Table 5-1-4-47).

Table 5-1-4-47 Fork Length Range and Mean Fork Length of Annular Sea Bream

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

The size composition of this species in all areas demonstrated a mono-modal distribution pattern for four seasons. The mode consisted of 10-11 cm in spring and winter, and 11-12 cm in summer and autumn (Fig. 5-1-4-21).

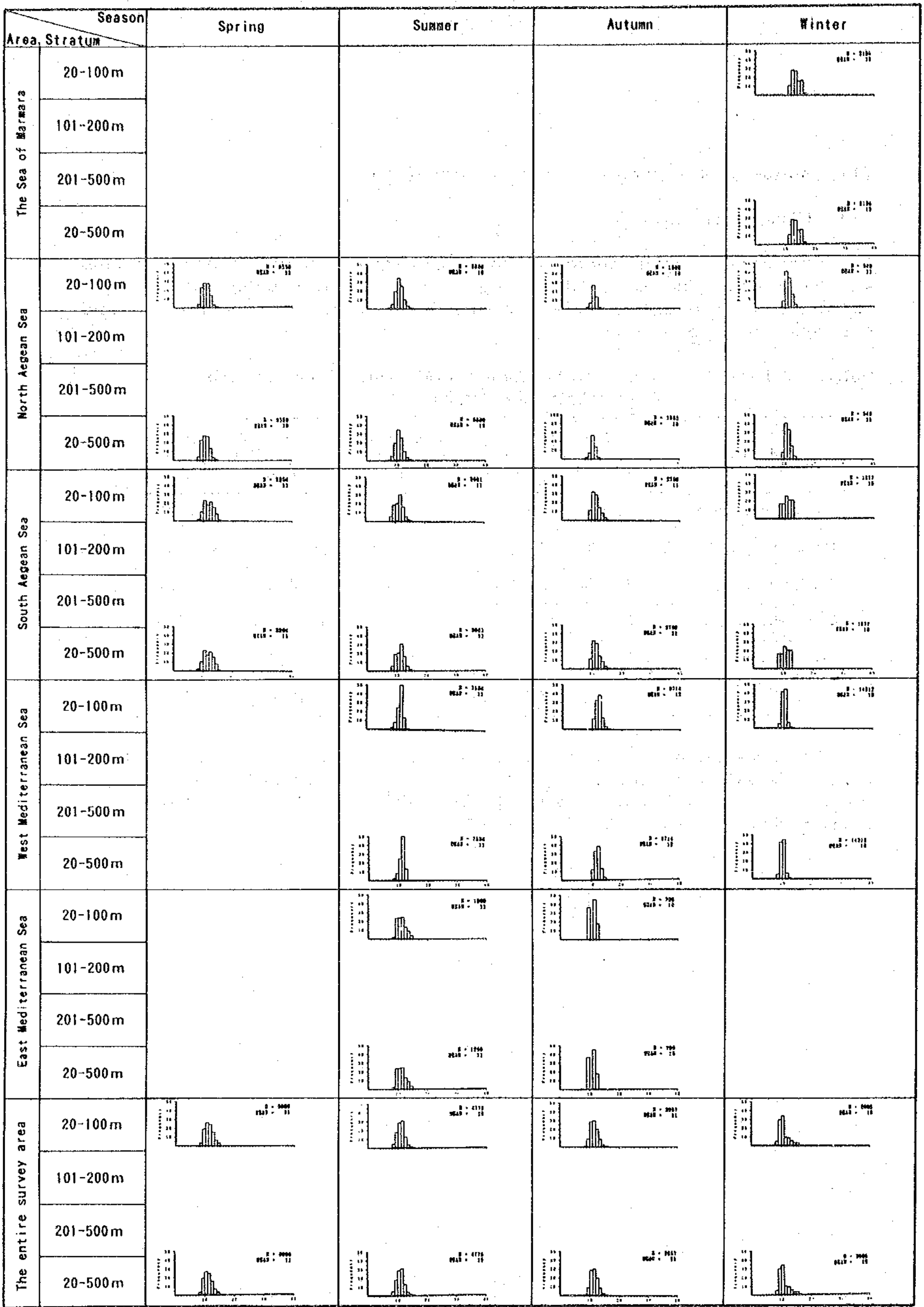


Fig. 5-1-4-21 Size composition (FL) of annular sea bream *Diplodus annularis* by sub areas, strata and seasons

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. 5-1-4-22.

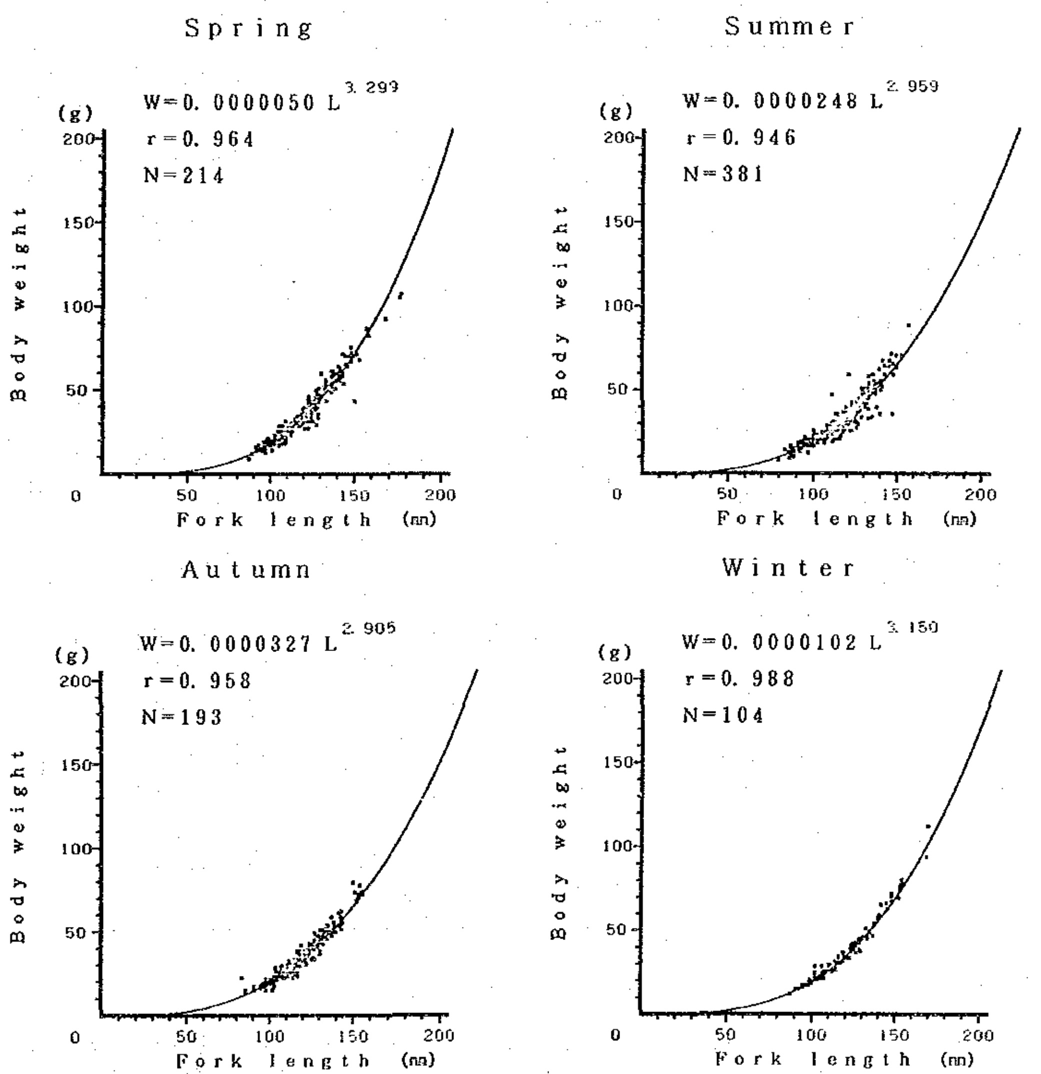


Fig. 5-1-4-22 Relationship Between Fork Length and Body Weight of Annular Sea Bream

The fork length and body weight ranges of this species by season, age and sex are shown along with their means in Table 5-1-4-48.

Although there were no differences in growth between males and females observed in the spring and summer, the size of females appeared to be larger than that of males among older fish age 3 years and older in autumn and winter. This is believed to be most likely due to recovery of the body of females following spawning. The sexual differentiation (gonad development) of this species appears to begin earlier in males at a fork length of roughly 80 mm and body weight of roughly 9 g, while that in females begins at a fork length of roughly 90 mm and body weight of roughly 12 g.

Table 5-1-4-48 Fork Length and Body Weight by Age and Sex of Annular Sea Bream

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0			85			9
	1	87~116(101)	89~119(102)		12~ 29(21)	14~ 35(22)	
	2	99~130(114)	97~132(117)		18~ 51(32)	17~ 59(36)	
	3	110~145(128)	120~143(130)		30~ 71(47)	33~ 70(51)	
	4	119~164(139)	124~154(137)		31~ 91(59)	42~ 85(59)	
	5	136~172(150)			50~103(74)		
	6	173			105		
Summer	0	84~106(96)		84~ 98(89)	9~ 25(19)		10~ 16(13)
	1	87~126(104)	91~123(106)	90~112(103)	13~ 38(24)	12~ 40(26)	15~ 31(23)
	2	97~147(119)	103~137(120)	106	17~ 69(36)	24~ 61(37)	25
	3	115~147(132)	110~144(131)	118	34~ 66(50)	31~ 70(51)	37
	4	150~154(152)			69~ 87(78)		
Autumn	0	93~109(98)	93~105(98)		16~ 25(20)	15~ 28(19)	
	1	89~137(110)	82~140(107)		17~ 49(29)	14~ 54(27)	
	2	99~130(117)	109~128(118)		19~ 50(35)	25~ 42(34)	
	3	100~140(127)	116~140(129)		15~ 60(43)	29~ 58(46)	
	4	107~149(134)	101~152(141)		22~ 67(51)	17~ 72(60)	
	5	151	127~147(137)		76	47~ 78(63)	
Winter	0	97~103(98)	91~107(99)	86	19~ 22(20)	15~ 25(20)	12
	1	90~127(105)	93~113(104)	89	15~ 37(24)	17~ 30(23)	15
	2	103~134(115)	102~123(114)		22~ 46(33)	21~ 38(31)	
	3	121~131(124)	123~145(132)		38~ 44(41)	38~ 69(51)	
	4	122	137~152(146)		41	56~ 79(69)	
	5	165	166		92	110	

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 5-1-4-49. 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 indicating the state of gonad following spending.

The number of males was large in three seasons except winter, and the sex ratios in all areas were roughly 0.7 in those three seasons. In winter, the number of females was somewhat larger than the number of males, with the sex ratio in all areas being 1.20.

The female maturity rates in the Aegean Sea were as shown below.

Spring: North Aegean Sea 83 (35)%
South Aegean Sea 100 (58)%
Summer: North Aegean Sea 75 (43)%
South Aegean Sea 14 (0)%

Figures in parentheses indicate the percentage of mature females (III).

Furthermore, 96% of the females in autumn demonstrated a post-spawning ovarian state, while 99% of the females in winter were immature.

Based on these results, the spawning period of this species in the Aegean Sea is predicted to extend from spring to summer, the peak spawning period is in spring, and spawning in the South Aegean Sea is predicted to take place earlier than in the North Aegean Sea. Although the spawning period in the Mediterranean Sea was unable to be determined due to insufficient data, since results for the Aegean Sea indicate that spawning takes place earlier in the south than in the north, the spawning period in this sub area most likely extends from winter to spring.

Table 5-1-4-49 Sex Ratios and Female Maturity Stages of Annular Sea Bream

Season	Sub area	Stratum (m)	* Maturity stage of ♀ I	II	III	Total	♂	Sex ratios ♀/♂
Spring	North Aegean Sea	20~100	620	1,815	1,298	3,734	5,779	0.65
	South Aegean Sea	20~100	0	586	802	1,388	1,820	0.76
	All area	20~100	281	1,144	1,027	2,454	3,619	0.68
Summer	North Aegean Sea	20~100	230	833	1,090	2,548	3,983	0.64
	South Aegean Sea	20~100	1,423	235	0	1,658	1,740	0.95
	W. Mediterranean Sea	20~100	2,880	0	0	2,880	6,720	0.43
	E. Mediterranean Sea	20~100	415	0	0	415	515	0.81
	All area	20~100	867	427	436	1,889	2,703	0.70
Autumn	North Aegean Sea	20~100	0	0	0	934	306	3.05
	South Aegean Sea	20~100	0	0	0	1,187	1,585	0.75
	W. Mediterranean Sea	20~100	0	0	0	2,914	6,800	0.43
	E. Mediterranean Sea	20~100	318	0	0	318	382	0.83
	All area	20~100	28	0	0	1,219	1,717	0.71
Winter	The Sea of Marmara	20~100	1,436	0	0	1,436	751	1.91
	North Aegean Sea	20~100	211	0	0	211	338	0.62
	South Aegean Sea	20~100	469	0	0	563	1,315	0.43
	W. Mediterranean Sea	20~100	7,156	0	0	7,156	5,725	1.25
	All area	20~100	1,819	0	0	1,835	1,536	1.20

* 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 5-1-4-50.

There was a large number of females age 2 years and older in winter. The female maturity rates according to age were higher for older fish in both spring and summer. In addition, the mature age of this species is probably 1 full year.

Table 5-1-4-50 Sex Ratios and Female Maturity Stages by Season and Age of Annular Sea Bream

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	1	167	250	276	694	750	0.93
	2	76	548	312	937	1,746	0.54
	3	0	233	299	533	601	0.89
	4	0	112	112	224	382	0.59
	5	0	0	0	0	116	0
	6	0	0	0	0	21	0
Summer	0	0	0	0	0	10	0
	1	334	43	11	389	584	0.67
	2	428	175	27	631	1,257	0.50
	3	38	12	11	61	155	0.39
	4	0	0	0	0	16	0
Autumn	0	11	0	0	109	125	0.87
	1	11	0	0	592	509	1.16
	2	0	0	0	222	568	0.39
	3	0	0	0	176	395	0.45
	4	0	0	0	100	115	0.87
	5	0	0	0	6	3	2.00
Winter	0	15	0	0	15	31	0.48
	1	846	0	0	846	965	0.88
	2	560	0	0	560	356	1.57
	3	122	0	0	138	127	1.09
	4	210	0	0	210	28	7.50
	5	28	0	0	28	28	1.00

* 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 5-1-4-51.

The maximum age of specimens of this species throughout all seasons was 6 years. The dominant age groups in each season consisted of 2 year old fish in spring and summer, and 1 year old fish in autumn and winter. However, the dominant age group in The Sea of Marmara consisted of 4 year old fish.

Table 5-1-4-51 Age Composition of Annular Sea Bream

Season	Sub area	Stratum (m)	Age						
			0	1	2	3	4	5	6
Spring	North Aegean Sea	20~100	49	2,459	4,732	1,532	672	116	
	South Aegean Sea	20~100		632	1,031	819	569	117	39
	All area	20~100	22	1,462	2,713	1,143	616	116	21
Summer	North Aegean Sea	20~100		671	1,865	287	27		
	South Aegean Sea	20~100	140	1,655	1,668	127	13		
	W. Mediterranean Sea	20~100		480	8,641	480			
	E. Mediterranean Sea	20~100	127	494	359	221			
	All area	20~100	75	1,029	1,899	222	16		
Autumn	North Aegean Sea	20~100	203	905	132				
	South Aegean Sea	20~100	274	1,017	713	551	199	16	
	W. Mediterranean Sea	20~100		2,914	3,400	2,428	971		
	E. Mediterranean Sea	20~100	280	350	70				
	All area	20~100	237	1,108	793	571	215	10	
Winter	The Sea of Marmara	20~100		141	523	590	754	178	
	North Aegean Sea	20~100	140	318	90				
	South Aegean Sea	20~100		657	751	469			
	W. Mediterranean Sea	20~100	716	10,019	3,578				
	All area	20~100	166	1,932	926	275	251	59	

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

5) Feeding habits

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

Spring:
No. of specimens: 214
Empty stomach rate: 59%

Polychaetes: 41.4%, Crustaceans: 38.0%, Echinoderms: 20.7%, Mollusks: 18.4%, Fishes: 11.5%, Sea algae: 3.5%
Unknown: 6.9%

Summer:
No. of specimens: 381
Empty stomach rate: 56%

Crustaceans: 40.4%, Polychaetes: 35.0%, Mollusks: 26.0%
Echinoderms: 11.5%, Fishes: 6.1%, Sea algae: 1.3%
Others: 1.3%, Unknown: 12.1%

Autumn:
No. of specimens: 193
Empty stomach rate: 62%

Polychaetes: 33.8%, Crustaceans: 29.8%, Mollusks: 17.6%
Fishes: 9.5%, Sea algae: 9.5%, Echinoderms: 6.8%
Unknown: 9.5%

Winter:
No. of specimens: 104
Empty stomach rate: 81%

Polychaetes: 50.0%, Crustaceans: 35.0%, Mollusks: 15.0%
Fishes: 5.0%, Sea algae: 5.0%, Unknown: 10.0%

Based on these results, this species demonstrated omnivorous feeding habits. More specifically, this species is both carnivorous, feeding on small benthic animals consisting primarily of polychaetes and crustaceans, as well as herbivorous, consuming sea algae.

(12) Common Two-Banded Sea Bream *Diplodus vulgaris*

1) Size composition

The fork length range of this species throughout all seasons was 8-20 cm. The mean fork length was small in summer at 12 cm, and within a range of 14-16 cm in other seasons (Table 5-1-4-52).

Table 5-1-4-52 Fork Length Range and Mean Fork Length of Common Two-Banded Sea Bream

Sub area	Stratum (m)	Range of FL (Mean FL) in cm			
		Spring	Summer	Autumn	Winter
North Aegean Sea	20~100	9~19 (14)	8~17 (12)		12~20 (16)
East Mediterranean Sea	20~100			13~18 (15)	
All area	20~100	9~19 (14)	8~17 (12)	13~18 (15)	12~20 (16)

Due to the small size of specimens of this species, the distribution pattern of size composition was unable to be specified. Consequently, the following indicates the dominant modes in each season. Furthermore, the distribution of size composition of this species is shown in Fig. 5-1-4-23.

Spring: 13 - 14 cm
Summer: 8 - 9 cm, 11 - 12 cm
Autumn: 15 - 16 cm
Winter: 15 - 16 cm, 16 - 17 cm

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. 5-1-4-24.

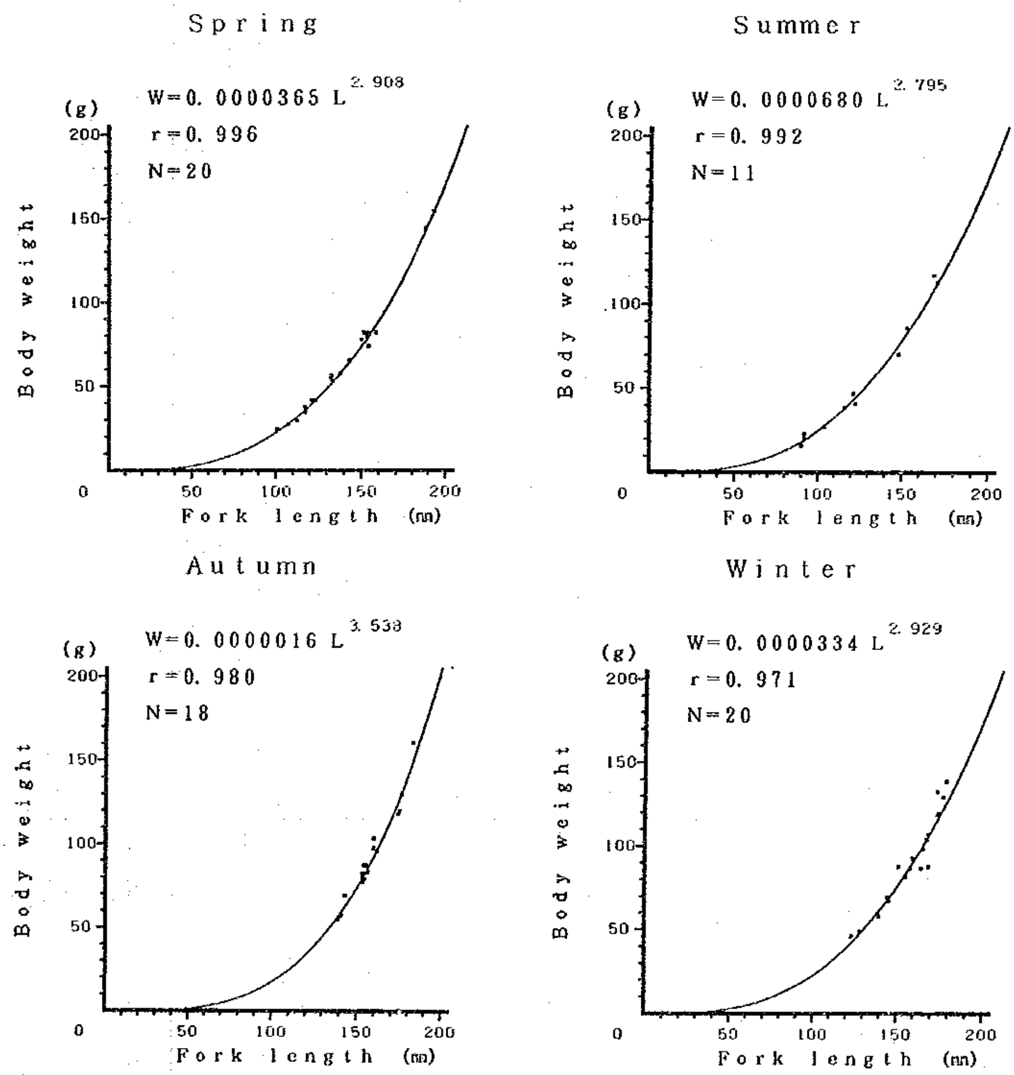


Fig. 5-1-4-24 Relationship Between Fork Length and Body Weight of Common Two-Banded Sea Bream

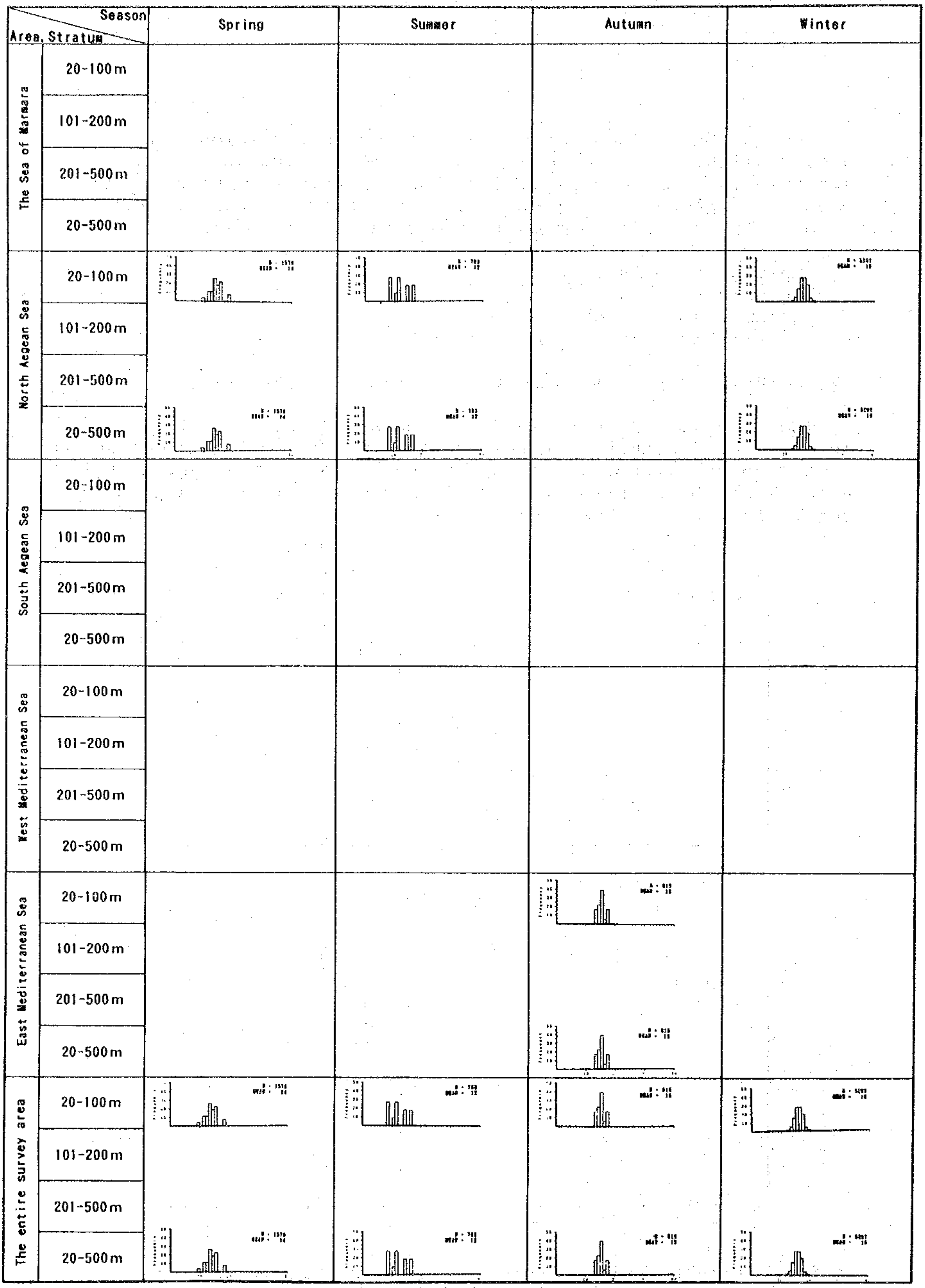


Fig. 5-1-4-23 Size composition (FL) of common two-banded sea bream *Diplodus vulgaris* by sub areas, strata and seasons

The fork length and body weight ranges of this species by season, age and sex, along with their means, are shown in Table 5-1-4-53.

There are believed to be no large differences in growth between males and females for all ages. In addition, the sexual differentiation of this species appears to begin at a fork length of roughly 110 mm and body weight of roughly 30 g for both males and females.

Table 5-1-4-53 Fork Length and Body Weight by Age and Sex of Common Two-Banded Sea Bream

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0	110~115(112)	105	99	29~ 34(32)	27	24
	1	115~150(132)	119~140(128)		37~ 79(58)	41~ 64(51)	
	2	130~151(144)	130~155(146)		55~ 80(72)	53~ 80(71)	
	3	189			151		
	4	184			141		
Summer	0			88			16
	1			90~120(100)			21~ 40(28)
	2		114	119		38	46
	3		145~167(156)			69~115(95)	
Winter	1	121~137(128)			45~ 57(50)		
	2	136~143(139)	155		59~ 66(63)	85	
	3	148~164(156)	142~165(156)		80~102(91)	68~ 91(83)	
	4	165~175(170)	170		105~136(120)	130	

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 5-1-4-54.

The sex ratios of this species consisted of 0.90 in spring, all of the specimens of this species were females in summer, 1.00 in autumn, and 0.43 in winter. Due to the limited size of data for this species, the reliability of these sex ratios is considered to be low.

The spawning period of this species is thought to be in autumn in the East Mediterranean Sea, and in winter in the North Aegean Sea.

Table 5-1-4-54 Sex Ratios and Female Maturity Stages of Common Two-Banded Sea Bream

Season	Sub area	Stratum (m)	* Maturity stage of ♀ I	II	III	Total	♂	Sex ratios ♀/♂
Spring	Nouth Aegean Sea	20~100	709	0	0	709	788	0.90
Summer	North Aegean Sea	20~100	356	0	0	356	0	—
Autumn	E. Mediterranean Sea	20~100	136	45	227	408	408	1.00
Winter	North Aegean Sea	20~100	0	1,324	265	1,589	3,707	0.43

* 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 5-1-4-55.

The sex ratios by age for this species have been omitted due to insufficient data. In looking at the female maturity stages by age in winter, in contrast to two and three year old fish all being semi-mature, all four year old fish were mature. This may indicate a difference in spawning period between small and large fish. In addition, the mature age of this species is probably 2 years.

Table 5-1-4-55 Sex Ratios and Female Maturity Stages by Season and Age of Common Two-Banded Sea Bream

Season	Age	* Maturity stage of ♀ I	II	III	Total	♂	Sex ratios ♀/♂
Spring	0	79	0	0	79	158	0.50
	1	315	0	0	315	158	1.99
	2	315	0	0	315	315	1.00
	3	0	0	0	0	79	0
	4	0	0	0	0	79	0
Summer	2	71	0	0	71	0	—
	3	285	0	0	285	0	—
Winter	1	0	0	0	0	794	0
	2	0	265	0	265	530	0.50
	3	0	1,059	0	1,059	1,059	1.00
	4	0	0	265	265	1,324	0.20

* 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 5-1-4-56.

The maximum age of specimens of this species was 4 years. The dominant age groups in each season in the North Aegean Sea consisted of 2 year old fish in spring, 1 and 3 year old fish in summer, and 3 year old fish in winter.

Table 5-1-4-56 Age Composition of Common Two-Banded Sea Bream

Season	Sub area	Stratum (m)	Age 0	1	2	3	4
Spring	North Aegean Sea	20~100	315	473	630	79	79
Summer	Nouth Aegean Sea	20~100	71	285	142	285	
Winter	North Aegean Sea	20~100		794	794	2,118	1,589

5) Feeding habits

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

Spring:
No. of specimens: 20
Empty stomach rate: 85%

Polychaetes: 66.7%, Mollusks: 33.4%

Summer:
No. of specimens: 11
Empty stomach rate: 64%

Polychaetes: 75.0%, Mollusks: 50.0%, Crustaceans: 50.0%
Others: 25.0%

Autumn:
No. of specimens: 18
Empty stomach rate: 44%

Crustaceans: 70.0%, Mollusks: 40.0%, Polychaetes: 10.0%
Echinoderms: 10.0%

Winter:
No. of specimens: 20
Empty stomach rate: 85%

Crustaceans: 66.7%, Polychaetes: 66.7%, Mollusks: 33.4%
Others: 33.4%

Based on these results, this species demonstrates carnivorous feeding habits, and is dependent on small benthic animals, particularly crustaceans, polychaetes and mollusks.

(13) Common Pandora *Pagellus erythrinus*

1) Size composition

The fork length of this species ranged from 5-25 cm throughout all seasons. The mean fork length was somewhat small in summer at 12 cm, and within a range of 14-16 cm in other seasons. There were no large differences in the mean fork length observed according to water depth (Table 5-1-4-57).

Table 5-1-4-57 Fork Length Range and Mean Fork Length of Common Pandora

Sub area	Stratum (m)	Range of FL (Mean FL) in cm			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~100	11~20 (16)		12~17 (14)	
North Aegean Sea	20~100	11~24 (16)	9~24 (15)	9~21 (16)	11~21 (16)
	101~200		9~21 (16)		
	20~200	11~24 (16)	9~24 (15)	9~21 (16)	11~21 (16)
South Aegean Sea	20~100	8~25 (16)	10~23 (15)	11~25 (14)	
	101~200		12~18 (15)	16~22 (19)	13~19 (15)
	20~200	8~25 (16)	10~23 (15)	11~25 (15)	13~19 (15)
West Mediterranean Sea	20~100	10~19 (13)	7~20 (13)	7~22 (14)	12~20 (16)
	101~200		14~19 (16)	16~23 (18)	13~24 (16)
	20~200	10~19 (13)	7~20 (13)	7~23 (14)	12~24 (16)
East Mediterranean Sea	20~100	8~20 (13)	5~19 (10)	8~24 (15)	
	101~200	10~23 (14)		12~20 (15)	13~20 (15)
	20~200	8~23 (14)	5~19 (10)	8~24 (15)	13~20 (15)
All area	20~100	8~25 (14)	5~24 (12)	7~25 (14)	11~21 (16)
	101~200	10~23 (14)	9~21 (16)	12~23 (16)	13~24 (16)
	20~200	8~25 (14)	5~24 (12)	7~25 (15)	11~24 (16)

The size composition of this species in all areas demonstrated a mono-modal pattern in autumn, having a mode at a 14-15 cm. In the other seasons, the pattern was bi-modal distribution. The two modes in all seasons except autumn demonstrated 11-12 cm and 14-15 cm in spring, 7-8 cm and 13-14 cm in summer, and 15-16 cm and 19-20 cm in winter. The modes within a range of 13-16 cm were dominant in each season.

The mode having a 7-8 cm in summer is representative of the stock of juvenile fish that have recently spawned, and the majority of those fish reflect the stock at stratum of 20-100 m in the East Mediterranean Sea (Fig. 5-1-4-25).

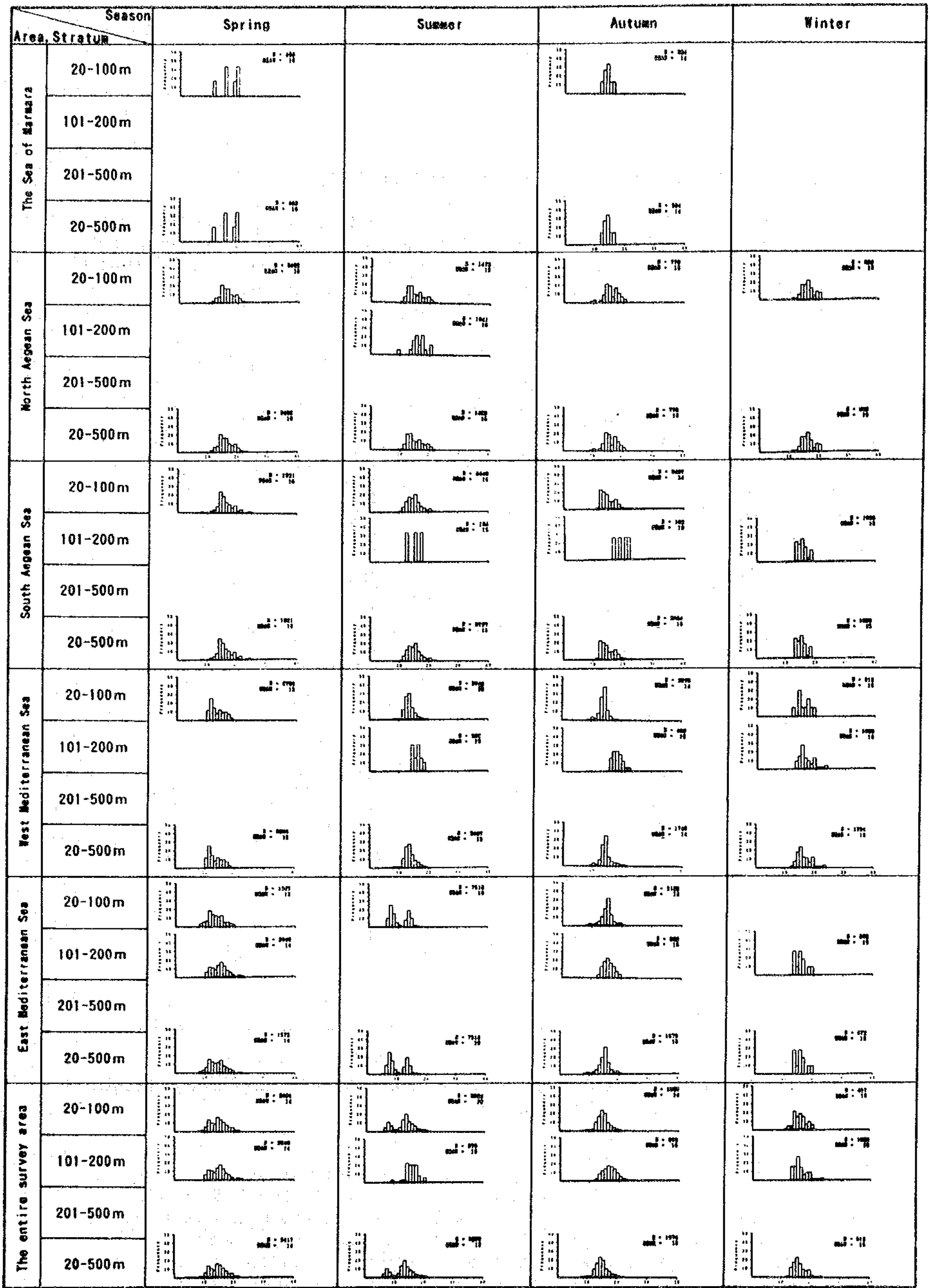


Fig.5-1-4-25 Size composition (FL) of common pandora *Pagellus erythrinus* by sub areas, strata and seasons

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. 5-1-4-26.

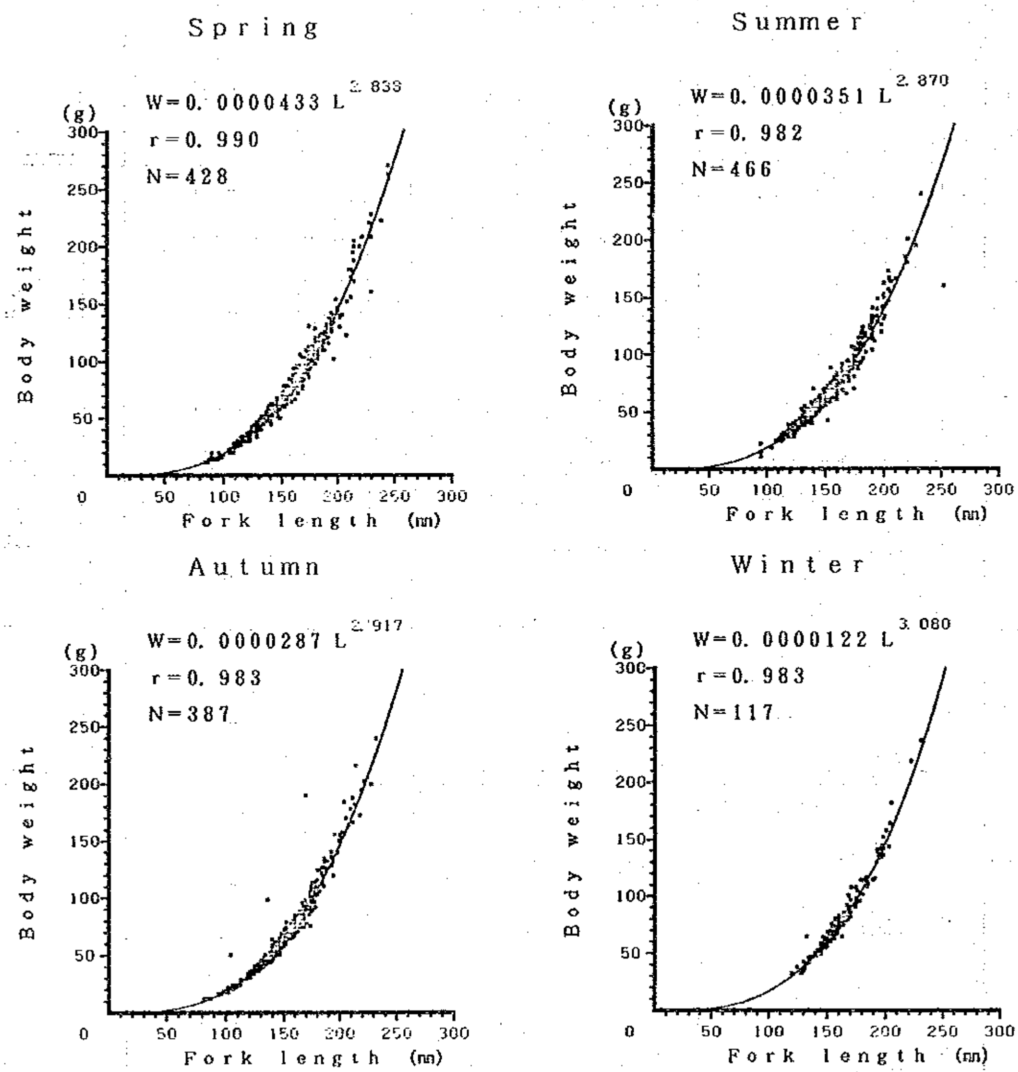


Fig. 5-1-4-26 Relationship Between Fork Length and Body Weight of Common Pandora

The body length and body weight ranges and means of this species by season, age and sex are shown in Table 5-1-4-58.

With respect to the sizes of males and females at each age, males tended to be larger than females, and that trend was particularly remarkable in autumn following completion of spawning. The sexual differentiation of this species appears to begin at a fork length of roughly 100 mm and body weight of roughly 20 g.

Table 5-1-4-58 Fork Length and Body Weight by Age and Sex of Common Pandora

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0		87~122(101)	85		12~31(21)	12
	1	105~123(117)	96~172(119)		23~36(30)	19~90(34)	
	2	123~155(140)	120~178(143)		37~67(53)	36~101(59)	
	3	154~173(164)	124~178(157)		73~99(86)	41~131(76)	
	4	162~197(180)	158~188(174)		80~135(110)	73~129(100)	
	5	174~239(202)	177~220(199)		98~223(148)	102~205(151)	
	6	197~245(221)			102~263(197)		
	7		245			271	
Summer	0			95			11~15(13)
	1	95~139(117)	114~140(124)	104~108(106)	22~46(34)	28~54(36)	19~25(22)
	2	113~161(136)	111~170(135)	113~136(125)	26~76(49)	25~88(47)	28~46(37)
	3	125~199(173)	128~204(160)		34~141(99)	39~163(77)	
	4	174~228(198)	188~207(196)		90~201(141)	125~164(141)	
	5	232~252(242)			160~240(200)		
Autumn	0	82~108(97)	102~107(104)	84~112(95)	12~22(19)	21~24(23)	12~25(17)
	1	136~142(139)	102~145(128)	122	46~51(49)	18~63(41)	36
	2	144~175(156)	104~176(147)		58~100(74)	39~102(61)	
	3	140~194(174)	143~186(163)		50~141(104)	52~190(83)	
	4	159~203(184)	136~187(174)	188	75~158(118)	76~133(100)	125
	5	187~210(197)	198		128~184(151)	140	
	6	208~214(211)	215~218(216)		165~188(176)	173~216(195)	
	7	220~228(224)	222~233(227)		195~200(198)	203~240(222)	
Winter	1		120~148(134)			33~60(44)	
	2	145	125~164(149)		51	38~83(63)	
	3	150~195(175)	150~189(164)		61~142(106)	57~115(82)	
	4	180~203(193)	170~196(179)		114~144(133)	82~135(104)	
	5	179~204(192)	197~205(200)		115~164(135)	145~182(159)	
	6	231	222		237	219	

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 5-1-4-59. 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 indicating the state of gonad following release of eggs.

The number of females was large in each season, with the sex ratio in spring being 2.36. From summer to winter, the number of females was also overwhelmingly dominant, with those sex ratios within a range of 4.31 - 6.13. The female maturity rates were summarized by season and sub area as shown below.

Spring:
All areas 66 (25)% a. 100 (100)% b. 76 (47)%
c. 90 (1)% d. 47 (31)% e. 61 (19)%

Summer:
All areas 42 (6)% b. 81 (23)% c. 73 (4)% d. 18 (1)%
e. 5 (0)%

Autumn:
All areas 11 (1)% a. 80 (34)% b. 43 (2)% c. 12 (0)%
d. 8 (0)% e. 6 (0)%

Winter:
All areas 7 (0)% b. 0 % c. 0 % d. 15 (0)%
e. 0 %

where, a. The Sea of Marmara, b. North Aegean Sea, c. South Aegean Sea, d. West Mediterranean Sea, e. East Mediterranean Sea
Figures in parentheses indicate the percentage of mature females (III).

Based on these results, the spawning period of this species is predicted to be from spring to autumn, and the peak spawning period is predicted to be in spring in each sub area. In addition, it was predicted that, in winter, there is a possibility of spawning in the Mediterranean Sea alone. With respect to the female maturity rates according to water depth, the female maturity rate was 10% higher at depths of 100 m or more than depths of 100 m or less in all three seasons from spring to autumn. Based on these results, that maturity of this species is dependent on water depth.

Table 5-1-4-59 Sex Ratios and Female Maturity Stages of Common Pandora

Season	Sub area	Stratum (m)	* Maturity stage of ♀ I	II	III	Total	♂	Sex ratios ♀/♂
Spring	The Sea of Marmara	20~100	0	0	200	200	200	1.00
	North Aegean Sea	20~100	597	692	1,164	2,454	954	2.57
	South Aegean Sea	20~100	136	1,174	14	1,324	502	2.64
	W. Mediterranean Sea	20~100	3,033	939	1,749	5,721	3,067	1.87
	E. Mediterranean Sea	20~100	522	545	31	1,099	262	4.20
		101~200	284	325	627	1,238	805	1.54
		20~200	448	478	214	1,141	429	2.66
	All area	20~100	635	754	396	1,786	705	2.53
		101~200	284	325	627	1,238	805	1.54
		20~200	581	688	432	1,702	720	2.36
Summer	North Aegean Sea	20~100	214	677	240	1,136	308	3.69
		101~200	58	231	404	693	347	2.00
		20~200	202	642	253	1,102	311	3.54
	South Aegean Sea	20~100	990	2,499	124	3,614	831	4.35
		101~200	0	55	55	111	55	2.02
		20~200	825	2,092	113	3,030	702	4.32
	W. Mediterranean Sea	20~100	2,708	515	51	3,275	191	17.15
		101~200	393	112	0	506	56	9.04
		20~200	1,782	354	31	2,167	137	15.82
	E. Mediterranean Sea	20~100	5,523	287	0	5,810	483	12.03
	All area	20~100	1,572	971	152	2,699	431	6.26
		101~200	211	127	114	454	128	3.55
		20~200	1,378	851	147	2,378	388	6.13
Autumn	The Sea of Marmara	20~100	67	155	113	336	0	—
	North Aegean Sea	20~100	257	185	11	454	318	1.43
	South Aegean Sea	20~100	1,828	377	0	2,995	505	5.93
		101~200	99	0	0	99	33	3.00
		20~200	1,396	283	0	2,271	387	5.87
	W. Mediterranean Sea	20~100	1,233	140	0	2,062	258	7.99
		101~200	244	67	0	312	176	1.77
		20~200	903	116	0	1,478	231	6.40
	E. Mediterranean Sea	20~100	1,691	98	0	1,790	276	6.49
		101~200	501	93	0	594	289	2.06
		20~200	1,453	97	0	1,551	279	5.56
	All area	20~100	1,195	168	12	1,621	287	5.65
		101~200	318	64	0	382	192	1.99
		20~200	1,027	148	10	1,383	269	5.14
Winter	North Aegean Sea	20~100	339	0	0	339	50	6.78
	South Aegean Sea	101~200	1,240	0	0	1,240	413	3.00
	W. Mediterranean Sea	20~100	0	489	0	489	326	1.50
		101~200	1,345	0	0	1,375	225	6.11
		20~200	896	163	0	1,079	258	4.18
	E. Mediterranean Sea	101~200	469	0	0	469	104	4.51
	All area	20~100	283	81	0	364	96	3.79
		101~200	1,099	0	0	1,114	241	4.62
		20~200	609	48	0	664	154	4.31

* 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 5-1-4-60.

The number of females was overwhelmingly dominant among 1 and 2 year old fish in all seasons. The number of males was generally dominant among older fish age 4 years and older in all seasons except winter. This result suggests that this species is essentially hermaphroditic protogynous. The female maturity rates by age in spring, considered to be the peak spawning period of this species, consisted of 0% among 0 year old fish, 19% among 1 year old fish, and 80-100% among fish age 2 years and older. Based on these findings, females are assumed to mature in 1 to 2 years, and the major spawning population consists of the two years and older age group.

Table 5-1-4-60 Sex Ratios and Female Maturity Stages by Season and Age of Common Pandora

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	0	84	0	0	84	0	—
	1	327	74	5	408	37	11.03
	2	106	306	160	573	24	23.88
	3	33	192	120	346	150	2.31
	4	25	80	136	242	282	0.86
	5	4	25	8	38	196	0.19
	6	0	0	0	0	26	0
	7	0	9	0	9	0	—
Summer	1	4	20	9	34	4	8.50
	2	1,053	223	63	1,340	62	21.61
	3	305	560	51	919	181	5.08
	4	12	45	0	57	130	0.44
	5	0	0	0	0	6	0
Autumn	0	6	0	0	6	7	0.86
	1	235	15	3	302	12	25.17
	2	531	77	3	695	46	15.11
	3	128	35	3	225	66	3.41
	4	70	17	0	94	76	1.24
	5	18	0	0	18	43	0.42
	6	1	3	0	4	11	0.36
	7	36	0	0	36	4	9.00
Winter	1	43	8	0	52	0	—
	2	228	24	0	252	8	31.50
	3	191	16	0	207	42	4.93
	4	41	0	0	41	60	0.68
	5	42	0	0	42	24	1.75
	6	13	0	0	13	13	1.00

* 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 5-1-4-61.

The maximum age of specimens of this species was 7 years. The dominant age group in each season was 2 year old fish. In addition, 1, 3 and 4 year old fish in spring, and 3 year old fish in summer and winter also accounted for large proportions of age composition in each season together with 2 year old fish. The dominant age group at stratum of 101-200 m from spring to autumn was 3 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: 428
Empty stomach rate: 28%

Crustaceans: 55.1%, Polychaetes: 47.6%, Mollusks: 21.4%
Fishes: 16.9%, Others: 3.0%, Unknown: 1.0%

Summer:
No. of specimens: 466
Empty stomach rate: 49%

Crustaceans: 50.7%, Polychaetes: 44.4%, Mollusks: 14.8%
Echinoderms: 13.1%, Fishes: 8.9%, Unknown: 7.6%

Autumn:
No. of specimens: 387
Empty stomach rate: 48%

Crustaceans: 46.8%, Polychaetes: 46.8%, Fishes: 18.5%
Echinoderms: 11.5%, Mollusks: 9.5%, Sea algae 0.5%
Unknown: 1.5%

Winter:
No. of specimens: 117
Empty stomach rate: 43%

Crustaceans: 59.8%, Polychaetes: 35.9%, Mollusks: 22.4%
Fishes: 12.0%, Echinoderms: 6.0%

Based on these results, this species was found to be a carnivore, feeding on benthic crustaceans, polychaetes and mollusks, while occasionally demonstrating herbivorous feeding habits.

Table 5-1-4-61 Age Composition of Common Pandora

Season	Sub area	Stratum (m)	Age 0	1	2	3	4	5	6	7
Spring	The Sea of Marmara	20~100		67		133		133	67	
	North Aegean Sea	20~100		187	622	761	1,004	724	110	
	South Aegean Sea	20~100	15	58	674	376	424	228	10	39
	W. Mediterranean Sea	20~100	568	2,464	1,438	1,688	2,128	499		
	E. Mediterranean Sea	20~100	119	490	417	186	106	54		
		101~200		269	600	618	467	58	29	
		20~200	82	422	473	319	217	55	9	
	All area	20~100	104	477	598	476	535	267	26	10
		101~200		269	600	618	467	58	29	
		20~200	88	445	598	498	524	235	26	9
Summer	North Aegean Sea	20~100	5	57	619	579	131	14		
		101~200		116	520	289	116			
		20~200	5	61	612	556	130	13		
	South Aegean Sea	20~100		73	650	3,133	589			
		101~200			55	111				
		20~200		61	551	2,629	490			
	W. Mediterranean Sea	20~100			2,189	1,440	116			
		101~200			168	394				
		20~200			1,381	1,021	69			
	E. Mediterranean Sea	20~100	148	148	5,693	671	72			
	All area	20~100	27	68	1,668	1,234	215	7		
		101~200		29	227	297	29			
		20~200	23	62	1,462	1,100	188	6		
Autumn	The Sea of Marmara	20~100		67	179	66	22			
	North Aegean Sea	20~100	30	95	248	272	136			
	South Aegean Sea	20~100		751	1,556	772	315	52	26	26
		101~200					66	33	33	
		20~200		563	1,167	579	253	47	28	19
	W. Mediterranean Sea	20~100	84	615	1,215	289	86	43	43	
		101~200				131	180	113	41	22
		20~200	56	410	810	236	117	66	42	7
	E. Mediterranean Sea	20~100	69	328	987	262	239	117	7	117
		101~200		193	250	266	134	38		
		20~200	55	301	840	263	218	101	5	93
	All area	20~100	48	374	894	323	180	60	14	48
		101~200		77	100	159	139	67	23	9
		20~200	39	317	741	292	172	61	16	40
Winter	North Aegean Sea	20~100		67	93	130	76	23		
	South Aegean Sea	20~100			496	744	248	165		
	W. Mediterranean Sea	20~100		81	244	407	81			
		101~200			518	324	129	194	129	
		20~200		27	427	351	113	129	86	
	E. Mediterranean Sea	20~100		104	364	52	52			
	All area	20~100		69	118	176	77	19		
		101~200		26	474	361	139	138	64	
		20~200		52	260	250	102	67	25	

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

(14) Axillary Sea Bream *Pagellus acarne*

1) Size composition

The fork length of this species was within a range of 5-21 cm throughout all seasons. The mean fork length of this species was within a range of 11-14 cm, being smallest in winter and largest in autumn (Table 5-1-4-62).

Table 5-1-4-62 Fork Length Range and Mean Fork Length of Axillary Sea Bream

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

The size composition of this species in all areas demonstrated a mono-modal distribution pattern in all seasons except summer, and the mode consisted of 13-14 cm in spring, 14-15 cm in autumn and 11-12 cm in winter. The size composition in all areas in summer demonstrated a bi-modal pattern, having modes at 11-12 cm and 13-14 cm. The peaks of the modes in spring and winter were large (Fig. 5-1-4-27).

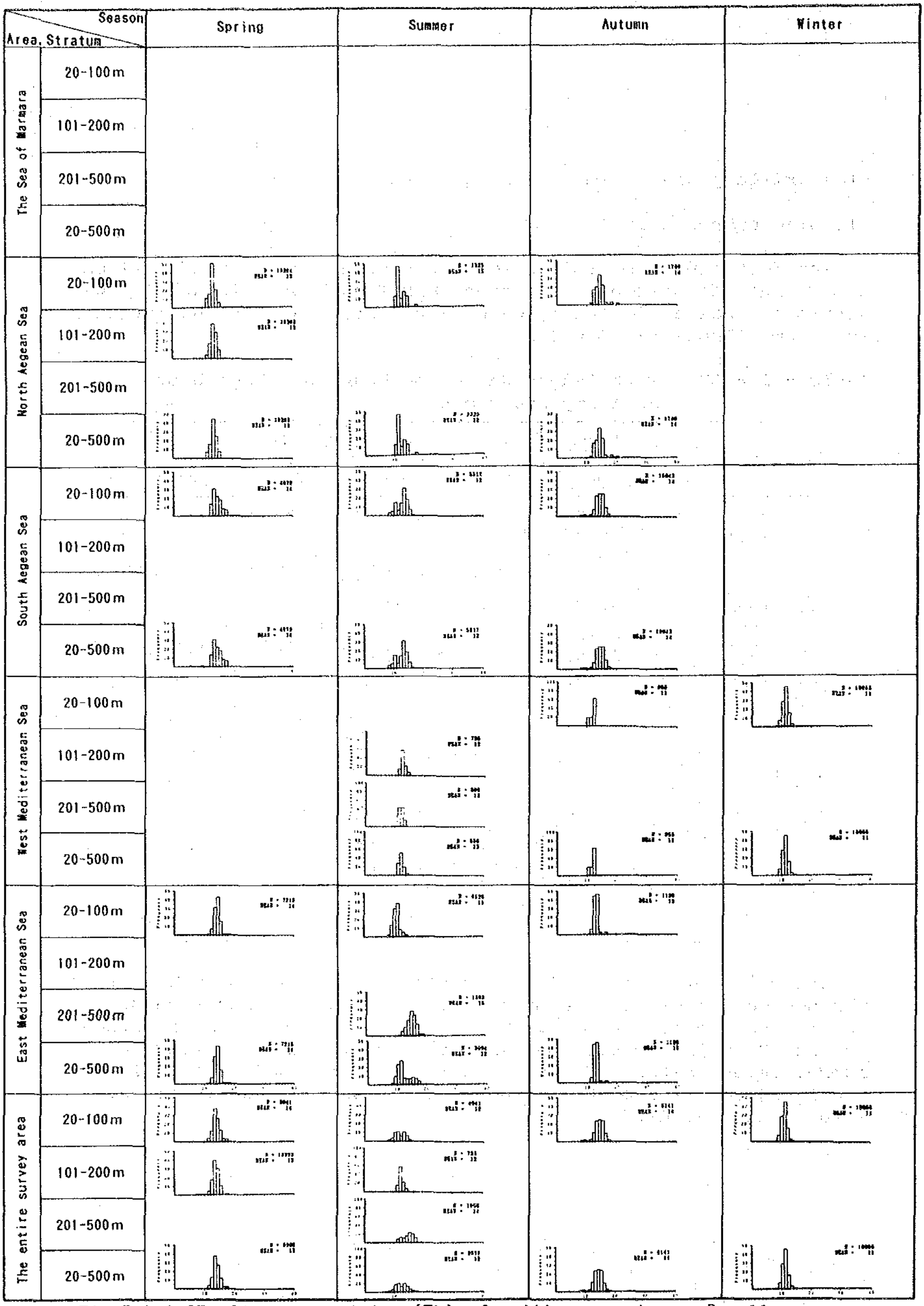


Fig. 5-1-4-27 Size composition (FL) of axillary sea bream *Pagellus acarne* by sub areas, strata and seasons

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. 5-1-4-28.

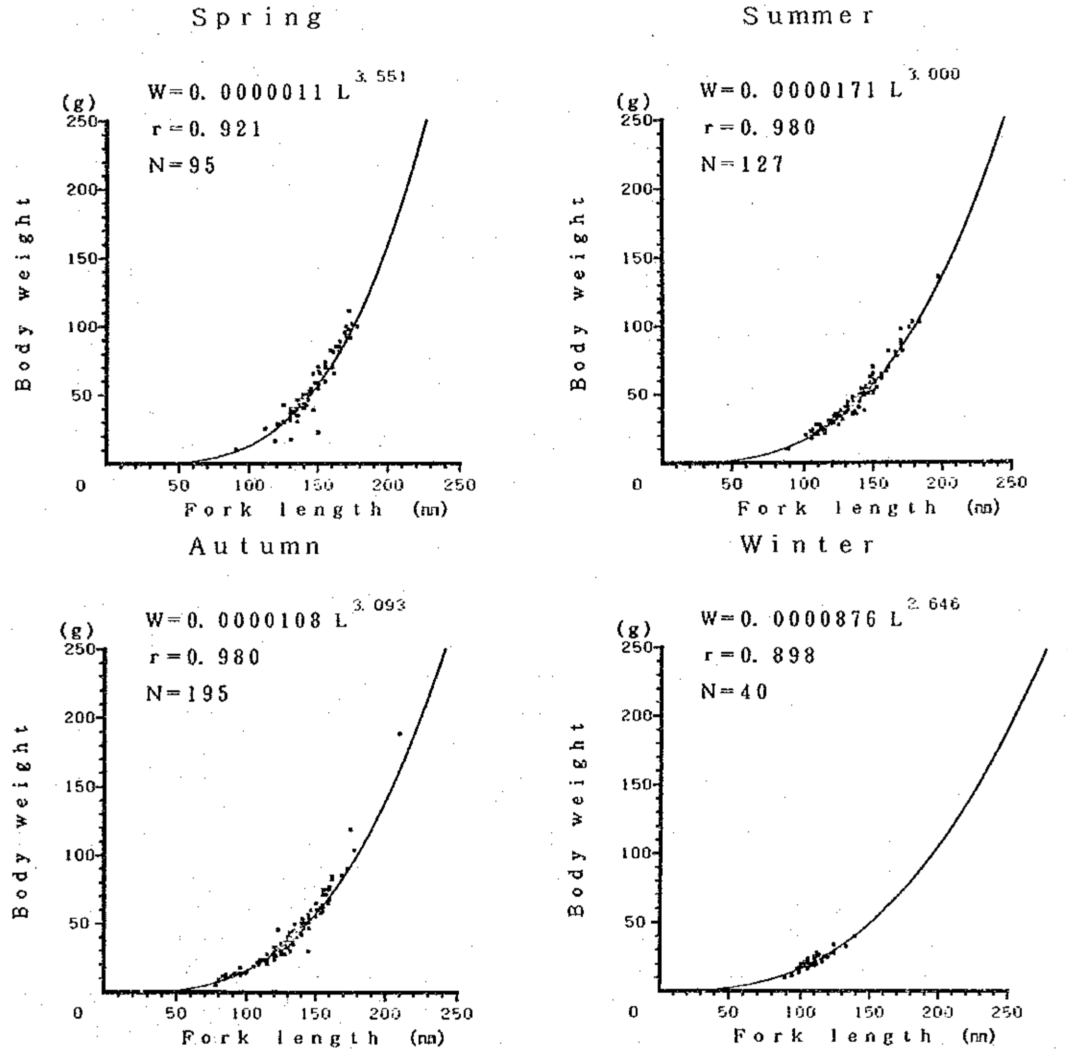


Fig. 5-1-4-28 Relationship Between Fork Length and Body Weight of Axillary Sea Bream

The body length and body weight ranges, along with their means, of this species by season, age and sex are shown in Table 5-1-4-63.

There were no large differences observed in growth between males and females at all ages. The sexual differentiation of this species appears to begin at roughly a fork length of 110 mm and body weight of 20 g.

Table 5-1-4-63 ***Fork Length and Body Weight by Age and Sex of Axillary Sea Bream***

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0			58~ 91(74)			10~ 11(11)
	1	125~130(128)	121~140(130)	112~125(118)	30~ 43(35)	18~ 41(34)	17~ 31(25)
	2	130~163(141)	130~161(140)	134	38~ 86(51)	34~ 82(48)	36
	3	147~173(159)	147~174(160)		58~ 92(75)	23~112(75)	
	4	178			100		
Summer	0			88~113(102)			10~ 24(18)
	1	109~130(118)	110~124(115)	105~125(115)	21~ 37(30)	21~ 34(27)	19~ 35(27)
	2	122~152(137)	122~153(138)	110~144(131)	28~ 63(44)	30~ 59(47)	23~ 44(38)
	3	147~157(151)	150~198(165)		51~ 62(55)	60~136(81)	
Autumn	0	105~108(106)		78~100(91)	19~ 22(21)		6~ 18(13)
	1	108~155(129)	120~155(132)		20~ 64(37)	29~ 59(42)	
	2	135~159(144)	133~162(152)		40~ 75(52)	30~ 84(62)	
	3	160~178(167)	160~175(167)		76~104(88)	77~119(93)	
	4		210			189	
Winter	0	105~120(112)	116	89~113(103)	17~ 26(22)	22	10~ 28(21)
	1	119~124(121)	114~139(127)	112	25~ 28(27)	27~ 40(34)	20

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 5-1-4-64. 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, those specimens that were hermaphroditic were treated as females.

The sex ratios were 2.57 in spring, 0.72 in summer, 0.52 in autumn and 0.27 in winter. Although the number of females is greater than that of males in spring, this becomes reversed in summer, with the number of males becoming greater. The number of males becomes increasingly dominant in moving from autumn into winter. This result is most likely due to the majority of females undergoing sex reversal into males from summer to winter.

The female maturity rates consisted of 100% in the North Aegean Sea, 99% in the South Aegean Sea, 0% in the West Mediterranean Sea and 53% in the East Mediterranean Sea in autumn, and 0% in the North Aegean Sea and 67% in the West Mediterranean Sea in winter. Based on these findings, although the spawning period of this species is in autumn, this can be considered to be winter with respect to only the West Mediterranean Sea.

Table 5-1-4-64 Sex Ratios and Female Maturity Stages of Axillary Sea Bream

Season	Sub area	Stratum (m)	* Maturity stage of ♀ I	II	III	Total	♂	Sex ratios ♀/♂
Spring	North Aegean Sea	20~100	8,235	0	0	8,235	0	—
	South Aegean Sea	20~100	2,764	0	0	2,764	1,246	2.22
	E. Mediterranean Sea	20~100	3,246	0	0	3,246	3,968	0.82
	All area	20~100	3,955	0	0	3,955	1,541	2.57
Summer	North Aegean Sea	20~100	262	0	0	262	514	0.51
	South Aegean Sea	20~100	1,344	0	0	1,344	2,808	0.48
	W. Mediterranean Sea	101~200	207	0	0	207	414	0.50
	E. Mediterranean Sea	201~500	982	0	0	982	220	4.46
	All area	20~100	803	0	0	803	1,661	0.48
		101~200	207	0	0	207	414	0.50
		201~500	655	0	0	655	147	4.46
		20~500	673	0	0	673	937	0.72
Autumn	North Aegean Sea	20~100	0	222	218	441	1,322	0.33
	South Aegean Sea	20~100	27	1,551	2,280	3,859	6,799	0.57
	W. Mediterranean Sea	20~100	127	0	0	127	828	0.15
	E. Mediterranean Sea	20~100	68	22	56	147	983	0.15
	All area	20~100	39	824	1,195	2,059	3,943	0.52
Winter	North Aegean Sea	20~100	203	0	0	203	0	—
	W. Mediterranean Sea	20~100	984	1,968	0	2,952	11,808	0.25
	All area	20~100	593	984	0	1,577	5,904	0.27

* 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 5-1-4-65.

The number of females was large among 3 year old fish in all seasons. Although the number of females was large among 1 and 2 year old fish in spring, this trend reversed starting in summer so that the number of males was larger in those seasons. This is probably due to females doing sex reversal into males from summer to winter, particularly with respect to 1 and 2 year old fish. In addition, the fact that all 0 year old fish in autumn were males suggests that this species is hermaphroditic, with males maturing earlier than females. The female maturity rates by age in autumn, considered to be the spawning period of this species, consisted of 66% among 1 year old fish, and 100% among fish 2 years and older. The majority of the members of this species are predicted to mature in 1 year.

Table 5-1-4-65 Sex Ratios and Female Maturity Stages by Season and Age of Axillary Sea Bream

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	1	828	0	0	828	201	4.12
	2	1,665	0	0	1,665	992	1.68
	3	1,461	0	0	1,461	265	5.51
	4	0	0	0	0	81	0
Summer	1	70	0	0	70	115	0.61
	2	295	0	0	295	694	0.43
	3	283	0	0	283	81	3.49
Autumn	0	0	0	0	0	16	0
	1	39	49	30	119	1,845	0.06
	2	0	664	725	1,390	1,842	0.75
	3	0	110	427	538	239	2.25
	4	0	0	11	11	0	—
Winter	0	492	0	0	492	3,936	0.13
	1	101	984	0	1,085	1,968	0.55

* 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 5-1-4-66.

The maximum age of specimens of this species was 4 years. The dominant age groups in each season consisted of 2 year old fish from spring to autumn, and 0 year old fish in winter.

Table 5-1-4-66 Age Composition of Axillary Sea Bream

Season	Sub area	Stratum (m)	Age 0	1	2	3	4
Spring	North Aegean	20~100		5,147	4,117	1,029	
	South Aegean	20~100	59	515	1,545	1,814	136
	East Mediterranean Sea	20~100			5,050	2,164	
	All area	20~100	35	1,338	2,760	1,727	81
Summer	North Aegean	20~100	122	488	488		
	South Aegean	20~100	1,139	683	2,952	744	
	West Mediterranean Sea	101~200		311	414		
		201~500		422	169		
		101~500		366	291		
	East Mediterranean Sea	201~500		20	576	714	
	All area	20~100	630	586	1,720	372	
		101~200		311	414		
		201~500		154	440	476	
		20~500	315	389	1,077	364	
Autumn	North Aegean	20~100		1,555	98	55	55
	South Aegean	20~100	322	2,728	6,376	1,520	
	West Mediterranean Sea	20~100		956			
	East Mediterranean Sea	20~100		972	124	34	
	All area	20~100	161	1,965	3,232	778	11
Winter	North Aegean	20~100	1,831	203			
	West Mediterranean Sea	20~100	12,791	6,888			
	All area	20~100	7,311	3,545			

5) Feeding Habits

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

Spring:
No. of specimens: 95
Empty stomach rate: 55%

Crustaceans: 62.8%, Polychaetes: 46.6%, Echinoderms: 30.3%, Mollusks: 11.7%, Fishes: 9.4%, Unknown: 9.4%

Summer:
No. of specimens: 127
Empty stomach rate: 63%

Crustaceans: 46.9%, Polychaetes: 27.7%, Mollusks: 19.2% Echinoderms: 19.2%, Fishes: 6.4%, Unknown: 21.3%

Autumn:
No. of specimens: 195
Empty stomach rate: 62%

Crustaceans: 62.2%, Polychaetes: 25.7%, Mollusks: 10.9% Echinoderms: 9.5%, Fishes: 5.5%, Others: 8.2% Unknown: 13.6%

Winter:
No. of specimens: 40
Empty stomach rate: 50%

Crustaceans: 85.0% Polychaetes: 30.0% Fishes: 15.0% Mollusks: 5.0% Other (Hydrozoans): 60.0%

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

(15) Red Sea Bream ***Pagellus bogaraveo***

1) Size Composition

The fork length of this species throughout the entire survey was within a range of 9-20 cm. There were no large differences in mean fork length in each season, with all values falling within a range of 11-13 cm. The mean fork length tended to be dependent on water depth, with larger mean fork lengths observed at deeper strata (Table 5-1-4-67).

Table 5-1-4-67 Fork Length Range and Mean Fork Length of Red Sea Bream

Sub area	Stratum (m)	Range of FL (Mean FL) in cm			
		Spring	Summer	Autumn	Winter
North Aegean Sea	20~100	9~13 (11)		11~14 (12)	9~15 (12)
	101~200	10~13 (12)			11~16 (13)
	201~500	12~20 (14)			18~19 (18)
	20~500	9~20 (12)		11~14 (12)	9~19 (12)
South Aegean Sea	201~500		14~15 (14)		
West Mediterranean Sea	101~200	10~14 (11)			
East Mediterranean Sea	201~500		11~13 (12)		
All area	20~100	9~13 (11)		11~14 (12)	9~15 (12)
	101~200	10~14 (11)			11~16 (13)
	201~500	12~20 (14)	11~15 (13)		18~19 (18)
	20~500	9~20 (11)	11~15 (13)	11~14 (12)	9~19 (12)

The size composition of this species in all areas demonstrated a mono-modal distribution pattern in all seasons. The mode in each season consisted of 11-12 cm in spring, 14-15 cm in summer, 12-13 cm in autumn and 13-14 cm in winter (Fig. 5-1-4-29).

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. 5-1-4-30.

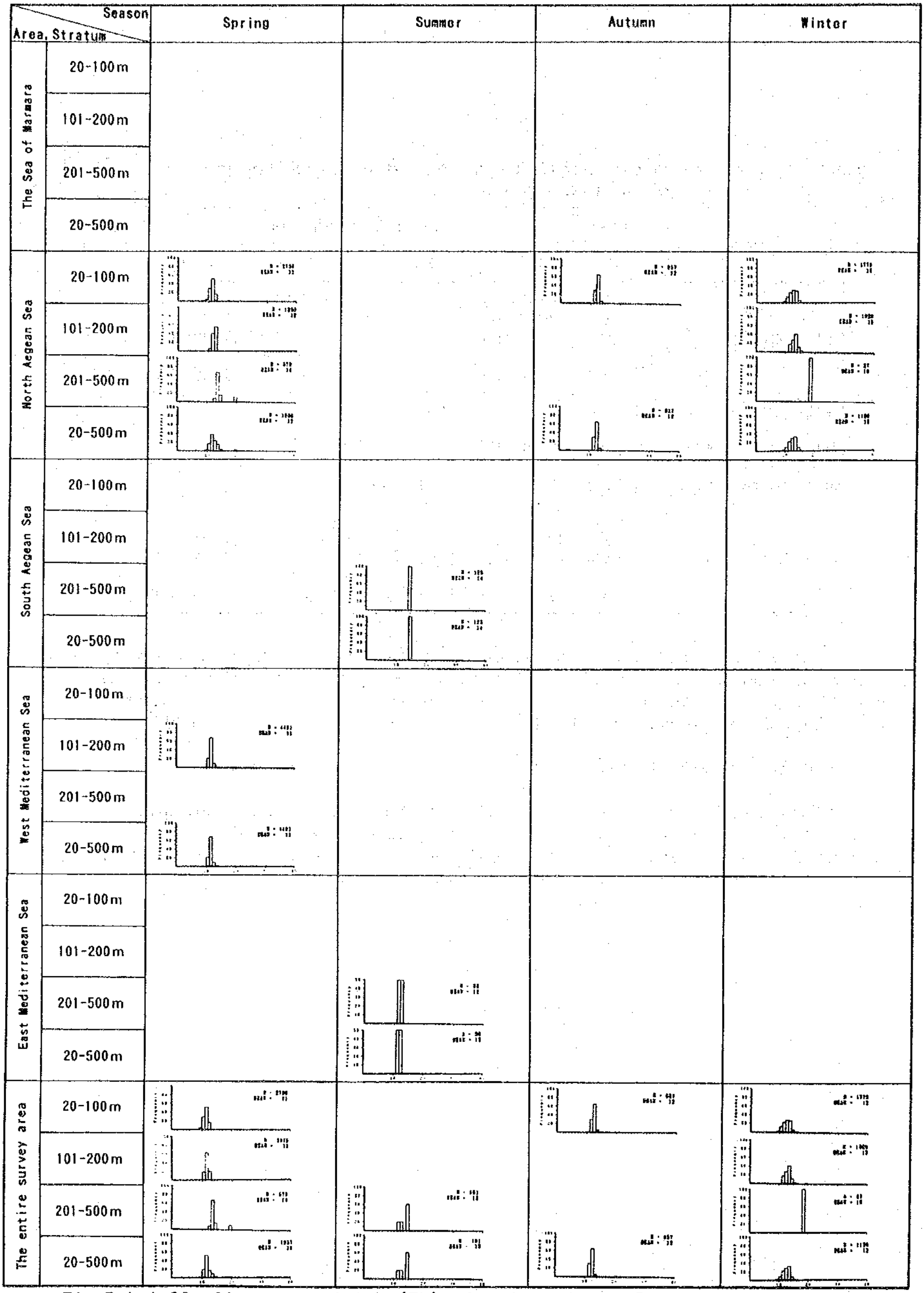


Fig.5-1-4-29 Size composition (FL) of red sea bream *Pagellus bogaraveo* by sub areas, strata and seasons

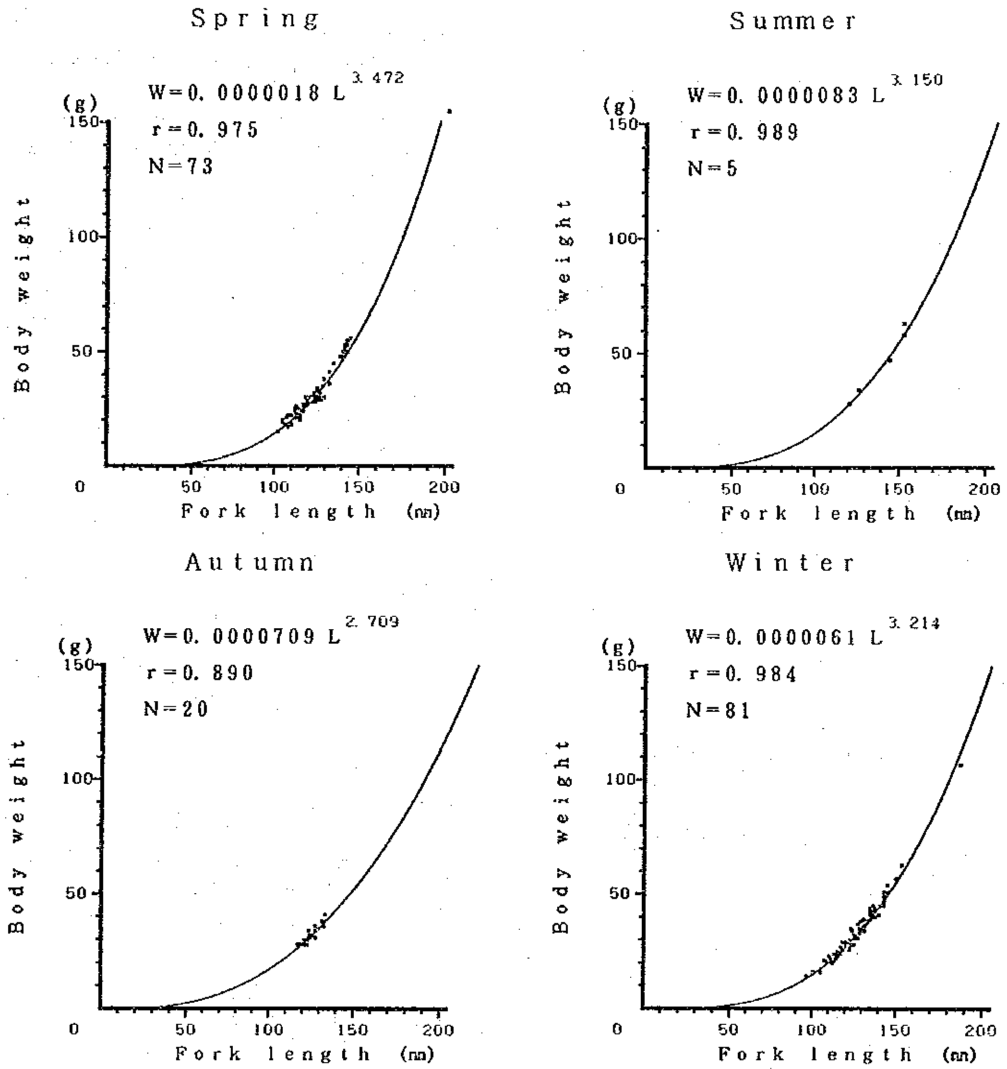


Fig. 5-1-4-30 Relationship Between Fork Length and Body Weight of Red Sea Bream

The body length and body weight of this species by season, age and sex are shown in Table 5-1-4-68.

The majority of the specimens of this species were immature fish, for which sex was indistinguishable, and male fish, and there were no growth differences observed between males and females. The majority of the members of this species are probably hermaphroditic protandrous. The sexual differentiation of males is thought to begin as early as a fork length of roughly 100 mm and body weight of roughly 20 g. In addition, since female gonads were not developed even in 3 year old fish, the mature age of this species is most likely at least 4 years old.

Table 5-1-4-68 **Fork Length and Body Weight by Age and Sex of Red Sea Bream**

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	0	103		100~110(105)	20		15~ 24(19)
	1	110~126(114)		105~125(115)	22~ 35(26)		17~ 33(26)
	2	130		122~142(132)	36		29~ 56(43)
	3			142			56
Summer	1			119			28
	2	142		124	47		34
	3	150			58~ 63(61)		
Autumn	1	115~131(122)	123	122	28~ 41(32)	32	31
	2	130			36		
Winter	0			95~132(115)			14~ 41(26)
	1			116~150(132)			26~ 63(41)
	2			147			57
	3	183			107		

3) Sex Ratios and Female Maturity Stages

Since the majority of the specimens of this species consisted of immature fish and male fish as was mentioned previously, it is not possible to verify sex ratios and female maturity stages. Consequently, the appearance frequencies of immature fish (a) and male fish (b) were summarized as shown below.

Spring: No. of specimens 1,191 a. 64% b. 36%
Summer: No. of specimens 101 a. 40% b. 60%
Autumn: No. of specimens 938 a. 5% b. 90%
(immature females: 5%, sex ratio at that time: 0.06)
Winter: No. of specimens 1,129, a. 99.6% b. 0.4%

These findings suggest that the sexual differentiation of males occurs most actively from spring to autumn.

4) Age Composition

The age composition of this species by season, sub area and strata is shown in Table 5-1-4-69.

The major components of age composition tended to be dependent on water depth, consisting of 1 year old fish at depths of 200 m or less (0 and 1 year old fish in winter), and 2 and 3 year old fish at depths of 201 m or more. Furthermore, there were no 0 year old fish observed in summer and autumn.

Table 5-1-4-69 Age Composition of Red Sea Bream

Season	Sub area	Stratum (m)	Age 0	1	2	3
Spring	North Aegean Sea	20~100	279	2,093	419	
		101~200		1,072	189	
		201~500			478	43
		20~500	69	791	391	21
	West Mediterranean Sea	101~200	898	3,368	225	
	All area	20~100	279	2,093	419	
		101~200	449	2,220	207	
		201~500			478	43
		20~500	235	1,306	357	17
Summer	South Aegean	201~500			41	82
	East Mediterranean Sea	201~500		40	40	
	All area	201~500		20	40	41
Autumn	North Aegean Sea	20~100		890	47	
Winter	North Aegean Sea	20~100	1,179	600		
		101~200	307	702	21	
		201~500				27
		20~500	594	521	8	5

5) Feeding habits

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

Spring:
No. of specimens: 73
Empty stomach rate: 60%

Crustaceans: 72.5%, Echinoderms: 41.4%, Polychaetes: 38.0%, Fishes: 34.5%

Summer:
No. of specimens: 5
Empty stomach rate: 60%

Crustaceans: 50.0%, Unknown: 50.0%

Autumn:
No. of specimens: 20
Empty stomach rate: 65%

Echinoderms: 57.2%, Crustaceans: 14.3%, Polychaetes: 14.3%, Mollusks: 14.3%, Fishes: 14.3%

Winter:
No. of specimens: 81
Empty stomach rate: 53%

Polychaetes: 73.7%, Crustaceans: 39.5%, Echinoderms: 13.2%, Fishes: 5.3%, Mollusks: 2.7%, Hydrozoans: 2.7%
Unknown: 7.9%

Based on these results, this species was found to be carnivorous, and dependent on small benthic animals.

(16) Barracuda ***Sphyraena sphyraena***

1) Size composition

The fork length of this species in the Mediterranean Sea in summer and autumn was within a range of 22-35 cm. There was no difference between the mean fork lengths in both seasons, being 27 and 28 cm, respectively (Table 5-1-4-70).

Table 5-1-4-70 Fork Length Range and Mean Fork Length of Barracuda

Sub area	Stratum (m)	Range of FL (Mean FL) in cm	
		Summer	Autumn
West Mediterranean Sea	20~100	24~26 (25)	
East Mediterranean Sea	20~100	22~35 (27)	25~30 (28)
All area	20~100	22~35 (27)	25~30 (28)

Although data relating to the size composition of this species was obtained from fish-body measurements of biological surveys, due to the extremely small number of fish, it was not possible to specify the distribution pattern of body length composition (Fig. 5-1-4-31).

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. 5-1-4-32.

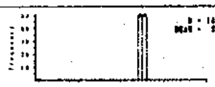
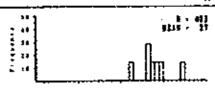
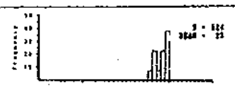
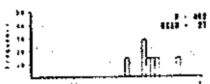
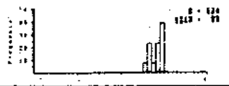
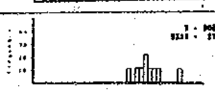
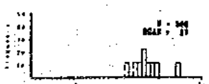
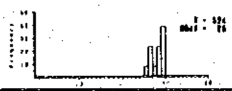
Area	Stratum	Spring	Summer	Autumn	Winter
The Sea of Marmara	20-100m				
	101-200m				
	201-500m				
	20-500m				
North Aegean Sea	20-100m				
	101-200m				
	201-500m				
	20-500m				
South Aegean Sea	20-100m				
	101-200m				
	201-500m				
	20-500m				
West Mediterranean Sea	20-100m				
	101-200m			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

Fig. 5-1-4-31 Size composition (FL) of barracuda *Sphyraena sphyraena* by sub areas, strata and seasons

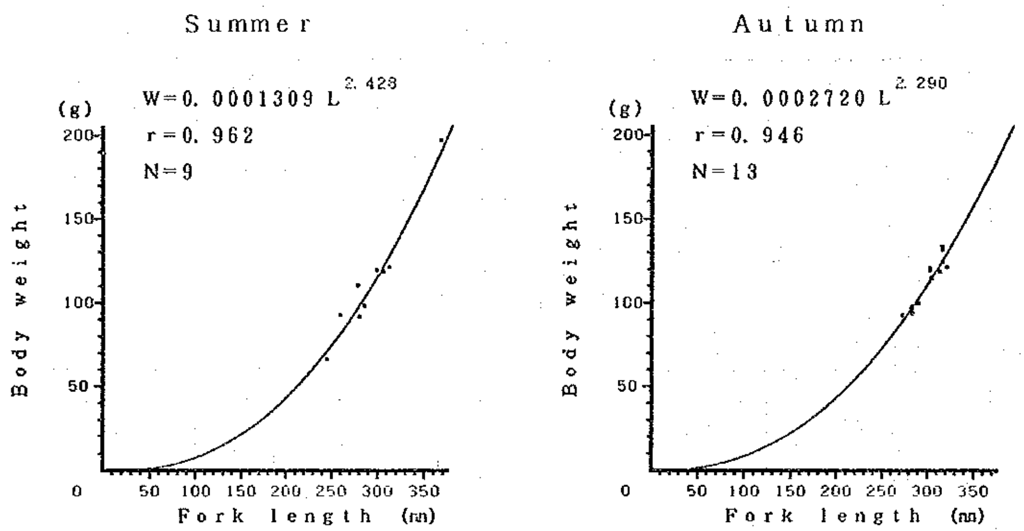


Fig. 5-1-4-32 Relationship Between Fork Length and Body Weight of Barracuda

The body length and body weight of this species by age and sex in summer and autumn are shown in Table 5-1-4-71.

Although there was only a small amount of data, females were found to be larger than males when looking only at 3 year old fish. In addition, the sexual differentiation of this species appears to begin in the first year (0 years old).

Table 5-1-4-71 Fork Length and Body Weight by Season and Age of Barracuda

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Summer	1		229			65	
	2	266	242		96	91	
	3	262~291(279)	260~343(301)		90~119(111)	108~193(151)	
Autumn	2	255~265(260)			91~ 96(93)		
	3	264~295(277)	271~300(288)		92~131(108)	98~129(117)	

3) Sex Ratios and Female Maturity Stages

The sex ratios and female maturity stages of this species in summer and autumn are shown in Table 5-1-4-72.

The sex ratios of this species in the Mediterranean Sea in summer and autumn were 0.81 and 1.17, the number of males and females was roughly equal. Although the spawning period of this species is unable to be specified, it is probably in summer.

Table 5-1-4-72 Sex Ratios and Female Maturity Stages of Barracuda

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios
			I	II	III	Total		♀/♂
Summer	West Mediterranean Sea	20~100	0	140	0	140	0	—
	East Mediterranean Sea	20~100	69	69	0	137	343	0.40
	All area	20~100	34	104	0	138	171	0.81
Autumn	East Mediterranean Sea	20~100	283	0	0	283	242	1.17

* 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 5-1-4-73.

The mature age of this species is predicted to be 2 years old.

Table 5-1-4-73 Sex Ratios and Female Maturity Stages by Season and Age of Barracuda

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Summer	1	34	0	0	34	0	—
	2	0	35	0	35	34	1.03
	3	0	69	0	69	137	0.50
Autumn	2	0	0	0	0	81	0
	3	283	0	0	283	161	1.76

* 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 5-1-4-74.

The major component of the age composition of this species in the Mediterranean Sea in summer and autumn was 3 year old fish in all seasons.

Table 5-1-4-74 Age Composition of Barracuda

Season	Sub area	Stratum (m)	Age		
			1	2	3
Summer	West Mediterranean Sea	20~100		70	70
	East Mediterranean Sea	20~100	69	69	343
	All area	20~100	34	69	206
Autumn	East Mediterranean Sea	20~100		81	444

5) Feeding Habits

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

Summer:
No. of specimens: 9
Empty stomach rate: 67%

Fishes: 100%

Autumn:
No. of specimens: 13
Empty stomach rate: 69%

Fishes: 100%

Based on the above findings, this species was found to feed exclusively on fish when looking at only summer and autumn.

(17) Obtuse Barracuda *Sphyraena chrysotaenia*

1) Size composition

All data relating to the size composition of this species was obtained from fish-body measurements of biological surveys. The fork length of this species was within a range of 13-31 cm throughout all seasons. The mean fork length of this species was within a range of 19-25 cm, and gradually increased from summer to winter (Table 5-1-4-75).

Table 5-1-4-75 Fork Length Range and Mean Fork Length of Obtuse Barracuda

Sub area	Stratum (m)	Range of FL (Mean FL) in cm		
		Summer	Autumn	Winter
South Aegean Sea	20~100		21~26 (23)	
West Mediterranean Sea	20~100	15~26 (19)		
East Mediterranean Sea	20~100	13~26 (19)		22~31 (25)
All area	20~100	13~26 (19)	21~26 (23)	22~31 (25)

The distribution pattern of size composition of this species was unable to be specified due to the small amount of data. Dominant modes were observed at 20-23 cm in all seasons (Fig. 5-1-4-33).

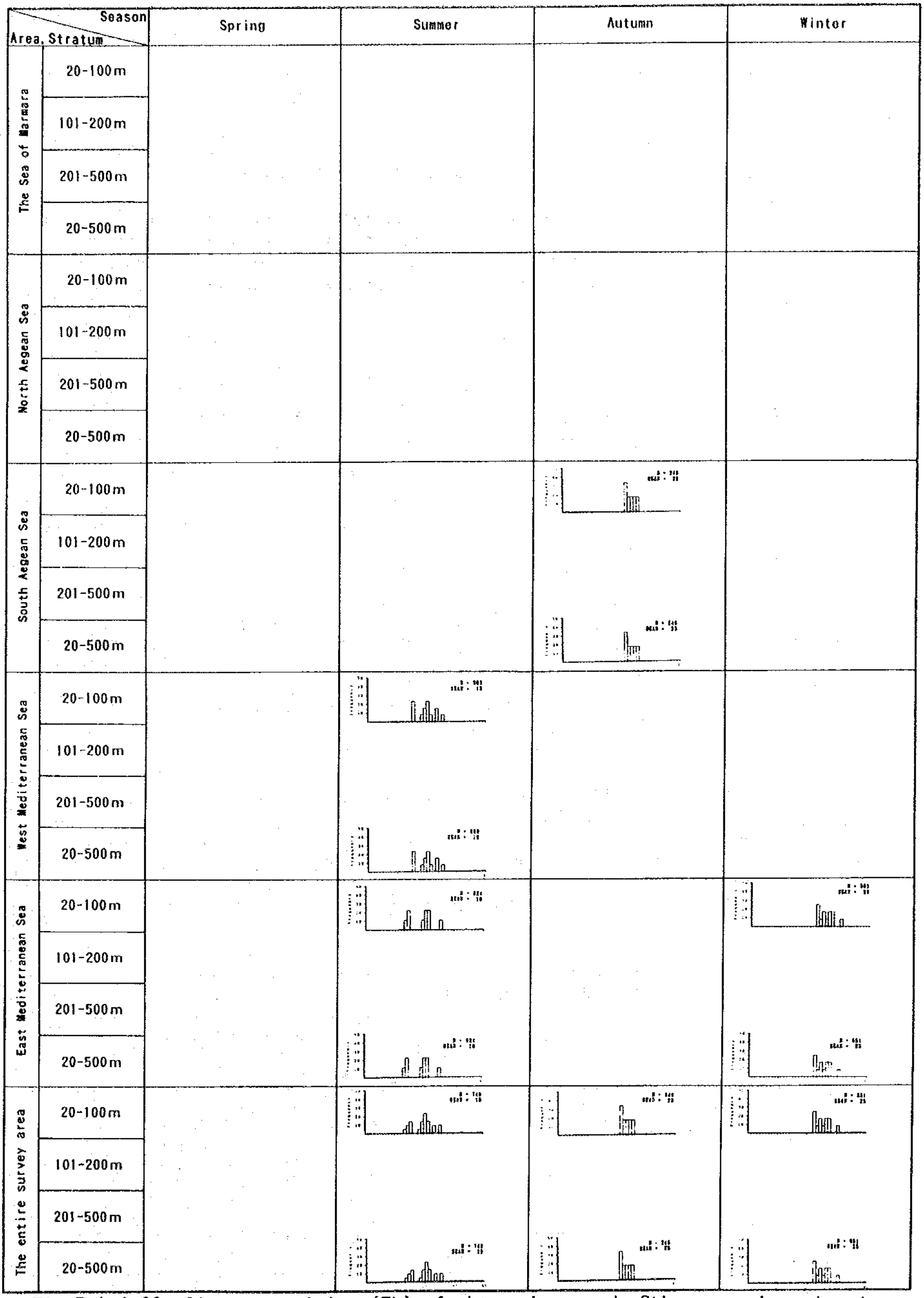


Fig. 5-1-4-33 Size composition (FL) of obtuse barracuda *Sphyraena chrysotaenia* by sub areas, strata and seasons

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. 5-1-4-34.

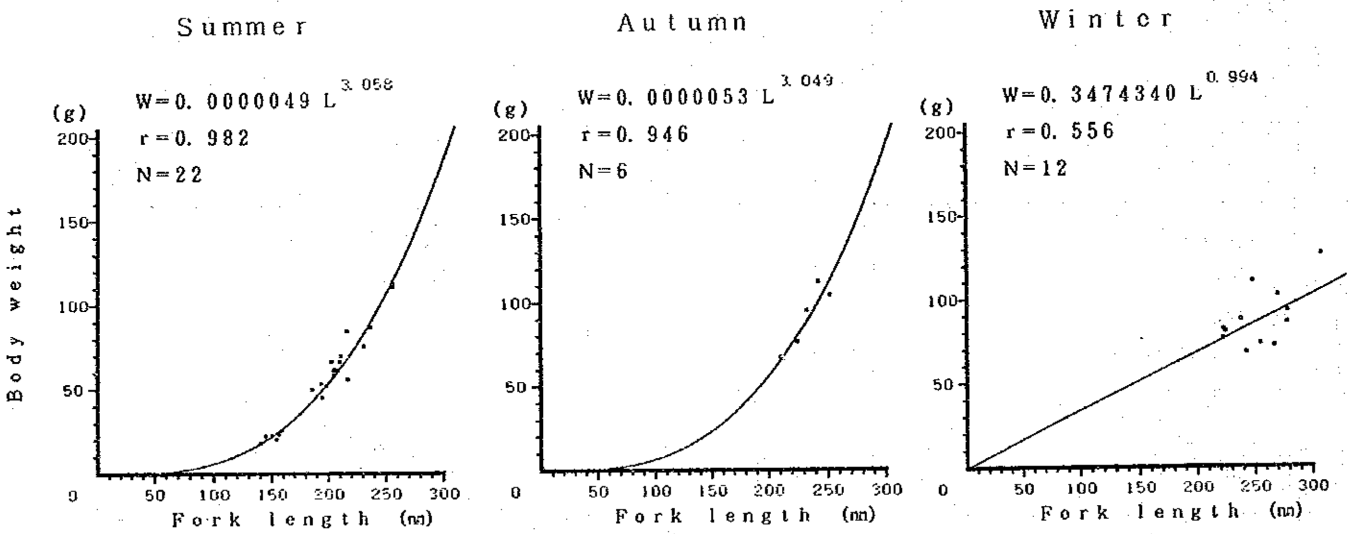


Fig. 5-1-4-34 Relationship Between Fork Length and Body Weight of Obtuse Barracuda

The body length and body weight ranges of this species by season, age and sex are shown in Table 5-1-4-76.

There were differences observed in the sizes of males and females at all ages, with the growth of females appearing to be faster than that of males. In addition, the sexual differentiation of this species appears to begin in the first year (0 years old).

Table 5-1-4-76 Fork Length and Body Weight by Age and Sex of Obtuse Barracuda

Season	Age	Range of FL (Mean FL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Summer	1	154	140~198 (158)		20	18~ 51 (27)	
	2	186~217 (203)	195~237 (217)		49~ 68 (59)	44~ 85 (69)	
	3		256			108~110 (109)	
Autumn	2	211~225 (216)	233~252 (242)		65~ 75 (69)	93~110 (102)	
Winter	1		279			91	
	3	222~238 (227)	225~308 (257)		75~ 86 (80)	67~124 (87)	
	4		270~278 (274)			84~100 (92)	

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 5-1-4-77.

There appeared to be a larger number of females in all seasons. The female maturity rates were 61% in the Mediterranean Sea in summer (all females were semi-mature in the West Mediterranean Sea while all were mature in the East Mediterranean Sea), and 100% in the South Aegean Sea in autumn (all semi-mature). This suggests that the spawning period of this species in summer in the Mediterranean Sea occurs earlier in the East Mediterranean Sea and later in the West Mediterranean Sea, and occurs in autumn in the South Aegean Sea.

Table 5-1-4-77 Sex Ratios and Female Maturity Stages of Obtuse Barracuda

Season	Sub area	Stratum (m)	* Maturity stage of ♀ I	II	III	Total	♂	Sex ratios ♀/♂
Summer	West Mediterranean Sea	20～100	135	405	0	540	338	1.60
	East Mediterranean Sea	20～100	208	0	139	346	277	1.25
	All area	20～100	171	202	69	443	307	1.44
Autumn	South Aegean Sea	20～100	0	123	0	123	123	1.00
Winter	East Mediterranean Sea	20～100	637	0	0	637	212	3.01

* 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 5-1-4-78.

Although there were no males observed among fish age 3 years and older, it was unable to be concluded that the life span of males is shorter than that of females due to insufficient data. The female maturity rate (mature/total) in summer was higher the older the fish. In addition, the mature age of this species is believed to be 1 year.

Table 5-1-4-78 Sex Ratios and Female Maturity Stages by Season and Age of Obtuse Barracuda

Season	Age	* Maturity stage of ♀ I	II	III	Total	♂	Sex ratios ♀/♂
Summer	1	171	34	0	205	34	6.03
	2	0	135	34	169	273	0.62
	3	0	34	34	68	0	—
Autumn	2	0	123	0	123	123	1.00
Winter	1	71	0	0	71	0	—
	3	425	0	0	425	212	2.01
	4	142	0	0	142	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 5-1-4-79.

The maximum age of specimens of this species was 4 years. In addition, there was no 0 year old fish observed. The dominant age groups consisted of 2 year old fish in summer and autumn, and 3 year old fish in winter.

Table 5-1-4-79 Age Composition of Obtuse Barracuda

Season	Sub area	Stratum (m)	Age 1	2	3	4
Summer	West Mediterranean Sea	20~100	270	540	68	
	East Mediterranean Sea	20~100	208	346	69	
	All area	20~100	239	443	68	
Autumn	South Aegean Sea	20~100		247		
Winter	East Mediterranean Sea	20~100	71		637	142

5) Feeding habits

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

Summer:
No. of specimens: 22
Empty stomach rate: 50%

Fishes: 91.0%, Crustaceans: 18.2%

Autumn:
No. of specimens: 6
Empty stomach rate: 67%

Fishes: 100%

Winter:
No. of specimens: 12
Empty stomach rate: 92%

Fishes: 100%

Based on the above findings, this species was found to primarily feed on fish.

(18) Common Sole *Solea vulgaris*

1) Size composition

The total length of this species was within a range of 13-40 cm throughout all seasons. The mean total length of this species was smaller in the summer at 20 cm, and larger in the other seasons, falling within a range of 25-28 cm (Table 5-1-4-80).

Table 5-1-4-80 Total Length Range and Mean Total Length of Common Sole

Sub area	Stratum (m)	Range of TL (Mean TL) in cm			
		Spring	Summer	Autumn	Winter
The Sea of Marmara	20~100	23~35 (28)	30~31 (30)	21~40 (26)	19~34 (24)
North Aegean Sea	20~100	30~32 (31)		31~32 (31)	
East Mediterranean Sea	20~100	23~31 (27)	13~28 (20)	29~30 (29)	27~28 (27)
All area	20~100	23~35 (28)	13~31 (20)	21~40 (26)	19~34 (25)

The size composition of this species is shown in Fig. 5-1-4-35. With the exception of summer, the size composition data of this species in the other three seasons was obtained from fish-body measurements of biological surveys. Studies of body length composition were conducted with respect to summer alone due to the relatively large number of specimens obtained in that season. The size composition of this species in summer demonstrated a mono-modal distribution pattern having a mode at 20-21 cm.

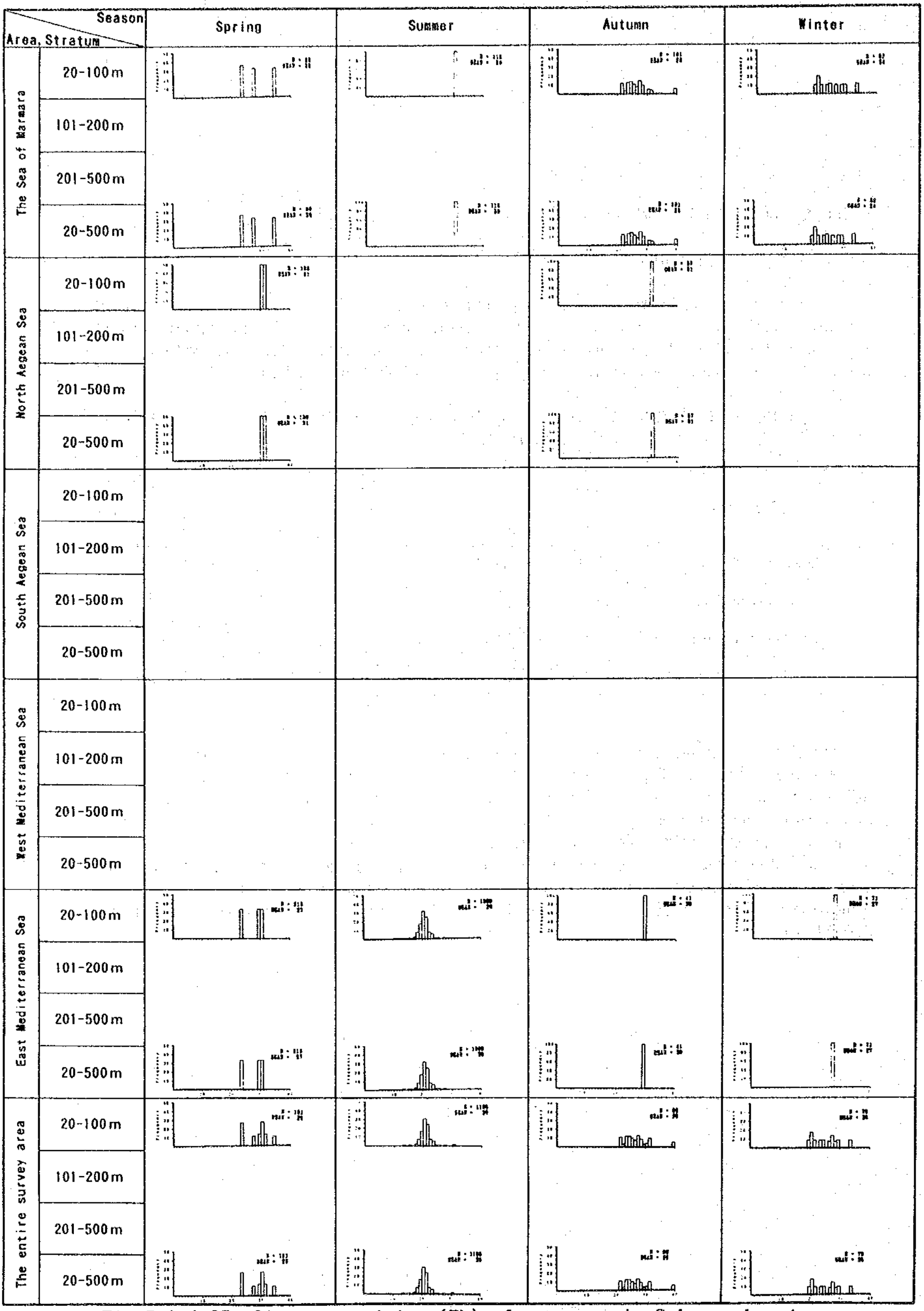


Fig. 5-1-4-35 Size composition (TL) of common sole *Solea vulgaris* by sub areas, strata and seasons

2) Relationship Between Body Length and Body Weight

The relationship between total 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. 5-1-4-36.

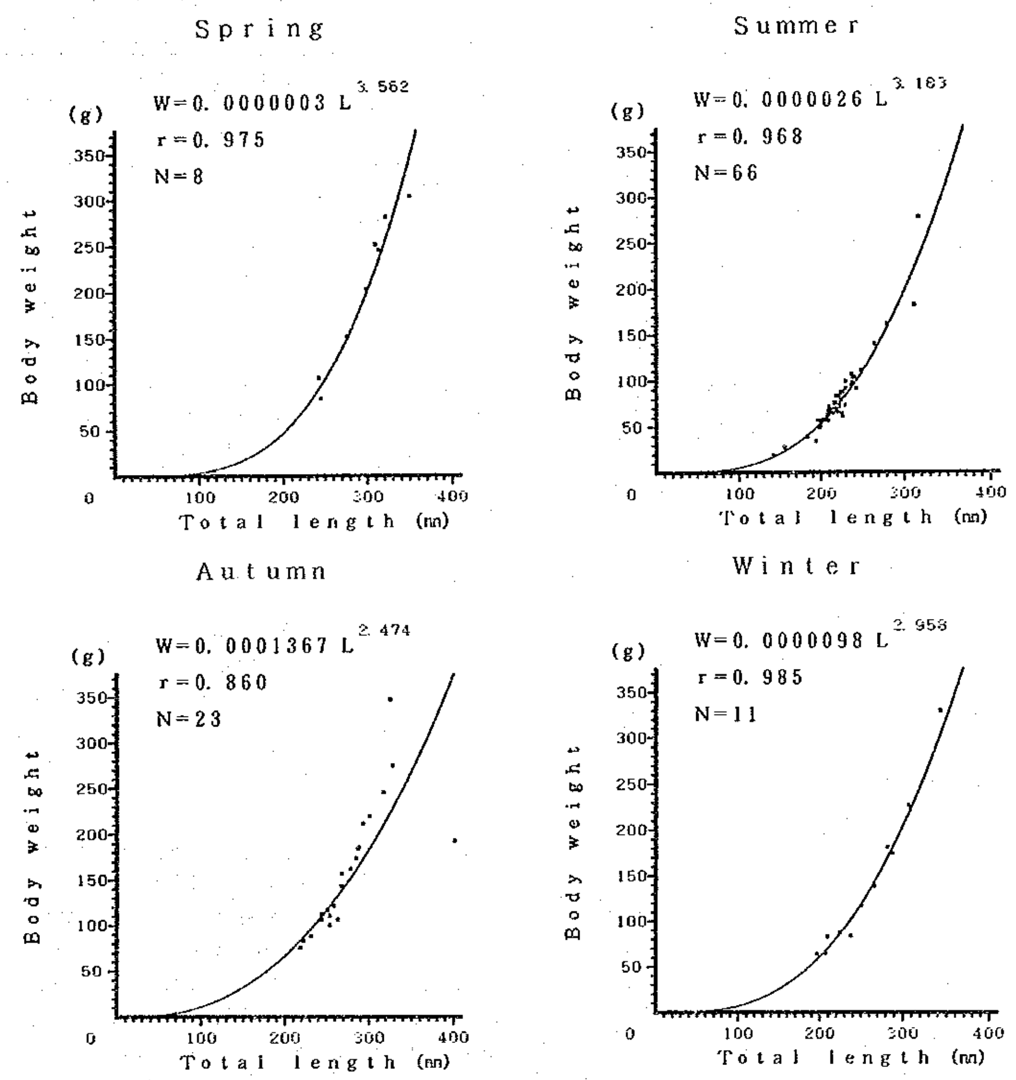


Fig. 5-1-4-36 Relationship Between Total Length and Body Weight of Common Sole

The body length and body weight ranges of this species by season, age and sex, along with their means, are shown in Table 5-1-4-81. The figures shown here apply to summer during which a relatively large number of specimens were obtained.

There appears to be no large differences between the growth of males and females. The sexual differentiation of this species appears to begin at a total length of roughly 150 mm and body weight of roughly 30 g in 1 year old fish. In addition, since there are some specimens for which sex was unable to be determined up to age 3 years, there are believed to be considerable individual differences in the sexual differentiation (gonad development) of this species.

Table 5-1-4-81 Total Length and Body Weight by Age and Sex of Common Sole

Season	Age	Range of TL (Mean TL) in mm			Range of BW (Mean BW) in g		
		♂	♀	?	♂	♀	?
Spring	1	271			143		
	2	303~314(308)			235~263(249)		
	3	238	342		100	284	
	4		293~306(299)			190~230(210)	
Summer	0			139			18
	1	152	180	180~190(185)	26	37	32~ 38(35)
	2	196~223(207)	192~221(207)	194~209(202)	49~ 82(64)	48~ 79(61)	46~ 67(57)
	3	210~233(219)	215~238(223)	212~222(216)	61~ 91(75)	66~ 97(78)	57~ 82(70)
	4		225~274(243)			93~151(112)	
Autumn	3	320			257		
	5		294			206	
Winter	2	202~219(208)	192		61~ 82(74)	60	
	3	232~245(238)	276		79~110(95)	170	
	4		261~281(271)			130~164(147)	
	5		300			213	
	6		335			309	

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 5-1-4-82. 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 indicating the state of gonad following spending. Furthermore, all specimens obtained in the North Aegean Sea were males.

Although sex ratios demonstrated values of 1 or less or 1 or more according to the season and sub area, the number of females appeared to be greater in the case of looking at all seasons. The female maturity rates and percentages of females that released eggs in The Sea of Marmara and the East Mediterranean Sea were summarized as shown below.

The Sea of Marmara:	Spring 0 (48)%	Summer 0 (100)%
	Autumn 17 (23)%	Winter 40 (0)%
East Mediterranean Sea:	Spring 0 (100)%	Summer 0 (100)%
	Autumn 100 (0)%	Winter 0 (0)%

Figures in parentheses indicate the percentage of spent females.

Based on the female maturity rates, the spawning period of this species is predicted to be from winter to spring in The Sea of Marmara, and in autumn in the East Mediterranean Sea. Based on the percentages of females that released eggs, there are two possibilities that can be considered, namely that spawning of this species occurs intermittently, and that redevelopment of ovaries following spawning takes a long period of time. Additional surveys and research are felt to be required in the future to further clarify these predictions.

Table 5-1-4-82 Sex Ratios and Female Maturity Stages of Common Sole

Season	Sub area	Stratum (m)	* Maturity stage of ♀				♂	Sex ratios
			I	II	III	Total		♀/♂
Spring	The Sea of Marmara	20~100	32	0	0	61	29	2.10
	North Aegean Sea	20~100	0	0	0	0	137	0
	East Mediterranean Sea	20~100	0	0	0	142	71	2.00
	All area	20~100	16	0	0	66	66	1.00
Summer	The Sea of Marmara	20~100	0	0	0	56	0	–
	East Mediterranean Sea	20~100	0	0	0	705	223	3.16
	All area	20~100	0	0	0	596	186	3.20
Autumn	The Sea of Marmara	20~100	27	8	0	47	60	0.78
	North Aegean Sea	20~100	0	0	0	0	57	0
	East Mediterranean Sea	20~100	0	41	0	41	0	–
	All area	20~100	22	10	0	42	54	0.78
Winter	The Sea of Marmara	20~100	24	9	8	42	42	1.00
	East Mediterranean Sea	20~100	71	0	0	71	0	–
	All area	20~100	32	7	7	46	35	1.31

* 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 5-1-4-83.

All specimens age 4 years and older were females, and there were no males observed in these age groups. This finding may suggest that the life span of this species is as long as 6 years female, and as short as 3 years among males. In addition, although the mature age of this species may be as early as 1 year, there were individual differences observed regarding this as was previously mentioned.

Table 5-1-4-83 Sex Ratios and Female Maturity Stages by Season and Age of Common Sole

Season	Age	* Maturity stage of ♀				♂	Sex ratios
		I	II	III	Total		♀/♂
Spring	1	0	0	0	0	14	0
	2	0	0	0	0	34	0
	3	0	0	0	14	17	0.82
	4	0	0	0	35	0	—
Summer	1	0	0	0	34	11	3.09
	2	0	0	0	215	86	2.50
	3	0	0	0	260	76	3.42
	4	0	0	0	44	0	—
Autumn	3	0	0	0	0	5	0
	5	0	3	0	3	0	—
Winter	2	7	0	0	7	21	0.33
	3	11	0	0	11	14	0.79
	4	13	0	0	13	0	—
	5	0	0	7	7	0	—
	6	0	7	0	7	0	—

4) Age Composition

The age composition of this species by season, sub area and strata is shown in Table 5-1-4-84.

The maximum age of specimens of this species was 6 years. The major components of age composition in each season are most likely 2 and 3 year old fish.

Table 5-1-4-84 Age Composition of Common Sole

Season	Sub area	Stratum (m)	Age						
			0	1	2	3	4	5	6
Spring	The Sea of Marmara	20~100		29		29			
	North Aegean Sea	20~100			137				
	East Mediterranean Sea	20~100				71	142		
	All area	20~100		14	34	32	35		
Summer	East Mediterranean Sea	20~100	15	145	607	579	57		
Autumn	North Aegean Sea	20~100				57			
	East Mediterranean Sea	20~100						41	
	All area	20~100				5		3	
Winter	The Sea of Marmara	20~100			34	17	16	8	9
	East Mediterranean Sea	20~100				71			
	All area	20~100			28	26	13	7	7

5) Feeding habits

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

Spring:
No. of specimens: 8
Empty stomach rate: 88%

Polychaetes: 100%

Summer:
No. of specimens: 66
Empty stomach rate: 85%

Crustaceans: 80.0%, Polychaetes: 30.0%, Mollusks: 10.0%

Autumn:
No. of specimens: 23
Empty stomach rate: 78%

Echinoderms: 80.0% (incl. 20.0% starfishes and 60% brittle stars), Unknown: 20.0%

Winter:
No. of specimens: 11
Empty stomach rate: 82%

Polychaetes: 100%, Echinoderms: 50.0%

Based on these findings, this species was found to feed on small benthic animals, and is mainly dependent on polychaetes, crustaceans and echinoderms. In addition, since the empty stomach rates were high at roughly 80-90% throughout all seasons, this species is believed to be nocturnal and feed during the night.

(19) Deep-Water Pink Shrimp *Parapenaeus longirostris*

1) Size composition

All data relating to the size composition of this species was obtained from size measurements of biological surveys. The total length range and mean values of this species are shown in Table 5-1-4-85.

The total length of this species was within a range of 4-20 cm throughout all seasons. The mean total length of this species was 10-11 cm, and there were no seasonal changes. The mean total length of this species in The Sea of Marmara tended to be dependent on water depth, with that at depths of 201 m or more tending to be larger than that at depths of 200 m or less.

Table 5-1-4-85 Total Length Range and Mean Total Length of Deep-Water Pink Shrimp

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

The size composition of this species in all areas demonstrated a mono-modal distribution pattern in spring and autumn, and a bi-modal distribution pattern in summer and winter. The modes of size composition in each season consisted of 11-12 cm in spring, 9-10 cm and 11-13 cm in summer, 11-12 cm in autumn, and 10-11 cm and 12-13 cm in winter (Fig. 5-1-4-37).

2) Relationship Between Body Length and Body Weight

The relationship between total 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. 5-1-4-38.

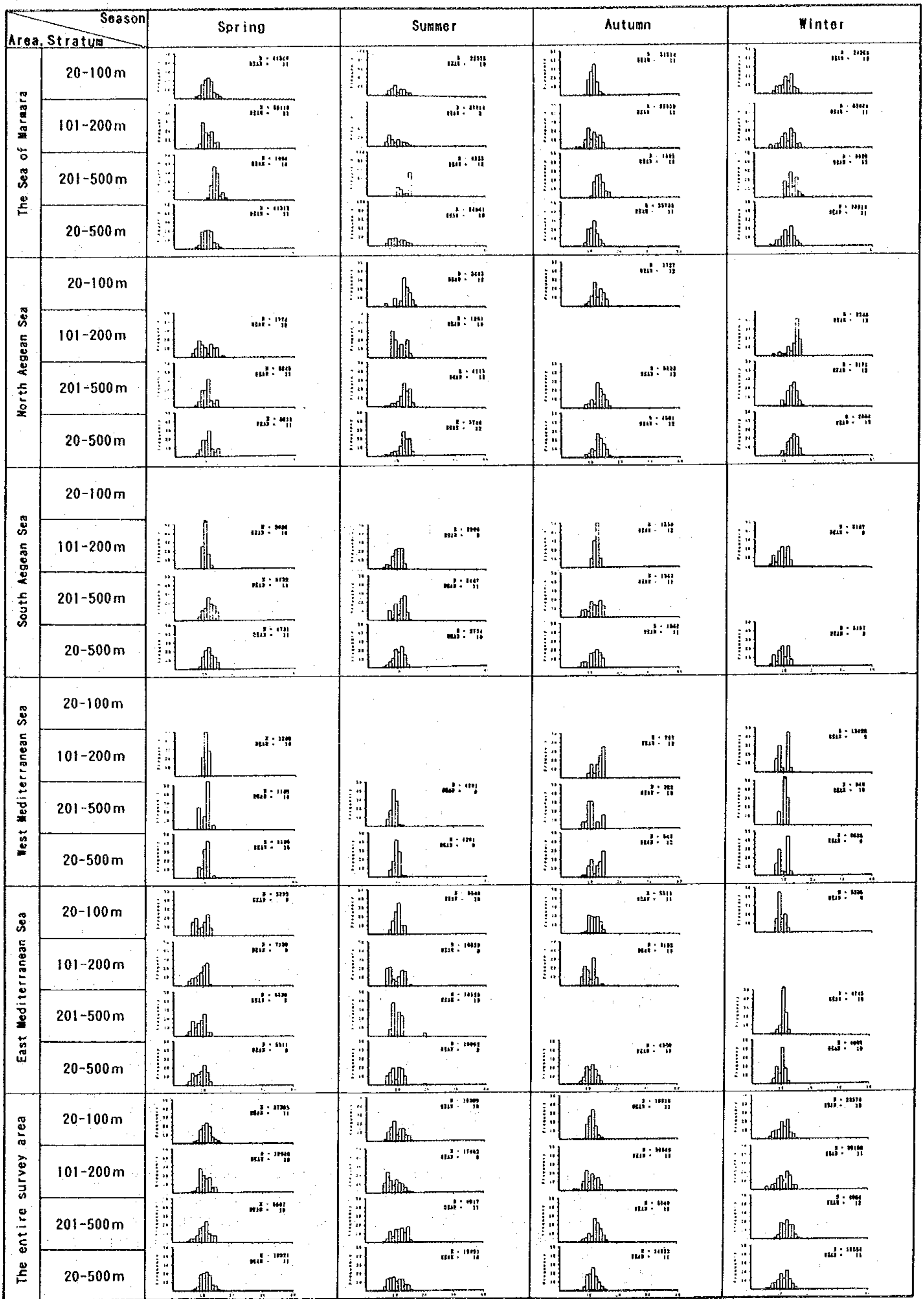


Fig.5-1-4-37 Size composition (TL) of deep-water pink shrimp *Parapenaeus longirostris* by sub areas, strata and seasons

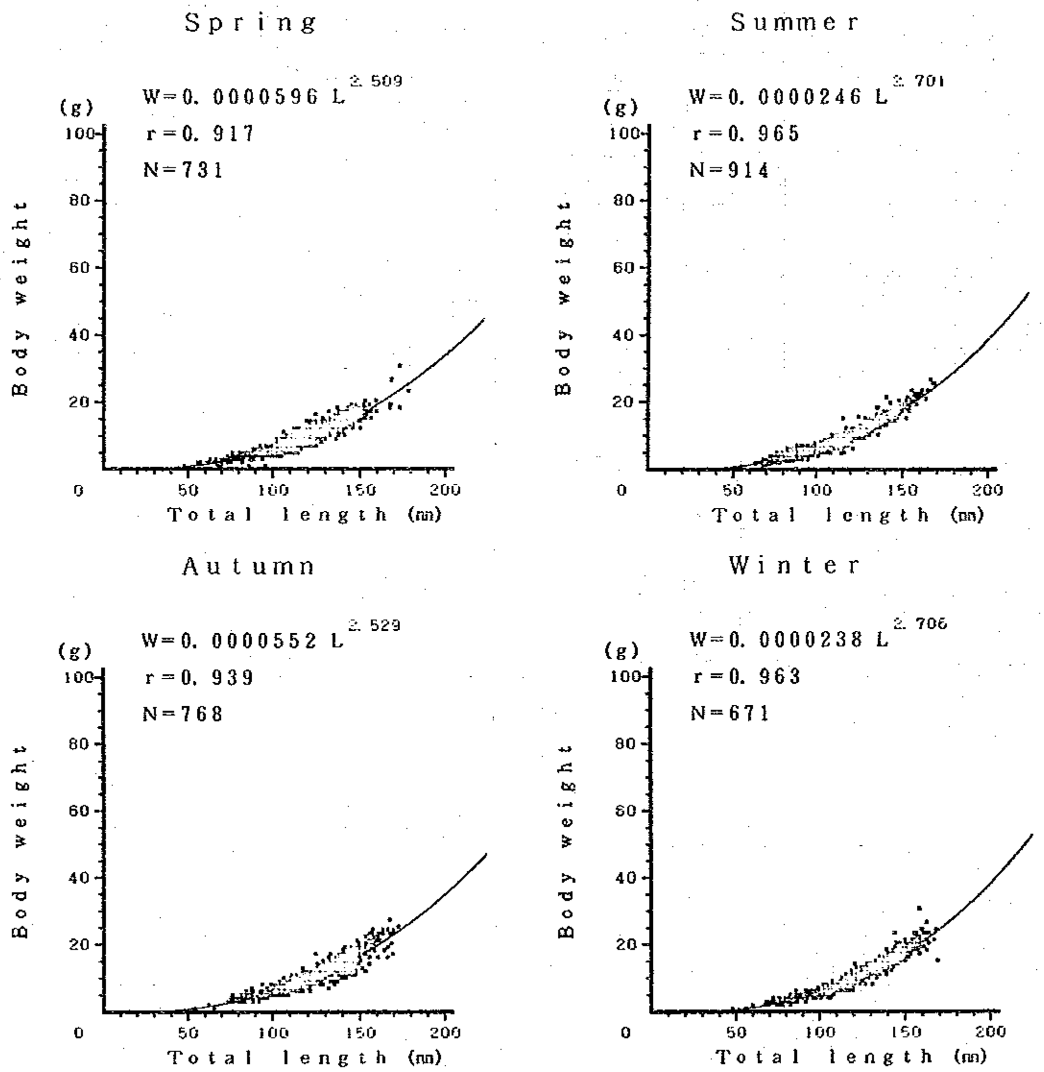


Fig. 5-1-4-38 Relationship Between Total Length and Body Weight of Deep-Water Pink Shrimp

The total length and body weight of this species by season and sex, along with their means, are shown in Table 5-1-4-86. Furthermore, identification of males and females of this species was not performed in the first round of this survey conducted in summer.

The size of female deep-water pink shrimp was found to be larger than that of males. Although females grew to roughly a total length of 18 cm and body weight of 40 g, the growth of males stopped at about a total length of 16 cm and body weight of 20 g.

Table 5-1-4-86 Total Length and Body Weight by Sex of Deep-Water Pink Shrimp

Season	Range of TL (Mean TL) in mm			Range of BW (Mean BW) in g		
	♂	♀	?	♂	♀	?
Spring	55~151(97)	47~175(116)		1~ 16(6)	1~ 42(10)	
Autumn	72~156(102)	53~169(125)		3~ 21(7)	1~ 27(12)	
Winter	58~153(101)	66~165(125)	47~ 70(57)	2~ 20(7)	2~ 30(12)	1~ 3(2)

3) Sex Ratios

The sex ratios of this species by season, sub area and strata are shown in Table 5-1-4-87. 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.

The number of females was approximately twice the number of males in all areas and throughout all seasons.

Onboard observation and measurement of the maturity stages of female gonads, important data for determination of the spawning period of this species, were unable to be performed. Therefore, the spawning period of this species was predicted by focusing on size composition, and particularly on the occurrence of juvenile shrimp having a body length of 10 cm or less believed to have recently spawned. Since a bi-modal distribution pattern was observed, having a single mode within a range of 6-9 cm, and another mode at a class of 10 cm or more depending on the sub-area in each season, the spawning period of this species is believed to most likely extend throughout the year.

Determination of the peak spawning period of this species, along with clarification of differences in those periods depending on the area will have to wait until the conducting of additional surveys and research in the future.

Table 5-1-4-87 Sex Ratios of Deep-Water Pink Shrimp

Season	Sub area	Stratum (m)	♀	♂	Sex ratios ♀/♂
Spring	The Sea of Marmara	20~100	29,132	15,216	1.92
		101~200	58,741	26,369	2.23
		201~500	944	62	15.23
		20~500	27,548	13,769	2.00
	North Aegean Sea	101~200	580	555	1.05
		201~500	4,231	4,016	1.05
		101~500	2,862	2,718	1.05
	South Aegean Sea	101~200	2,696	0	—
		201~500	5,475	310	17.66
		101~500	4,548	207	21.97
	West Mediterranean Sea	101~200	1,209	0	—
		201~500	1,011	178	5.68
		101~500	1,110	89	12.47
	East Mediterranean Sea	20~100	1,735	616	2.82
		101~200	5,356	1,785	3.00
		201~500	4,011	2,531	1.59
		20~500	3,745	1,771	2.12
	All area	20~100	24,917	12,970	1.92
		101~200	13,653	5,797	2.36
		201~500	3,683	1,830	2.01
		20~500	13,318	6,560	2.03
Autumn	The Sea of Marmara	20~100	20,996	10,522	2.00
		101~200	68,094	24,777	2.75
		201~500	1,328	269	4.94
		20~500	23,342	10,372	2.25
	North Aegean Sea	20~100	1,378	352	3.92
		201~500	4,274	1,261	3.39
		20~500	3,383	982	3.45
	South Aegean Sea	101~200	1,350	0	—
		201~500	941	429	2.19
		101~500	1,022	343	2.98
	West Mediterranean Sea	101~200	767	0	—
		201~500	296	25	11.84
		101~500	531	12	44.25
	East Mediterranean Sea	20~100	4,883	629	7.76
		101~200	2,912	221	13.18
		20~200	4,095	466	8.79
	All area	20~100	13,536	6,383	2.12
		101~200	24,021	8,332	2.88
		201~500	2,736	818	3.35
		20~500	10,519	4,310	2.44
Winter	The Sea of Marmara	20~100	17,197	7,603	2.26
		101~200	48,189	29,506	1.63
		201~500	5,079	1,760	2.89
		20~500	20,177	10,139	1.99
	North Aegean Sea	101~200	1,913	338	5.66
		201~500	2,184	988	2.21
		101~500	2,124	843	2.52
	South Aegean Sea	101~200	2,694	475	5.67
	East Mediterranean Sea	101~200	3,665	1,571	2.33
		201~500	1,821	2,926	0.62
		101~500	2,436	2,474	0.99
	All area	20~100	16,231	7,172	2.26
		101~200	19,222	11,268	1.71
		201~500	2,628	1,388	1.89
		20~500	11,862	5,960	1.99

4) Age and Feeding Habits

Since data relating to the age and feeding habits of this species was unable to be obtained from this survey, the following provides a summary of general information pertaining to Penaeid shrimps - prawns taken from existing references.

Age: The majority of Penaeid shrimps - prawns have a life span of 1-2 years.

Feeding habits: Although juvenile shrimp in which mouth parts have developed become carnivorous, consuming putrefied flesh and the flesh of shellfish, they frequently become cannibalistic when there is an insufficient supply of food.

(20) Norway Lobster *Nephrops norvegicus*

1) Size composition

All data relating to the size composition of Norway lobster was obtained from size measurements of biological surveys. The total length range and mean values of this species are shown in Table 5-1-4-88.

The total length of Norway lobster was within a range of 4-22 cm throughout all seasons. The mean total length was within a range of 11-12 cm throughout all seasons, and there were no seasonal fluctuations observed.

Table 5-1-4-88 Total Length Range and Mean Total Length of Norway Lobster

Sub area	Stratum (m)	Range of TL (Mean TL) in cm			
		Spring	Summer	Autumn	Winter
North Aegean Sea	20~100			9~17 (13)	
	101~200	5~19 (12)			5~18 (10)
	201~500	6~22 (11)	7~20 (12)	4~19 (11)	4~20 (12)
	20~500	5~22 (11)	7~20 (12)	4~19 (11)	4~20 (12)
South Aegean Sea	201~500	8~16 (12)	7~19 (12)	8~18 (12)	7~16 (10)
All area	20~100			9~17 (13)	
	101~200	5~19 (12)			5~18 (10)
	201~500	6~22 (11)	7~20 (12)	4~19 (11)	4~20 (11)
	20~500	5~22 (11)	7~20 (12)	4~19 (11)	4~20 (11)

The size composition of Norway lobster in all areas demonstrated a poly-modal distribution pattern in spring, a bi-modal pattern in summer, a mono-modal pattern in autumn, and a bi-modal pattern in winter. The modes of the distribution of size composition in spring appeared to consist of 6-7 cm, 8-9 cm, 11-12 cm and 13-14 cm. The modes in summer consist of 8-9 cm and 13-14 cm, that in autumn consists of 10-11 cm, and those in winter consist of 9-10 cm and 15-16 cm. The small-sized group having a mode at 10 cm or less most likely reflects the stock size of juvenile lobster, while the medium and large-sized groups having modes at 10 cm or larger probably reflect the stock size of parent lobster (Fig. 5-1- 4-39).

2) Relationship Between Body Length and Body Weight

The relationship between total length (X) and body weight (Y) for the total number of males and females of Norway lobster 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. 5-1-4-40.

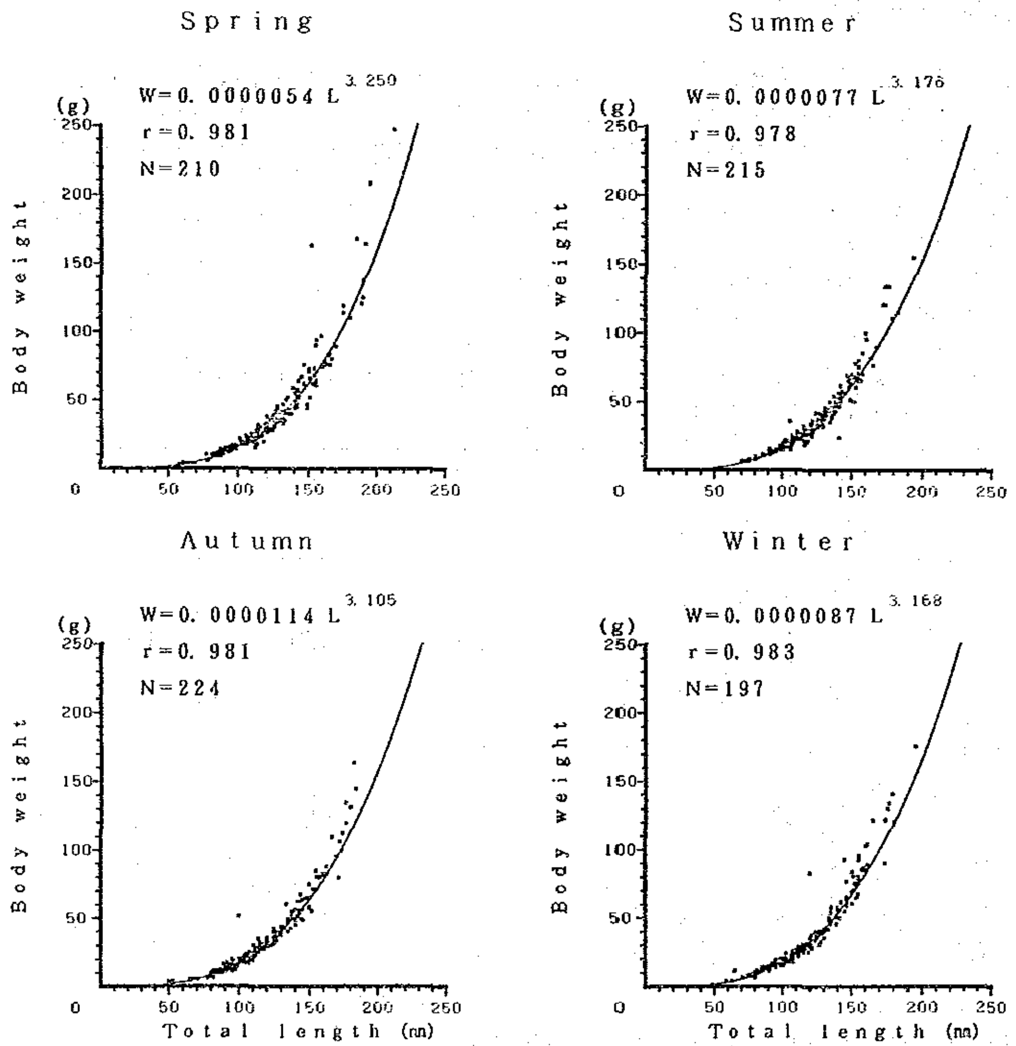


Fig. 5-1-4-40 Relationship Between Total Length and Body Weight of Norway Lobster

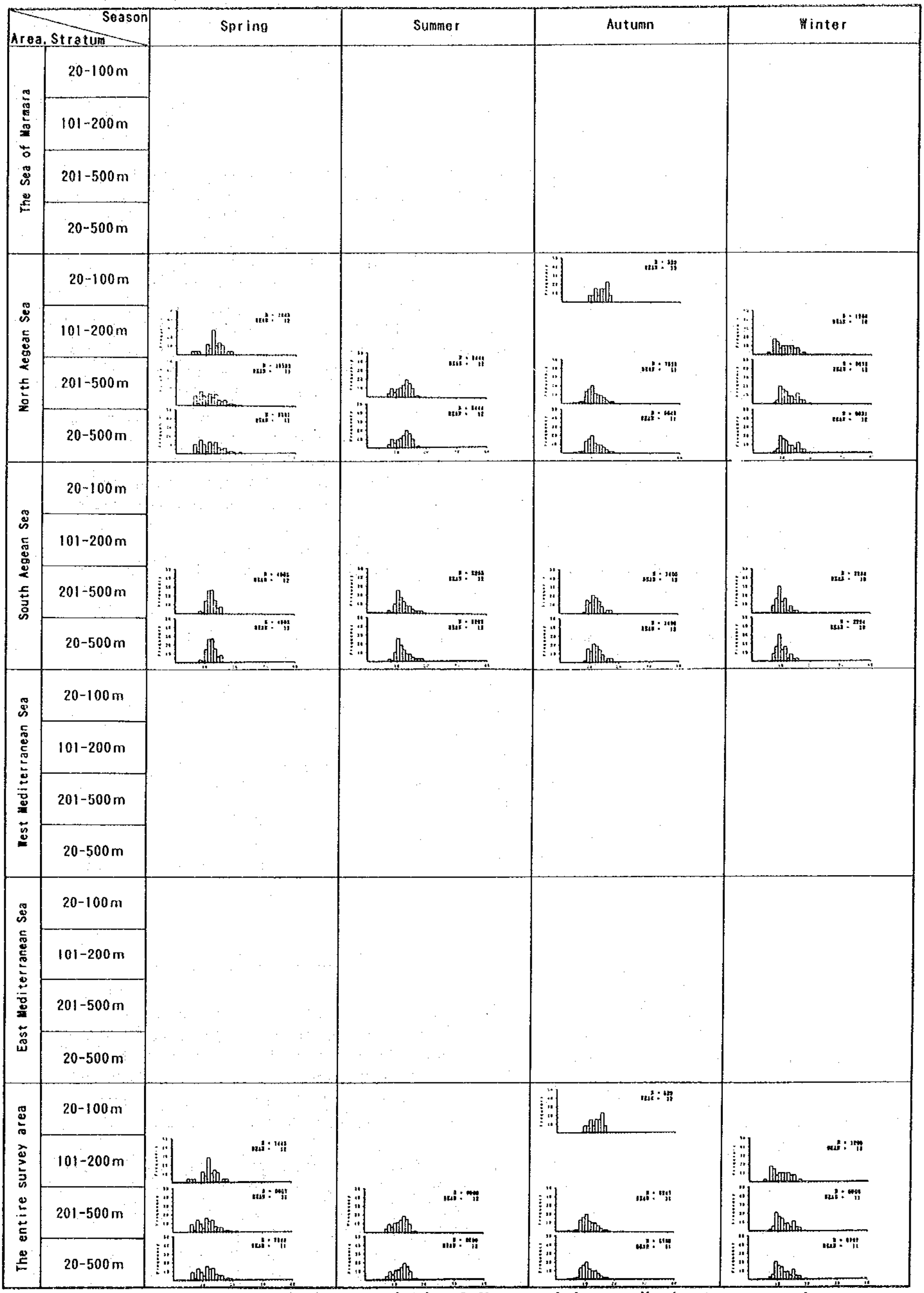


Fig. 5-1-4-39 Size composition (TL) of Norway lobster *Nephrops norvegicus* by sub areas, strata and seasons

The total length and body weight of Norway lobster by season and sex, along with their means, are shown in Table 5-1-4-89. Furthermore, the sex of this species was not identified in the first round of this survey in summer.

Although females were larger in spring, this trend was reversed in autumn and winter, with the size of males being larger in those seasons. The size of males was larger in winter than in autumn. This result suggests that, although females that finished spawning in winter grow faster than males from winter to spring and probably into summer to prepare for the next spawning period, during the period from autumn to winter, which corresponds to the incubation period of fertilized eggs following doing coitus, the growth of females stops since they are unable to molt their shells. On the other hand, during this same period, males repeatedly molt their shells and continue to grow. In addition, large males and females of roughly 20 cm presented in the spring were no longer observed in autumn. It is unclear as to whether this result was caused by the deaths of larger individuals from spring to autumn, or sampling errors in both seasons.

Table 5-1-4-89 Total Length and Body Weight by Sex of Norway Lobster

Season	Range of TL (Mean TL) in mm		Range of BW (Mean BW) in g	
	♂	♀	♂	♀
Spring	61~191(122)	58~213(127)	4~163(38)	3~247(47)
Autumn	53~184(120)	50~156(108)	4~164(40)	4~ 81(26)
Winter	63~195(122)	49~177(104)	4~176(45)	2~134(24)

3) Sex Ratios

The sex ratios of Norway lobster by season, sub area and strata are shown in Table 5-1-4-90.

The sex ratios for each season were 0.62 in spring, 0.57 in autumn and 0.48 in winter. The number of males was greater than the number of females in each season, the proportion of the total increased slightly from spring to autumn, demonstrating values of 62%, 64% and 68%. In addition, the number of females was larger than the number of males in the North Aegean Sea at depths of 200 m or less.

Since the majority of female specimens in autumn, and probably 90% or more, were incubating eyed eggs in their abdomen, and a few females were incubating eyed eggs in winter, it probably safe to assume that the spawning period of this species is in winter. The mode having a class of 6-7 cm within body length composition in the North Aegean Sea in spring reflects the stock size of juvenile lobsters immediately after being anchored on bottom that originated from larvae that hatched in winter.

Table 5-1-4-90 Sex Ratios of Norway Lobster

Season	Sub area	Stratum (m)	♀	♂	Sex ratios ♀/♂
Spring	North Aegean Sea	101～200 201～500	732 4,170	314 6,424	2.33 0.65
		101～500	3,310	4,897	0.68
	South Aegean Sea	201～500	1,348	3,456	0.39
	All area	101～200 201～500	732 3,229	314 5,435	2.33 0.59
		101～500	2,775	4,504	0.62
Autumn	North Aegean Sea	20～100 201～500	326 2,616	204 4,716	1.60 0.56
		20～500	2,387	4,265	0.56
	South Aegean Sea	201～500	582	818	0.71
	All area	20～100 201～500	326 2,246	204 4,007	1.60 0.56
		20～500	2,086	3,690	0.57
Winter	North Aegean Sea	101～200 201～500	701 3,449	502 7,614	1.40 0.45
		101～500	2,762	5,836	0.47
	South Aegean Sea	201～500	797	1,500	0.53
	All area	101～200 201～500	701 2,786	502 6,085	1.40 0.46
		101～500	2,369	4,969	0.48

4) Age and Feeding habits

The age (life span) and feeding habits of Norway lobster as well as other Nephropsidae species of lobsters are unknown since references relating to the age and feeding habits were unable to be compiled at the present time.

The life span of this species is most likely one year or more up to several years. In addition, this species is probably carnivorous, consuming both putrefied flesh and shellfish as other species of Reptantia such as spiny lobster.

(21) Horned Octopus *Eledone cirrhosa*

1) Size Composition

All data relating to the size composition of this species was obtained from size measurements of biological surveys. The mantle length range of this species along with those mean values are shown in Table 5-1-4-91.

The mantle length of this species was within a range of 1-14 cm throughout all seasons. The mean mantle length of this species was smaller in autumn at 3 cm, and within a range of 5-7 cm from winter to summer.

Table 5-1-4-91 Mantle Length Range and Mean Mantle Length of Horned Octopus

Sub area	Stratum (m)	Range of ML (Mean ML) in cm			
		Spring	Summer	Autumn	Winter
North Aegean Sea	20~100	6~11 (8)	3~14 (7)		5~ 9 (6)
	101~200	5~ 8 (6)	1~12 (6)	2~ 5 (3)	4~ 8 (6)
	201~500	5~12 (6)	1~11 (4)	3~ 4 (3)	2~ 9 (4)
	20~500	5~12 (7)	1~14 (6)	2~ 5 (3)	2~ 9 (5)
South Aegean Sea	101~200		7~11 (9)		
	201~500	5~10 (6)	1~11 (7)		
	101~500	5~10 (6)	1~11 (8)		
All area	20~100	6~11 (8)	3~14 (7)		5~ 9 (6)
	101~200	5~ 8 (6)	1~12 (6)	2~ 5 (3)	4~ 8 (6)
	201~500	5~12 (6)	1~11 (5)	3~ 4 (3)	2~ 9 (4)
	20~500	5~12 (7)	1~14 (6)	2~ 5 (3)	2~ 9 (5)

The distribution pattern of size composition of this species in all areas was mono-modal in spring (mode: 6-7 cm), poly-modal in summer (modes: 2-3 cm, 5-6 cm and 7-8 cm), mono-modal in autumn (mode: 3-4 cm) and bi-modal in winter (modes: 3-4 cm and 5-7 cm). The modes representing a mantle length of 5 cm or more reflect the stock size of young and adult octopuses, while the modes representing a mantle length of 5 cm or less reflect the stock size of larval octopuses. The entire stock size of this species in autumn consisted of larvae (Fig. 5-1-4-41).

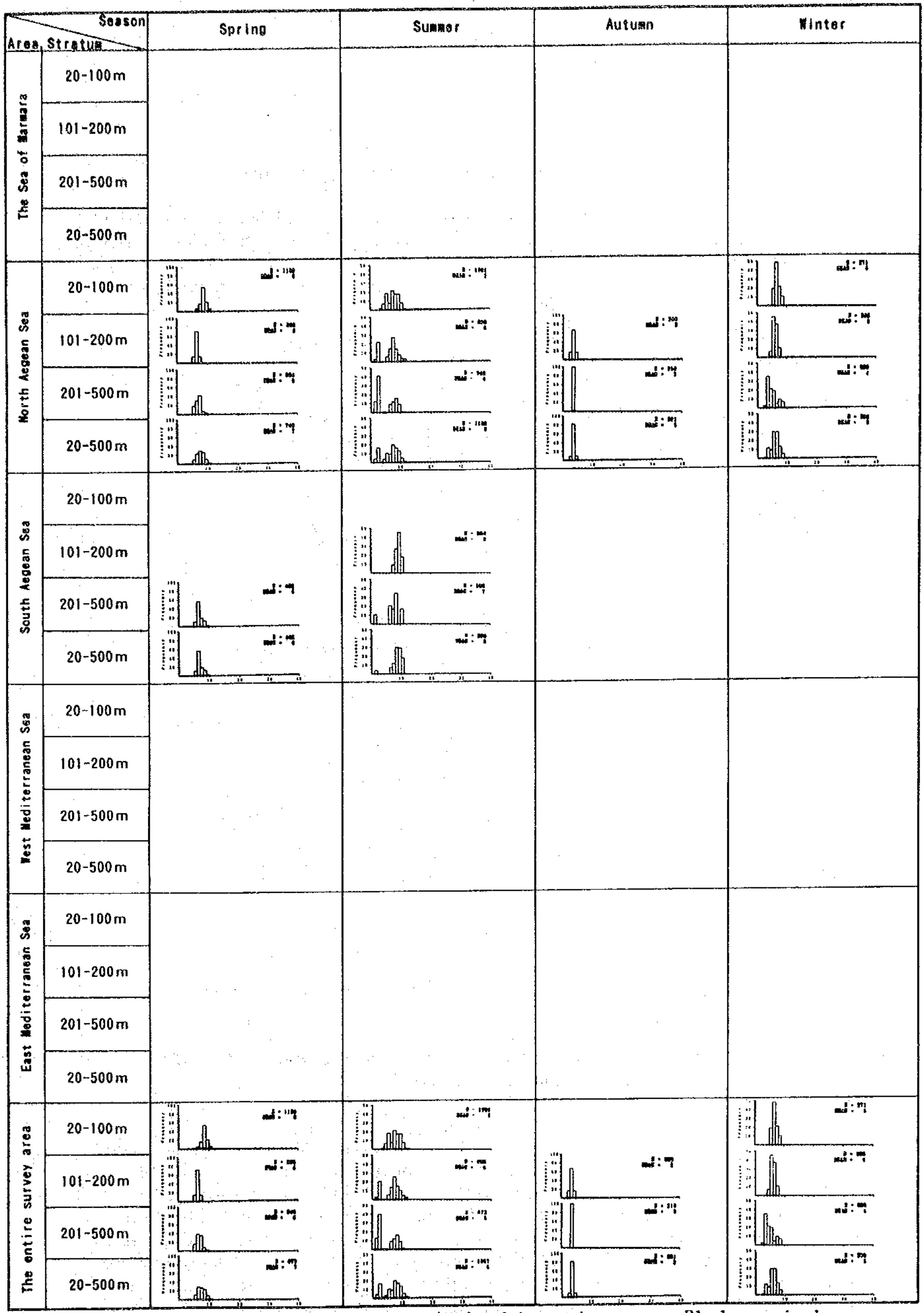


Fig.5-1-4-41 Size composition (ML) of horned octopus *Eledone cirrhosa* by sub areas, strata and seasons

2) Relationship Between Body Length and Body Weight

The relationship between mantle 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. 5-1-4-42.

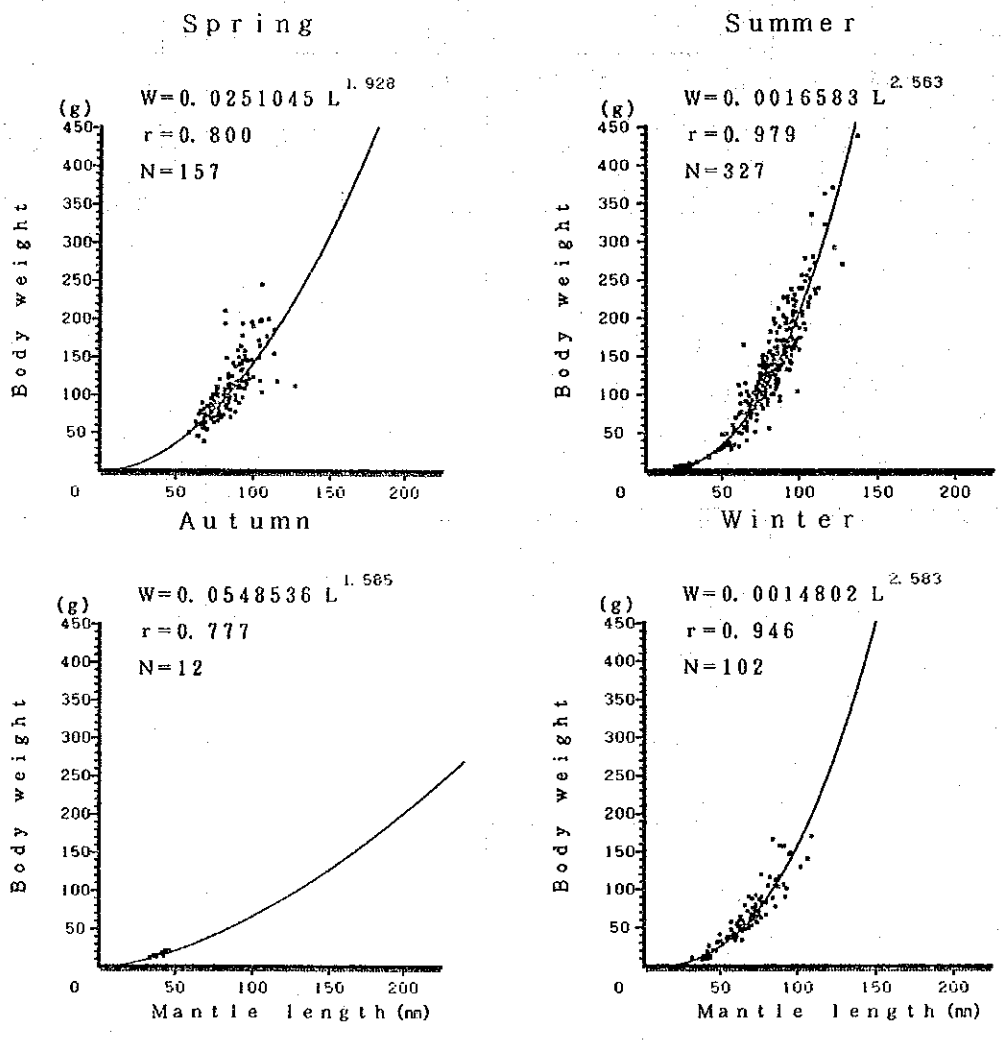


Fig. 5-1-4-42 Relationship Between Mantle Length and Body Weight of Horned Octopus

The mantle length and body weight of this species by season and sex, along with their means, are shown in Table 5-1-4-92.

Although there were no differences in growth between males and females in autumn, females were larger than males in the other three seasons. The difference in body weight between males and females was particularly large in summer, with females weighing roughly 40 g more than males on average. The size of males and females sequentially increased from autumn to winter and from spring to summer. Larval octopuses having a mantle length of roughly 2-3 cm appeared from summer to winter. In addition, there were no individuals having a mantle length of 5 cm or more observed in autumn as was previously mentioned. An estimate of the life history of this species was summarized as shown below based on these results.

It is thought that females of this species spawn fertilized eggs within their ovaries and then die. Males most likely die following mating. After the hatched larvae live planktonic life for roughly one to one and a half years, corresponding to the period from summer to winter of the following year, they become anchored on the bottom and continue to grow there. They are thus thought to mature in the summer of their second year. The spawning population of that year most originates in the larval population that hatched two years earlier. The reason for the rapid increase in body weight of females in summer is due to broad-ranging development of reproductive functions including ovary development following fertilization.

Table 5-1-4-92 Mantle Length and Body Weight by Sex of Horned Octopus

Season	Range of ML (Mean ML) in mm			Range of BW (Mean BW) in g		
	♂	♀	?	♂	♀	?
Spring	52~ 89(72)	56~113(75)	75~ 80(78)	39~211(102)	46~245(109)	100~113(108)
Summer	17~120(72)	19~134(76)	17~ 93(24)	28~292(106)	18~438(135)	2~238(9)
Autumn	30~ 41(35)	34~ 40(37)		12~ 22(17)	13~ 20(16)	
Winter	37~ 84(59)	28~ 97(60)		10~166(64)	9~170(67)	

3) Sex Ratios

The sex ratios of this species by season, sub area and strata are shown in Table 5-1-4-93.

The sex ratios of this species in all areas were 0.50 in winter, indicating a large number of males, and 1.57-1.90 in the other seasons, indicating a large number of females. Rather than these findings indicating that this species is hermaphroditic in the autumn with males maturing faster than females, while a large number of those males then undergo sex reversal starting in winter, they are believed to be the result of sampling errors in autumn since the number of specimens in autumn was only 12 while that of the other three seasons was 100 or more. Thus, the number of females is probably larger than the number of males throughout all seasons.

Table 5-1-4-93 Sex Ratios of Horned Octopus

Season	Sub area	Stratum (m)	♀	♂	Sex ratios ♀/♂
Spring	North Aegean Sea	20～100	597	378	1.58
		101～200	593	0	—
		201～500	324	244	1.33
		20～500	437	268	1.63
	South Aegean Sea	201～500	263	200	1.32
	All area	20～100	597	378	1.58
		101～200	593	0	—
		201～500	301	228	1.32
		20～500	393	251	1.57
Summer	North Aegean Sea	20～100	1,246	533	2.34
		101～200	436	339	1.29
		201～500	327	191	1.71
		20～500	641	335	1.91
	South Aegean Sea	101～200	454	101	4.50
		201～500	35	107	0.33
		101～500	140	106	1.32
	All area	20～100	1,246	533	2.34
		101～200	438	312	1.40
		201～500	276	176	1.57
		20～500	586	309	1.90
Autumn	North Aegean Sea	101～200	85	169	0.50
		201～500	70	140	0.50
		101～500	77	154	0.50
Winter	North Aegean Sea	20～100	233	38	6.13
		101～200	165	141	1.17
		201～500	186	139	1.34
		20～500	192	109	1.76
	South Aegean Sea	101～200	117	0	—
	All area	20～100	233	38	6.13
		101～200	157	117	1.34
		201～500	186	139	1.34
		20～500	187	101	1.85

4) Age and Feeding Habits

As was mentioned previously, the life span of this species is most likely 2 years, including a planktonic life extending for one year or more.

Although the larvae of cephalopods such as squid and octopus typically grow into juvenile forms by consuming small copepods and their nauplius larvae, since they feed on amphipods, small shrimps, crabs, opposum shrimps and small fishes after they grow into juvenile forms, the feeding habits of this species are probably also dependent on similar food.

5-1-5 Mesh Selectivity Experiment

5-1-5 Mesh Selectivity Experiment

It is necessary to determine the fishing mortality coefficient by length class when evaluating the resources of commercially important species. Therefore, as a result of conducting mesh selectivity experiments over the three seasons of spring, autumn and winter, the relationship between body length and mesh selectivity was obtained for 10 species of fish. The total number of fish and body length range for each species and each cod end mesh size that were used in the study of mesh selectivity are shown in Table 5-1-5-1.

Mesh selectivity was determined in the form of the proportion of the total catch of the cod end with respect to the total catch of the cod end and cover net (retention rate) by species and mesh size for each length class in cm. Furthermore, after standardizing the catch to the catch per unit area, the total value for each of the three seasons was determined.

The length that indicates a 50% retention rate by species and cod end mesh size (referred to as the "length at 50% retention " L_{50}) was obtained by plotting the retention rates on the normal probability paper at each length class and drawing a straight line through each point to represent the average of those points. L_{50} was then read from the graph. Moreover, the standard deviation ($L\sigma$) was also read from the normal probability paper and fit to a frequency function $f(z)$ of retention rate per 1 cm of body length by applying to the formula indicated below.

$$f(z) = \frac{1}{L\sigma\sqrt{2\pi}} e^{-(z-L_{50})^2/(2 \cdot L\sigma^2)}$$

where:

z : Body length (total length: TL cm, fork length: FL cm)
L_{50} : Length at 50% retention
$L\sigma$: Standard deviation

The normalized mesh selectivity rate for each length class is obtained by cumulating the frequency functions $f(z)$ at each length class. The curve of mesh selectivity is obtained by plotting the mesh selectivity for each body length.

Generally the mesh selectivity curve may be obtained by simply connecting the mesh selectivity for each body length when majority of catch by one trawling operation. In this survey, however, since a mixture of numerous fish and sea weeds, etc., were often present in trawl net, it was difficult to determine a direct mesh selectivity curve from the actually measured values per haul. Consequently, the mesh selectivity curve was illustrated graphically based on the results of the above calculation.

Table 5-1-5-1 Summary of Mesh Selectivity Experiment

Species	Mesh size	50 mm	70 mm	90 mm	110 mm
Merluccius merluccius	Total catch	95,852	127,102	13,899	18,404
	T L (cm)	(7~75)	(8~78)	(15~47)	(17~39)
Serranus cabrilla	Total catch	28,250	0	10,862	0
	F L (cm)	(10~22)	–	(13~21)	–
Trachurus trachurus	Total catch	121,694	202,848	45,728	18,469
	F L (cm)	(8~25)	(8~30)	(7~26)	(10~24)
Mullus barbatus	Total catch	171,997	225,720	64,323	0
	F L (cm)	(8~23)	(7~24)	(9~22)	–
Mullus surmuletus	Total catch	3,651	0	0	2,076
	F L (cm)	(9~26)	–	–	(12~24)
Dentex macrophthalmus	Total catch	4,284	41,058	11,012	0
	F L (cm)	(11~21)	(9~22)	(7~20)	–
Diplodus annularis	Total catch	17,079	41,753	9,321	0
	F L (cm)	(9~19)	(8~17)	(10~17)	–
Pagellus erythrinus	Total catch	8,847	53,466	9,088	0
	F L (cm)	(9~26)	(8~26)	(11~26)	–
Pagellus acarne	Total catch	32,555	58,638	0	0
	F L (cm)	(11~22)	(8~20)	–	–
Pagellus bogaraveo	Total catch	3,884	4,490	2,790	0
	F L (cm)	(11~17)	(11~15)	(10~14)	–

(1) L_{50} by Species and Cod End Mesh Size

L_{50} and L σ of each species are shown in Table 5-1-5-2. The mesh selectivity curves of each species obtained based on that data are shown in Figs. 5-1-5-1 to 5-1-5-10.

Table 5-1-5-2 L_{50} and L σ Values (cm) By Species and Cod End Mesh Size

Species \ Mesh size	50 mm	70 mm	90 mm	110 mm
Merluccius merluccius	20.0 (4.0)	26.0 (7.0)	35.0 (4.0)	36.5 (7.5)
Serranus cabrilla	20.5 (7.5)	—	—	—
Trachurus trachurus	16.5 (3.5)	17.5 (3.5)	—	27.5 (6.0)
Mullus barbatus	16.5 (2.5)	20.0 (4.0)	23.0 (4.5)	—
Mullus surmuletus	16.0 (2.0)	—	—	—
Dentex macrophthalmus	13.0 (2.0)	15.5 (2.5)	19.0 (4.0)	—
Diplodus annularis	12.0 (1.5)	15.0 (2.0)	18.0 (4.5)	—
Pagellus erythrinus	14.0 (2.0)	16.5 (3.0)	17.5 (4.0)	—
Pagellus acarne	14.5 (2.0)	15.0 (3.0)	—	—
Pagellus bogaraveo	15.0 (1.5)	—	—	—

Notes:
The upper rows of numbers for each species indicate L_{50}, while the lower rows of numbers in parentheses indicate L σ. "-" indicates these species that were not sampled in the mesh selectivity experiment.

1) **Hake** ***Merluccius merluccius***

L_{50} of hake was obtained from all four types of cod end mesh sizes at which the mesh selectivity experiment was carried out.

L_{50} for each mesh size consisted of 20.0 cm at mesh size of 50 mm, 26.0 cm at 70 mm, 35.0 cm at 90 mm and 36.5 cm at 110 mm. The mesh selectivity curve was close to the shape of a knife edge at mesh size of 50 mm. Also the retention rate and the mesh selectivity curve were well adjusted. On the other hand, the mesh selectivity curve was smooth larger than the mesh size 70 mm the variance of the retention rate was getting wider against the selectivity curve. The results suggest that the mesh size larger than 70 mm will cause decrease in the fishing efficiency for this species.

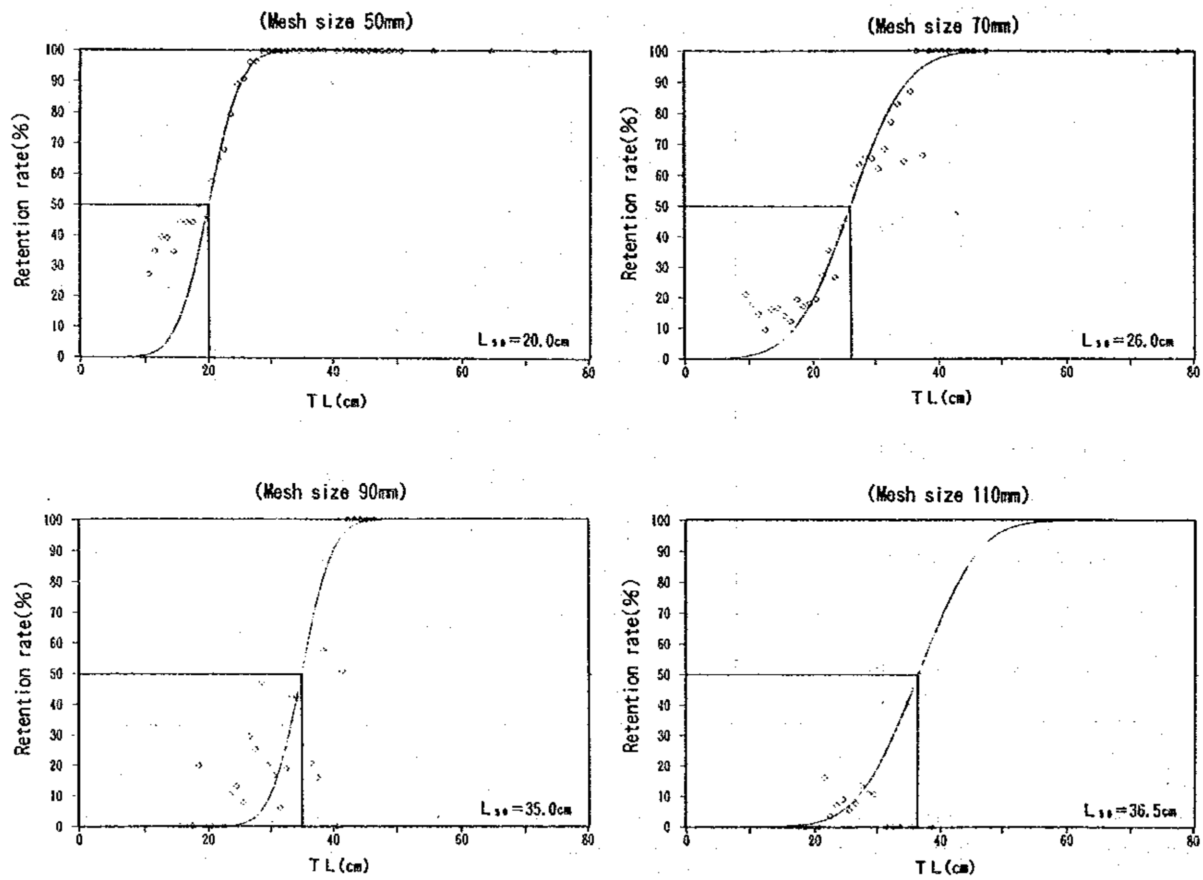


Fig. 5-1-5-1 Retention Rates and Mesh Selectivity Curves by Mesh Size of Hake

2) **Comber** ***Serranus cabrilla***

Comber was caught at two types of cod end mesh sizes, and L_{50} of 20.5 cm was obtained for a cod end mesh size of 50 mm. The mesh selectivity curve at the mesh size of 50 mm was smooth and the variance of retention rate was wide. At a mesh size of 90 mm, a retention rate of 100% was demonstrated with respect to those fish caught having a fork length range of 13-21 cm. This is believed not to reflect an accurate retention rate because, at the location of trawling where the majority of this species was caught, large amounts of sponges, sea weeds and grasses were caught in the net resulting in clogging of the test net.

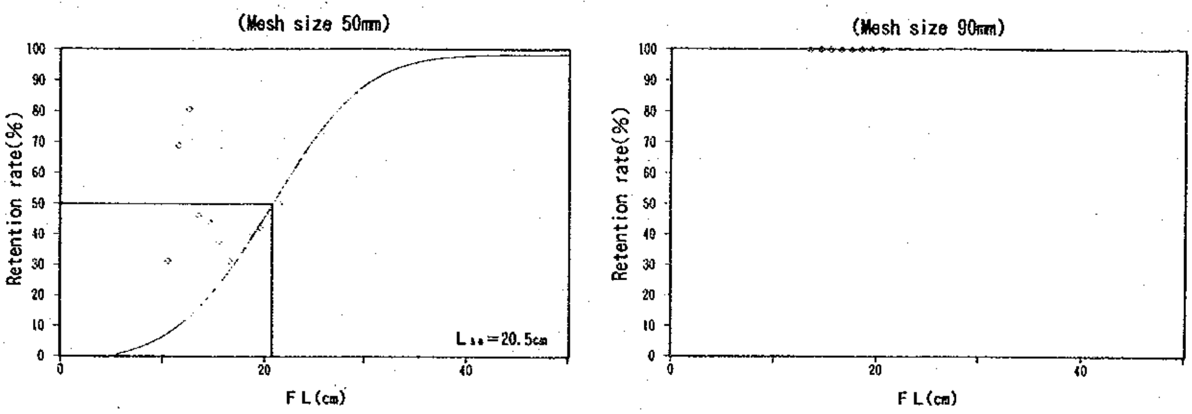


Fig. 5-1-5-2 Retention Rates and Mesh Selectivity Curves by Mesh Size of Comber

3) Atlantic Horse-Mackerel *Trachurus trachurus*

Atlantic horse-mackerel was caught at four types of cod end mesh sizes, and L_{50} was obtained for three types of mesh sizes. L_{50} for each mesh size consisted of 16.5 cm at a mesh size of 50 mm, 17.5 cm at 70 mm and 27.5 cm at 110 mm. The retention rate at a mesh size of 90 mm was 0%. The mesh selectivity curves demonstrated a knife edge shape at mesh sizes of 50 mm and 70 mm. This indicates that, in the case of fishing for this species, by changing the mesh size used to within a range of 50-70 mm, it is believed that, in addition to being able to avoid catching of small fish, it will also be possible selectively catch large fish. In addition, since the retention rate was 0% at a mesh size of 90 mm, in the case of fishing for this species, it is believed that a mesh size of 90 mm or larger demonstrates a sudden decrease in fishing efficiency because the maximum value of retention rate was under 20% at a mesh size of 110 mm.

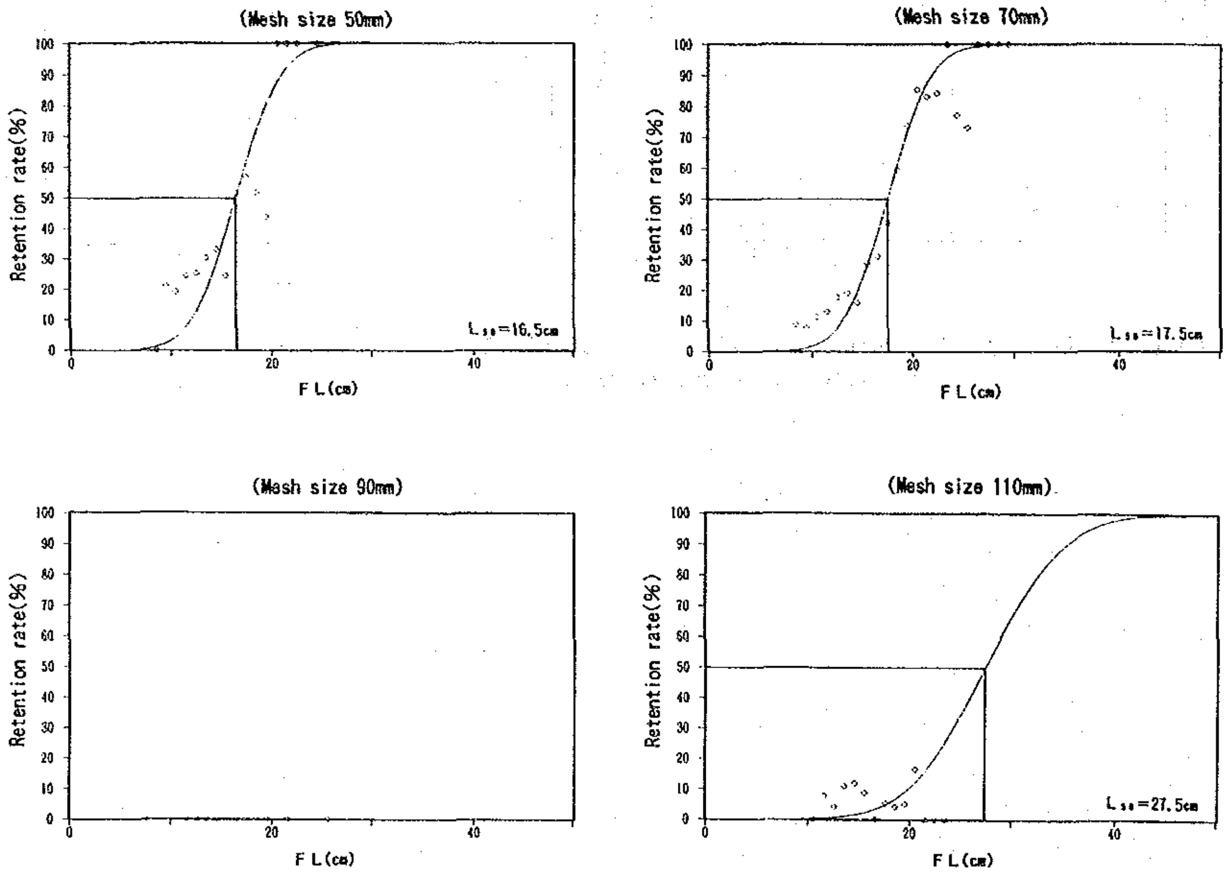


Fig. 5-1-5-3 Retention Rates and Mesh Selectivity Curves by Mesh Size of Atlantic Horse-Mackerel

4) Red Mullet *Mullus barbatus*

L_{50} of red mullet was obtained from cod end mesh sizes of 50 mm, 70 mm and 90 mm.

L_{50} for each mesh size consisted of 16.5 cm at a mesh size of 50 mm, 20.0 cm at 70 mm and 23.0 cm at 90 mm. The mesh selectivity curve demonstrated a knife edge shape at a mesh size of 50 mm, and the mesh selectivity curves at the mesh size of 70 mm, 90 mm were smooth and the variance of retention rate was wide. The results suggest that the mesh size larger than 70 mm will cause decrease in the fishing efficiency for this species.

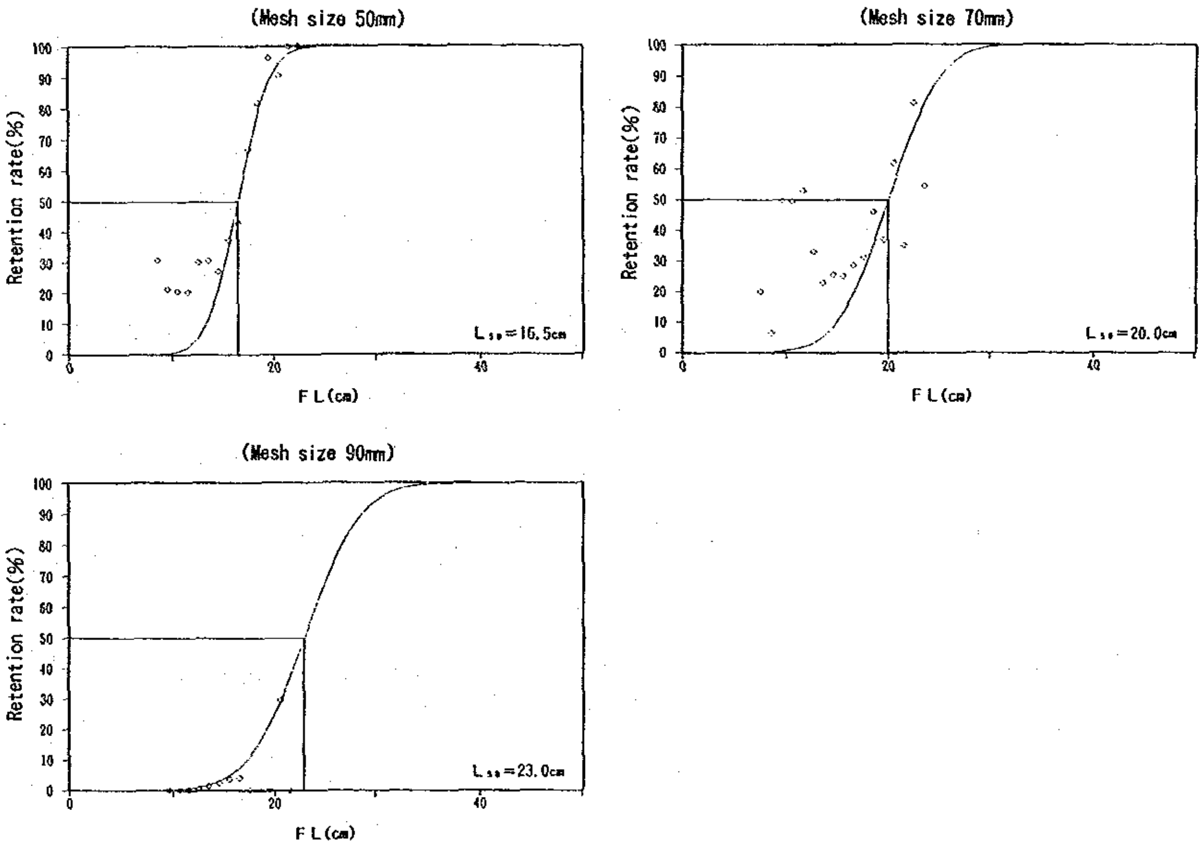


Fig. 5-1-5-4 Retention Rates and Mesh Selectivity Curves by Mesh Size of Red Mullet

5) **Striped Red Mullet *Mullus surmuletus***

Striped red mullet was caught at two types of cod end mesh sizes, and L_{50} of 16.0 cm was obtained for a cod end mesh size of 50 mm.

The mesh selectivity curve at a mesh size 50 mm showed a knife edge shape like the previous section, red mullet. Considering the fact that the shape of fish form was similar to the red mullet, the mesh size larger than 70 mm will cause decrease in the fishing efficiency for this species.

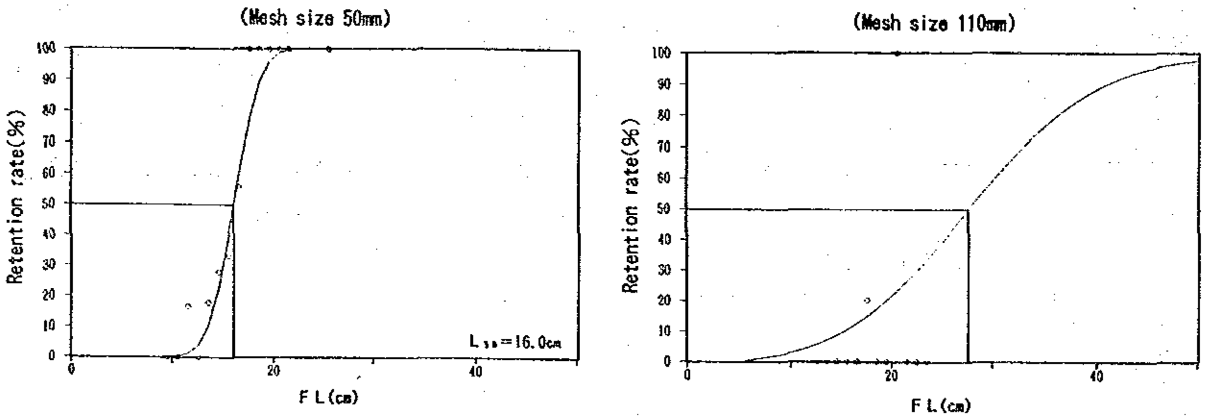


Fig. 5-1-5-5 Retention Rates and Mesh Selectivity Curves by Mesh Size of Striped Red Mullet

6) **Large-Eye Dentex** *Dentex macrophthalmus*

L_{50} of large-eye dentex was obtained from cod end mesh sizes of 50 mm, 70 mm and 90 mm.

L_{50} for each mesh size consisted of 13.0 cm at a mesh size of 50 mm, 15.5 cm at 70 mm and 19.0 cm at 90 mm. The mesh selectivity curves approximated a knife edge shape at mesh sizes of 50 mm and 70 mm. At 70 mm mesh size the variance of retention rate was wide although the shape of selectivity curve was similar to knife edge. Furthermore at 90 mm mesh size, the curve was smooth. These results suggest that the mesh size larger than 70 mm will cause decrease in the fishing efficiency for this species.

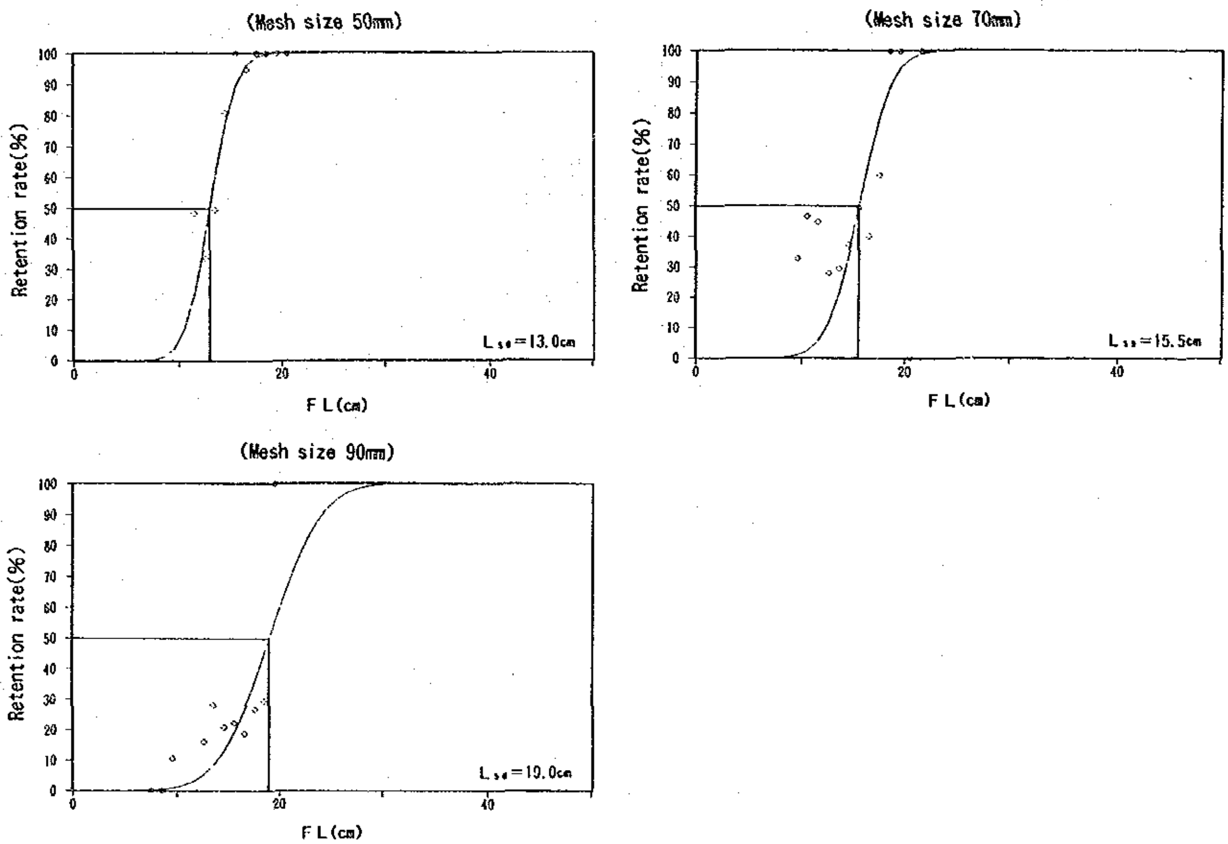


Fig. 5-1-5-6 Retention Rates and Mesh Selectivity Curves by Mesh Size of Large-Eye Dentex

7) Annular Sea Bream *Diplodus annularis*

L_{50} of annular sea bream was obtained from cod end mesh sizes of 50 mm, 70 mm and 90 mm.

L_{50} for each mesh size consisted of 12.0 cm at a mesh size of 50 mm, 15.8 cm at 70 mm and 18.0 cm at 90 mm. Although the mesh selectivity curves demonstrated a knife edge shape at mesh sizes of 50 mm and 70 mm. At 70 mm mesh size, the variance of retention rate was wide. Furthermore at 90 mm mesh size, the selectivity curve was smooth. These results suggest that the mesh size larger than 70 mm will cause decrease in the fishing efficiency for this species.

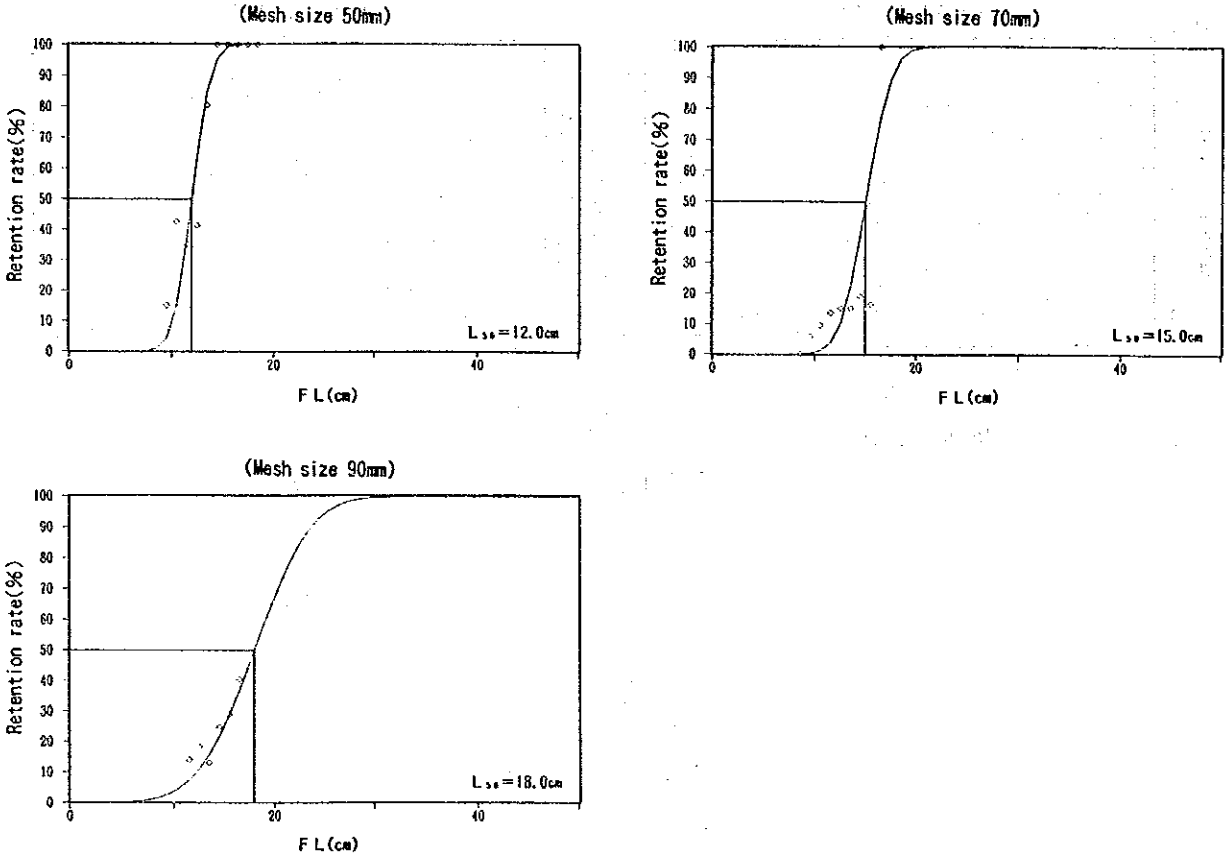


Fig. 5-1-5-7 Retention Rates and Mesh Selectivity Curves by Mesh Size of Annular Sea Bream

8) **Common Pandora *Pagellus erythrinus***

L_{50} of common pandora was obtained from cod end mesh sizes of 50 mm, 70 mm and 90 mm.

L_{50} for each mesh size consisted of 14.0 cm at a mesh size of 50 mm, 16.5 cm at 70 mm and 17.5 cm at 90 mm. The mesh selectivity curves demonstrated a knife edge shape at mesh sizes of 50 mm and 70 mm, and became somewhat smoother at a mesh size of 90 mm. Based on these findings, in the case of fishing for this species, it is considered to be possible to catch larger fish select at the same time preventing to catch smaller fish with a size less than L_{50} by changing the cod end mesh size within the range between 50 mm and 70 mm mesh sizes.

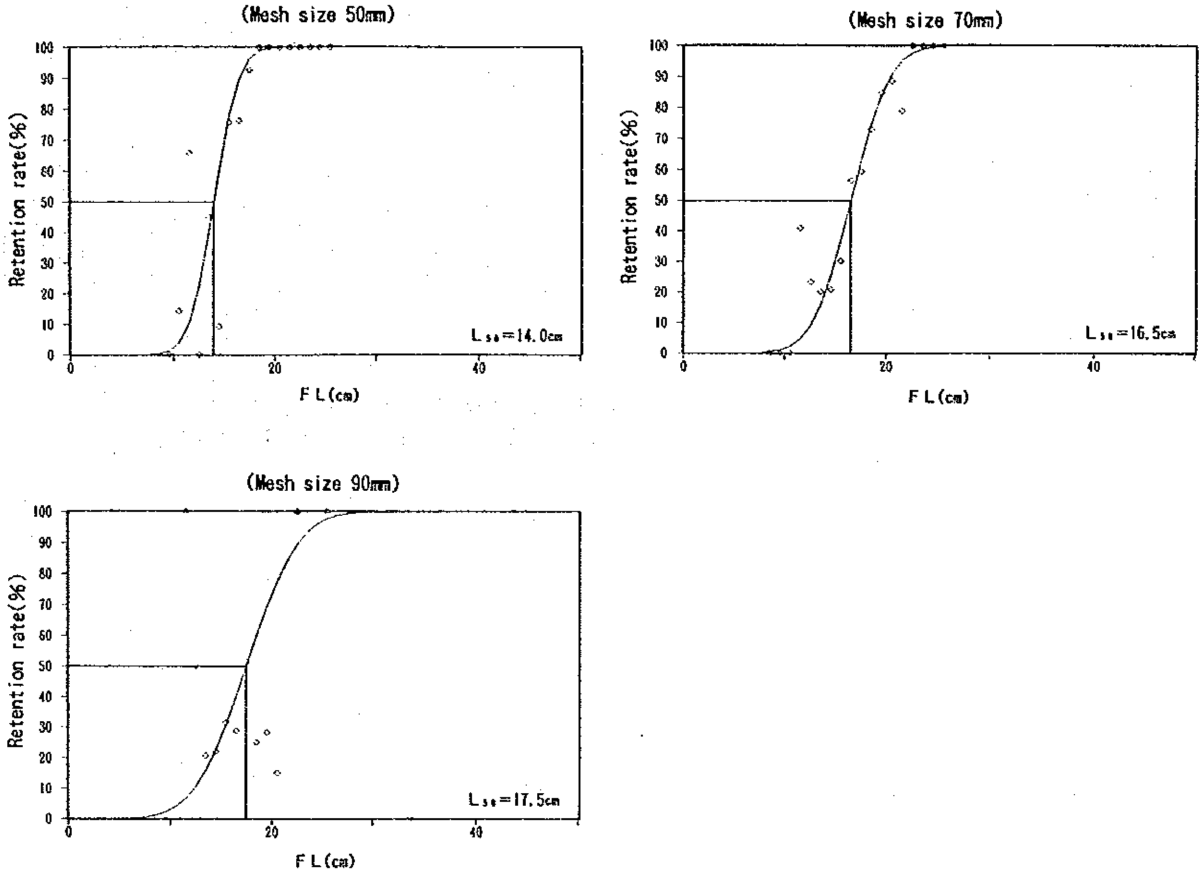


Table 5-1-5-8 Retention Rates and Mesh Selectivity Curves by Mesh Size of Common Pandora

9) **Axillary Sea Bream *Pagellus acarne***

L_{50} of axillary sea bream was obtained from cod end mesh sizes of 50 mm and 70 mm.

L_{50} for each mesh size consisted of 14.5 cm at a mesh size of 50 mm and 15.0 cm at a mesh size of 70 mm. The mesh selectivity curves demonstrated at knife edge shape at a mesh size of 50 mm, while that at a mesh size of 70 mm was somewhat smoother, and also the variance of retention rate was wide. These results suggest that the cod end mesh size larger than 70 mm will cause decrease in the fishing efficiency.

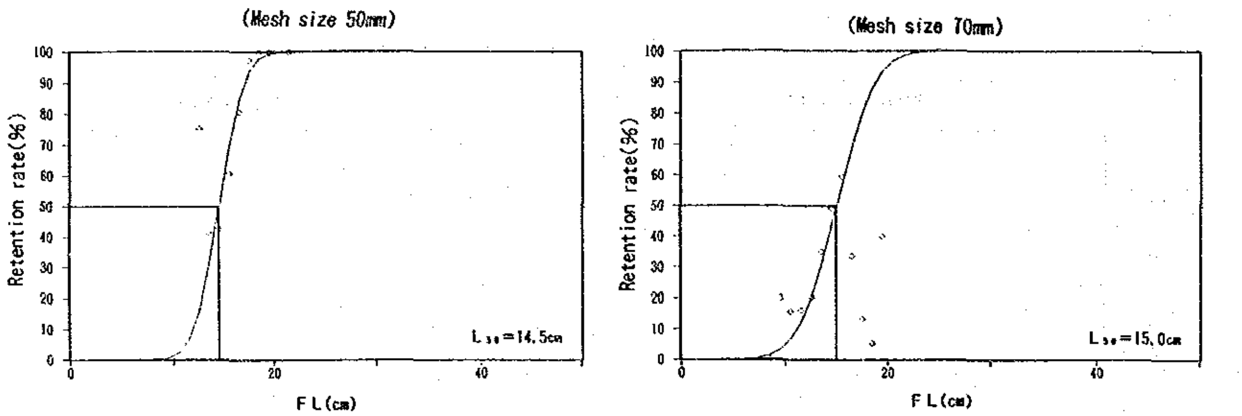


Fig. 5-1-5-9 Retention Rates and Mesh Selectivity Curves by Mesh Size of Axillary Sea Bream

10) Red Sea Bream *Pagellus bogaraveo*

Red sea bream was caught at three cod end mesh sizes, and L_{50} of 15.0 cm was obtained for a mesh size of 50 mm. The mesh selectivity curve at a mesh size 50 mm showed a knife edge shape but larger than the mesh size 70 mm the retention rate was under 30%. These results suggest that the mesh size larger than 70 mm will cause decrease in the fishing efficiency for this species.

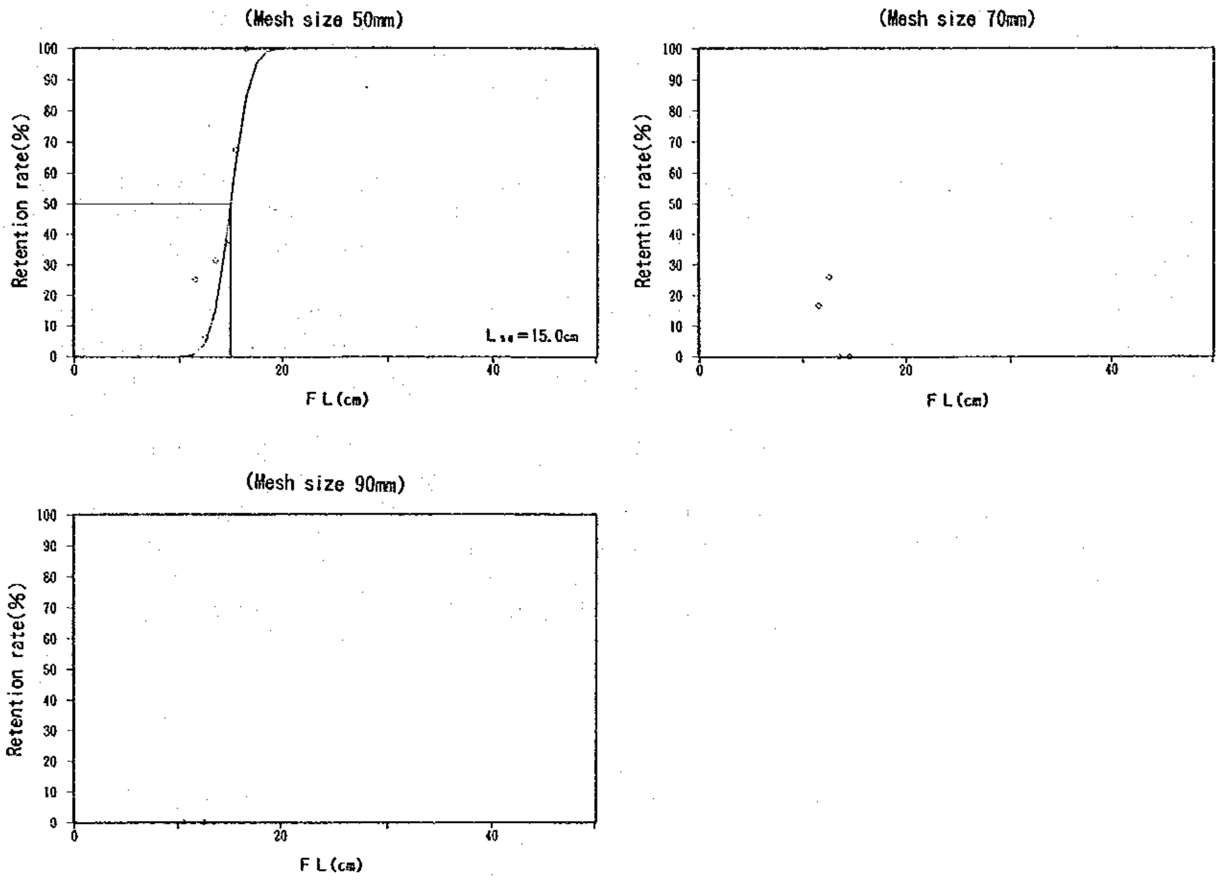


Fig. 5-1-5-10 Retention Rates and Mesh Selectivity Curves by Mesh Size of Red Sea Bream

(2) Changes in Retention Rate Accompanying Changes in Cod End Mesh Size

As a result of determining the correlation between L_{50} and cod end mesh size for 6 species for which L_{50} was obtained at three or more cod end mesh sizes, that correlation was fit to the linear function indicated below.

$$Y = A + BX$$

where:

Y : L_{50} for each cod end mesh size (cm)
X : Cod end mesh size (mm)
A, B : Constants

The mesh selectivity curves by species and cod end mesh size estimated from the relationship between L_{50} and cod end mesh size as determined from this correlation formula are shown in Fig. 5-1-5-11.

Furthermore, determination of the L_{50} by species for a mesh size of 44 mm, currently used by trawling in the Aegean Sea and Mediterranean Sea in Turkey, is indicated below.

Hake *Merluccius merluccius*	: 18.9 cm
Atlantic horse-mackerel *Trachurus trachurus*	: 14.2 cm
Red mullet *Mullus barbatus*	: 14.2 cm
Large-eye dentex *Dentex macrophthalmus*	: 11.9 cm
Annular sea bream *Diplodus annularis*	: 11.1 cm
Common pandora *Pagellus erythrinus*	: 13.7 cm

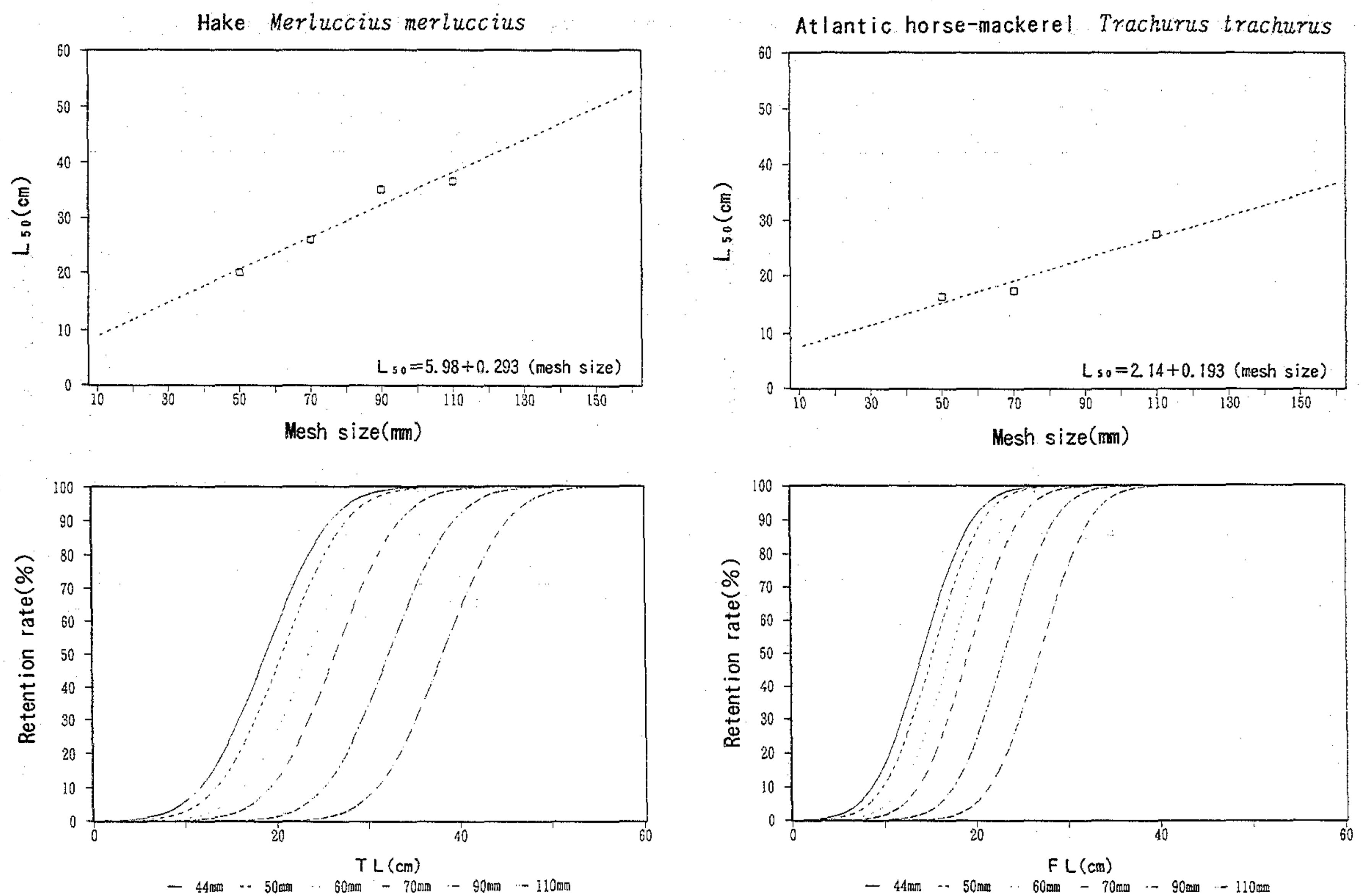


Fig. 5-1-5-11 (1) Length at 50% Retention (L_{50}) and Mesh Selectivity Curves by Mesh Size

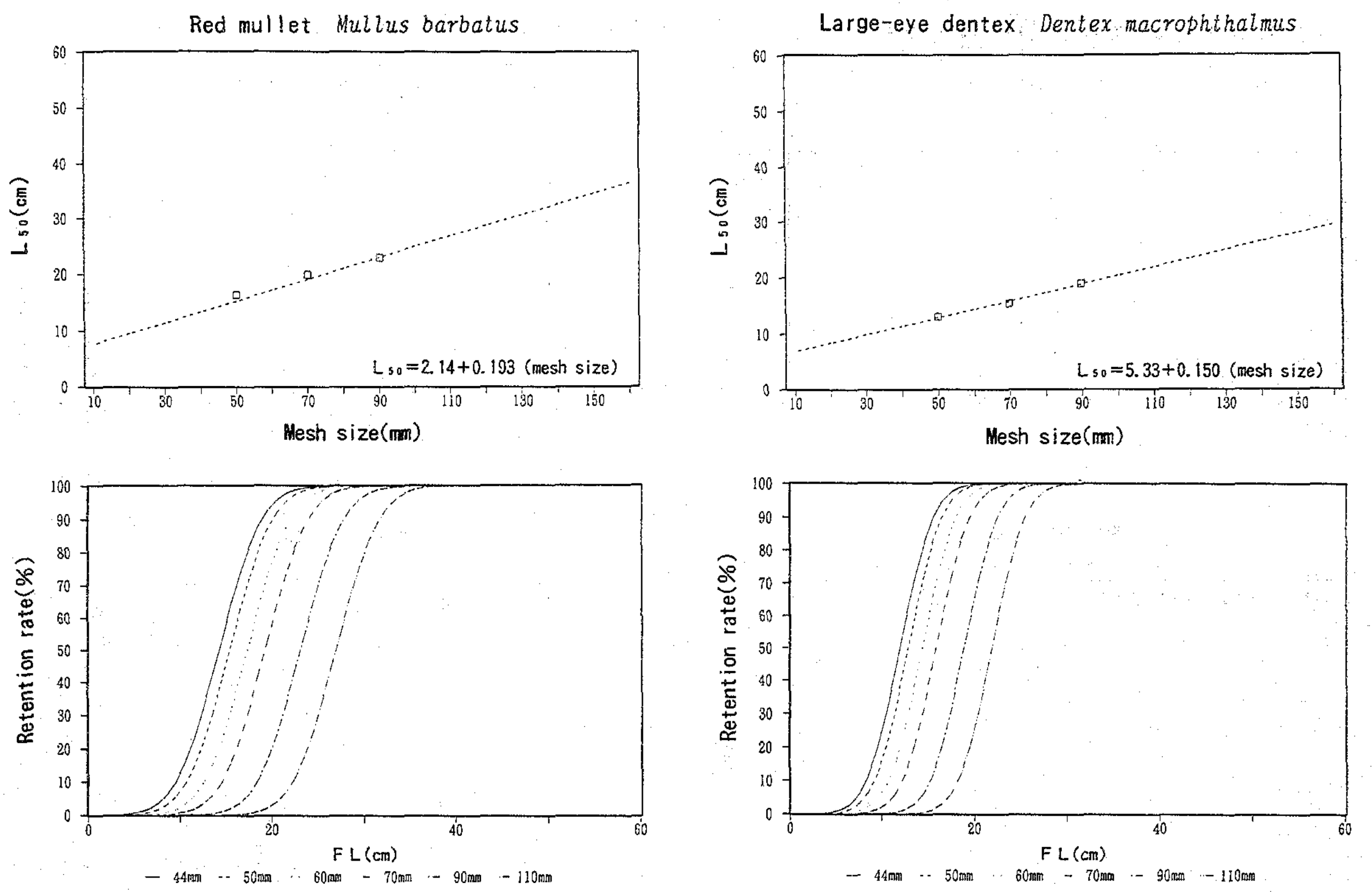


Fig. 5-1-5-11 (2) Length at 50% Retention (L_{50}) and Mesh Selectivity Curves by Mesh Size

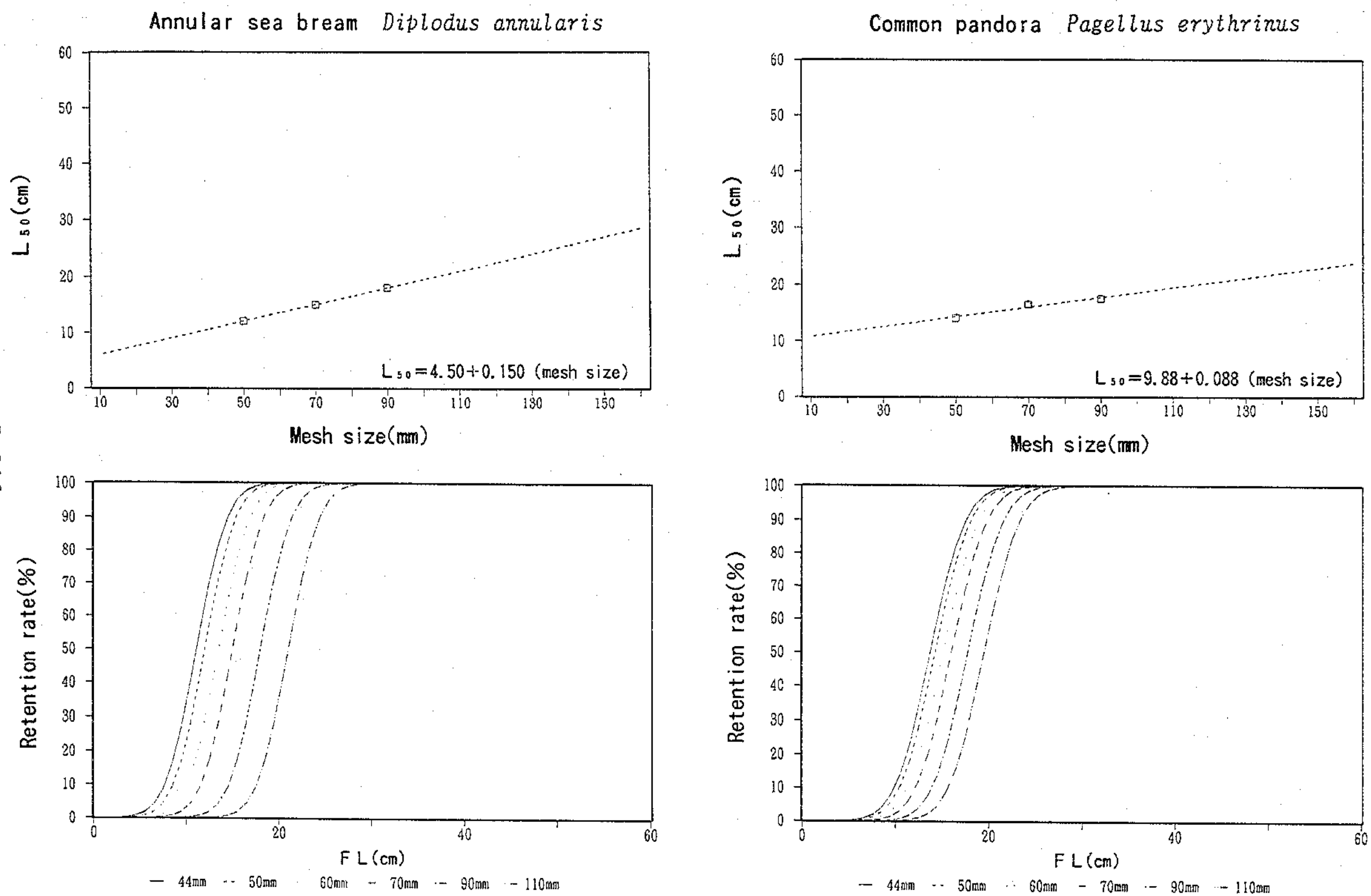


Fig. 5-1-5-11 (3) Length at 50% Retention (L_{50}) and Mesh Selectivity Curves by Mesh Size

5-1-6 Comparative Test of Fishing Efficiency

5-1-6 Comparative Test of Fishing Efficiency

The comparative tests of fishing efficiency between the K. Piri Reis (to be referred to as the research vessel) and Turgut Reis commercial fishing boat (to be referred to as the commercial fishing boat) were conducted on 12 times in the North Aegean Sea (refer to Table 5-1-6-2) and on 31 times in the East Mediterranean Sea (refer to Table 5-1-6-3) by parallel operation. There 45 species in the North Aegean Sea and 36 species in the East Mediterranean Sea that were simultaneously caught by the research vessel and commercial fishing boat.

In order to examine whether or not the comparative test of fishing efficiency was conducted targeted at the similar populations of benthic animals, a study was conducted of the similarity of the species composition of catches of both vessels (Kimoto, 1976).

The similarity index $C\pi^*$ was 0.83 in the North Aegean Sea and 0.87 in the East Mediterranean Sea between the total catches of both vessels, with both indicating values close to 1.0. Based on these findings, it was judged that the comparative test of fishing efficiency was carried out targeted at closely similar population of benthic animals in both areas.

Furthermore, during the course of analysis, the catches per species of both vessels at each trawling station were standardized to the catch per unit area (kg/km^2, abbreviated as CPUA).

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*Similarity Index: $C\pi$ (Kimoto 1976)

$$C\pi = \frac{2 \sum_{i=1}^{S} nai \cdot nbi}{(\sum \Pi a^2 + \sum \Pi b^2)\ Na \cdot Nb} \qquad 0 \leqq C\pi \leqq 1.0$$

$$\sum \Pi a^2 = \frac{\sum_{i=1}^{S} nai^2}{Na^2} \qquad \sum = \Pi b^2 = \frac{\sum_{i=1}^{S} nbi^2}{Nb^2}$$

where:

Na, Nb : Total number of specimens A and B

nai, nbi : Number of each specimen of the ith species for both specimens A and B

(1) Fishing Efficiency in Terms of CPUA

Firstly, the ratio of the CPUA of the commercial fishing boat to that of the research vessel at each trawling station was determined for the CPUA values of the research vessel and the commercial fishing boat. The *t*-test was then performed on the difference between the mean and the reference value to test the significance of the mean. The ratio of the CPUA of the commercial fishing boat to that of the research vessel was 0.525 in the North Aegean Sea and 0.668 in the East Mediterranean Sea. Thus, a significant difference was not detected between the fishing efficiency of both vessels based on the total catches (Table 5-1-6-1).

(2) Fishing Efficiency by Species

Next, the respective ratios of the CPUA of the commercial fishing boat to that of the research vessel were determined for the CPUA values of species caught by both vessels. These were then averaged to obtain the fishing efficiency. Moreover, the significance of fishing efficiency was tested for a degree of freedom of 5 and above after determining the individual CPUA ratios of both vessels for each species (Table 5-1-6-2 and 5-1-6-3).

The range of the fishing efficiency of the commercial fishing boat with respect to the research vessel was 0.2-5.9 in the North Aegean Sea and 0.2-3.2 in the East Mediterranean Sea. There were no significant differences observed in the fishing efficiency of both vessels for nearly all species. Those species for which a significant difference in the fishing efficiency was detected consisted of smallspotted catshark *Scyliorhinus canicula* and large-scaled gurnard *Lepidotrigla cavillone* in the North Aegean Sea, and large-scaled gurnard *Lepidotrigla cavillone* and streaked gurnard *Trigloporus lastoviza* in the East Mediterranean Sea. The fishing efficiency of the research vessel was lower than that of the commercial fishing both for each of these three species.

Table 5-1-6-1 Ratio of Catch Per Unit Area (CPUA) at Each Trawling Station Between the Research Vessel and Commercial Fishing Boat

North Aegean Sea

Operation number	CPUA (kg/1 k㎡)		Ratio of CPUA Commercial fishing boat/ Research vessel	t_0 $t(f, \alpha)$ *
	Commercial fishing boat	Research vessel		
T-1	460.9	1,276.5	0.36	
T-2	2,844.1	1,157.2	2.46	
T-3	333.0	642.1	0.52	
T-4	718.7	741.8	0.97	
T-5	528.7	648.0	0.82	
T-6	832.3	1,578.7	0.53	
T-7	2,492.4	3,321.0	0.75	
T-8	1,765.3	2,642.4	0.67	
T-9	1,088.1	387.9	2.81	
T-10	589.3	32.4	18.19	
T-11	609.9	703.2	0.87	$t(11, 0.05)$
T-12	2,018.6	1,244.2	1.62	=2.201
Mean	1,190.1	1,198.0	2.5	0.525 <2.201

East Mediterranean Sea

Operation number	Commercial fishing boat	Research vessel	Ratio of CPUA Commercial fishing boat/ Research vessel	t_0 $t(f, \alpha)$ *
T-13	252.0	573.8	0.44	
T-14	202.6	431.9	0.47	
T-16	267.3	1,038.1	0.26	
T-17	50.8	38.4	1.32	
T-18	283.6	350.1	0.81	
T-19	294.6	320.8	0.92	
T-20	463.4	119.5	3.88	
T-21	191.9	389.3	0.49	
T-22	504.3	18.6	27.11	
T-23	475.1	668.9	0.71	
T-24	134.2	500.8	0.27	
T-25	10,115.8	847.0	11.94	
T-26	728.5	2,173.3	0.34	
T-27	94.4	278.0	0.34	
T-28	354.9	413.6	0.86	
T-29	314.1	205.8	1.53	
T-30	416.4	249.7	1.67	
T-31	595.8	274.0	2.17	
T-32	696.3	882.7	0.79	
T-33	459.9	457.4	1.01	
T-34	159.6	340.6	0.47	
T-35	103.7	483.9	0.21	
T-36	288.7	601.7	0.48	
T-38	183.6	357.2	0.51	
T-39	197.0	1,299.7	0.15	
T-41	482.4	590.9	0.82	
T-42	389.0	592.2	0.66	
T-43	644.1	768.4	0.84	
T-44	1,694.6	1,176.0	1.44	
T-46	407.3	236.5	1.72	$t(30, 0.05)$ =2.042
T-47	921.4	590.9	1.56	
Mean	721.5	557.1	2.1	0.668<2.042

* t_0: Value of Student's t value calculated from observed values
f : Degree of freedom
α : Level of significance, $t(f, \alpha)$

Table 5-1-6-2 Comparison of Relative Fishing Efficiency Between the Research Vessel and Commercial Fishing Boat in the North Aegean Sea

Scientific name	Number of stations at which species were caught: Commercial fishing boat	Number of stations at which species were caught: Research vessel	Number of stations at which both vessels caught the species	Ratio of catch rates 1 Commercial fishing boat/ Research vessel
Scyliorhinus canicula	9	8	8	5.9*
S. stellaris	5	7	4	1.8
Mustelus mustelus	2	1	1	0.5
Squalus blainvillei	1	1	1	2.5
Raja asterias	2	4	2	0.7
R. clavata	6	5	4	0.9
Argentina sphyraena	4	3	3	1.6
Macroramphosus scolopax	1	1	1	3.7
☆*Merluccius merluccius*	10	10	10	3.1
Trisopterus minutus capelanus	7	8	7	1.3
Zeus faber	6	6	3	4.5
Capros aper	1	1	1	2.2
☆*Serranus cabrilla*	10	7	7	1.5
S. hepatus	9	8	7	1.8
☆*S. scriba*	1	1	1	1.5
Cepola rubescens	6	2	1	6.9
☆*Mullus barbatus*	11	10	10	2.3
☆*M. surmuletus*	5	2	1	0.5
Boops boops	2	3	1	0.7
Dentex dentex	1	1	1	0.3
☆*Diplodus annularis*	7	7	7	1.1
☆*D. vulgaris*	2	2	2	1.4
☆*Pagellus erythrinus*	4	4	2	0.7
☆*P. acarne*	2	2	1	0.4
Spicara smaris	2	1	1	0.2
Coris julis	1	1	1	0.5
Uranoscopus scaber	6	5	4	3.0
Gobius niger	3	2	1	0.3
Callionymus lyra	2	1	1	0.7
Scorpaena porcus	2	3	2	0.6
S. scrofa	2	1	1	4.0
Trigla lyra	6	3	3	0.7
Lepidotrigla cavillone	10	7	7	5.2*
Trigloporus lastoviza	2	4	1	0.4
Citharus linguatula	10	7	7	1.0
Lophius piscatorius	8	7	6	0.6
☆*Parapenaeus longirostris*	2	3	2	1.1
☆*Nephrops norvegicus*	3	2	2	0.5
Squilla mantis	2	1	1	2.0
Sepia officinalis	1	1	1	0.2
S. orbignyana	5	4	4	1.0
Loligo vulgaris	1	3	1	0.3
Illex coindetii	4	7	3	0.6
Octopus vulgaris	3	2	2	1.1
Eledone moschata	10	10	8	0.7

☆ Important species
1 Mean rations of catch rates calculated from individual tows.
* Ratios of catch rates that were determined to be significantly different.

Table 5-1-6-3 **Comparison of Relative Fishing Efficiency Between the Research Vessel and Commercial Fishing Boat in the East Mediterranean Sea**

Scientific name	Number of stations at which species were caught		Number of stations at which both vessels caught the species	Ratio of catch rates 1 Commercial fishing boat/ Research vessel
	Commercial fishing boat	Research vessel		
Mustelus mustelus	6	2	2	0.2
Squatina squatina	3	6	1	0.3
Rhinobatos rhinobatos	1	1	1	0.4
Raja clavata	2	5	1	0.3
Synodus saurus	2	3	2	1.0
☆*Saurida undosquamis*	24	21	18	1.3
Macroramphosus scolopax	7	7	6	1.6
☆*Merluccius merluccius*	20	16	11	2.1
Zeus faber	10	5	2	0.5
☆*Serranus cabrilla*	11	5	4	1.6
S. hepatus	16	9	7	1.9
☆*Trachurus trachurus*	9	9	3	0.3
☆*Mullus barbatus*	16	16	13	1.4
☆*M. surmuletus*	13	8	7	2.8
☆*Upeneus moluccensis*	20	13	13	1.3
☆*Sparus aurata*	2	3	2	1.5
Pagrus pagrus	5	8	3	1.0
Boops boops	4	12	3	0.4
☆*Dentex macrophthalmus*	6	4	2	0.7
☆*Diplodus annularis*	3	1	1	0.3
☆*Pagellus erythrinus*	26	22	20	1.4
Spicara maena	3	17	2	0.6
S. smaris	17	4	4	0.6
Trachinus draco	3	3	1	1.9
Uranoscopus scaber	9	5	2	2.9
Scorpaena notata	4	5	3	1.6
Trigla lucerna	11	4	2	0.8
Lepidotrigla cavillone	17	14	12	3.2*
Trigloporus lastoviza	16	11	10	2.5*
Citharus linguatula	14	9	7	0.6
Lophius piscatorius	2	7	2	0.2
☆*Parapenaeus longirostris*	6	3	3	0.7
Oratosquilla massavensis	4	1	1	1.8
Sepia elegans	4	3	3	0.6
S. officinalis	8	1	1	1.1
Eledone moschata	6	6	2	0.4

☆ Important species
1 Mean rations of catch rates calculated from individual tows.
* Ratios of catch rates that were determined to be significantly different.

5-1-7 Shrimp Resource Survey

5-1-7 Shrimp Resource Survey

The species composition and catch per unit area* (individual/km^2, referred to as CPUA) of shrimps caught using shrimp trawl net inside and outside Iskenderun Bay in the East Mediterranean Sea in autumn (but not including demersal fishes and other demersal animals caught simultaneously by shrimp trawl net) are summarized as shown below by time of day and depth. In addition, a comparative study was also conducted between demersal fish trawling gear and shrimp trawling gear with respect to those shrimps only caught during the day.

(1) Species Composition and CPUA of Shrimps

There were 2 species of shrimps caught during the day and 10 species of shrimps caught during the night. There was an abundant number of shrimps species, particularly at the deepest strata (350 m), at night. The CPUA value of all shrimps in all areas was high at day. The CPUA value at day was three times higher than that at night. This is the result of large numbers of arrow shrimp *Plesionika heterocarpus* being caught at the deepest strata during the day. Green tiger prawn *Penaeus semisulcatus* (total length: roughly 20 cm), a large kuruma shrimp, was caught at depths of 50 m or less during the night. However, the number of this species was extremely low at roughly only 15 per km^2. The CPUA of deep-water pink shrimp *Parapenaeus longirostris* were high both at day and at night (Table 5-1-7-1).

Approximate values for catch per unit area were estimated using the respective mean weights for those species of shrimp caught on which biological measurements were made. The species on which biological measurements were made along with the values of catch per unit area at day and at night are as shown below.

Parapenaeus longirostris
- Day: 6 g/shrimp x 777 shrimp/km^2 = 4,662 g/km^2
- Night: 8 g/shrimp x 467 shrimp/km^2 = 3,736 g/km^2

Penaeus semisulcatus
- Night: 63 g/shrimp x 9 shrimp/km^2 = 567 g/km^2

Plesionika heterocarpus
- Day: 2 g/shrimp x 1,038 shrimp/km^2 = 2,076 g/km^2

Plesionika martia
- Night: 5 g/shrimp x 3 shrimp/km^2 = 15 g/km^2

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* The weight per haul by species of shrimps was less than 100 g in the majority of cases (minimum unit of measurement for weighing catches). As a result, it was impossible to process quantities according to weight. Therefore, quantities were processed in this survey using the individual of shrimps caught instead of weight.