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Species Composition and Distribution of Fish Larvae and Juveniles in the Waters off Northeastern Taiwan in Spring 2005 with Particular Reference to Mackerel and Scad

Yu-Tzu Wang[1], Chia-Lin Lee[1*], Chia-I Pan[2], Sew-Horng Wu[1], Chen-Te Tseng[3] and Yi-Xing Cheng[1]

[1]Marine Fisheries Division, Fisheries Research Institute
[2] Department of Environmental Biology and Fishery Science, National Taiwan Ocean University
[3] Planning and Information Division, Fisheries Research Institute

ABSTRACT

To understand the occurrence and abundance of the fish larvae and juveniles in the waters off northeastern Taiwan, larvae in the area of 24.5~27.0°N, 121~123.5°E were collected with a Bongo net, and environmental factors (temperature, salinity, and depth) were investigated with conductivity-temperature-depth instrument (CTD) casting during March~May 2005. In total, 4958 larvae representing 88 families and 187 species were collected from 93 nettings at 36 stations. *Scomber japonicus*, *Auxis* spp., *S. australasicus*, *Trichiurus lepturus*, *Engraulis japonicus*, *Benthosema pterotum*, and *Trachurus japonicus* were dominant, comprising 56.2% of the total catch in terms of numbers. Cluster analysis by the density of fish larvae (individuals (ind.)/1000 m^3) and Bray-Curtis similarity indices, indicated the larval fish assemblages could be classified into 6 assemblage groups during March, April, and May. In March, *S. japonicus* (37.8%) was the most dominant, followed by *T. japonicus* and *S. australasicus*. In April, the fish assemblages were dominated by *S. australasicus* (19.55%), *E. japonicus* (14.03%), and *T. japonicus* (10.14%) distributed in the northwestern part of the study area, and *T. lepturus* (11.94%) and *B. pterotum* (10.07%) in the southeastern part. In May, *Auxis* spp. was the most dominant (25.33%). These results indicate that the study area in the spring is a spawning ground for mackerel (*Scomber* spp.) and scad (*T. japonicus*). The species composition and abundance of fish larvae changed drastically with month and location. The species succession and distribution were influenced by the spawning season of the fish and the meandering of the Kuroshio Current in the waters off northeastern Taiwan.

Key words: fish larvae, mackerel, scad, northeastern waters off Taiwan, Kuroshio

INTRODUCTION

Mackerel (*Scomber* spp.) and scad (*Trachurus japonicus*) are important coastal fishes in Taiwan. They occur almost year round in the waters off northeastern Taiwan. They are harvested by purse seine and have become the most important species since the introduction of Japanese style mackerel purse seines in 1977. According to the Taiwan Fisheries Yearbook (Taiwan Fisheries Bureau, 1978, 1998; Fisheries Agency, 2002, 2006), the production of mackerel and scad increased from 2189 tons (comprising 0.63% of the total inshore fisheries production) in 1977 to a peak of 81,029 tons (32.72%) in 1997. However, the production dropped to 22,205 tons in 2001, but increased thereafter and

*Correspondence: 199 Hou-Ih Road, Keelung 202, Taiwan. TEL: (02) 24622101; FAX: (02) 24633110; E-mail: cllee@mail.tfrin.gov.tw

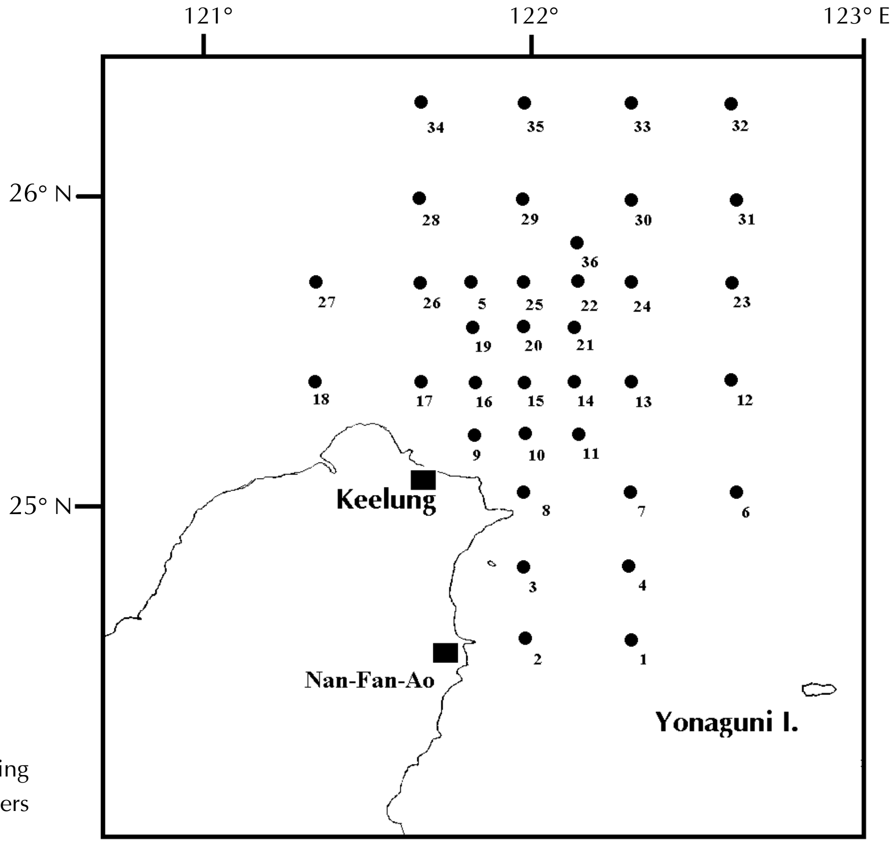

Fig. 1 Stations for CTD casting and Bongo netting in the waters off NE Taiwan, spring 2005.

reached 63,000 tons in 2005. On the other hand, catch data compiled from the Nanfangao fishing market, indicated that the catch of both species groups during January~November was 62,014 tons in 2005 which was about 1.46 times that in 2004 (42,426 tons).

Fluctuations in fish abundances can be attributed to (1) recruitment and survival rates of fish larvae (Hjort, 1914), (2) productivity in the spawning grounds which may influence the survival rates of larval fishes (Cushing, 1969, 1990; Henderson *et al*., 1984; Anderson, 1988; Chenoweth *et al*., 1989), (3) oceanic stability which may influence the distribution of primary production (Lasker, 1975, 1981; Peterman and Bradford, 1987; Peterman *et al*., 1988), and (4) food organisms, such as anchovies, of the adult fish. These factors indicate that the survival of fish larvae might play an important role in the annual fluctuations of mackerel and scad.

The spawning grounds of mackerel and scad are assumed to be in the waters off northeastern Taiwan. Although the larval fish assemblages in the waters off NE Taiwan have been investigated in the summer and autumn (Chiu, 1991a, b, 1992; Chiu and Lee, 1991; Yeh, 1992, 1993, 1998; Chiu and Hsyu, 1994), the spawning seasons of mackerel and scad occur in spring. Accordingly, the baseline data for understanding fluctuations in mackerel and scad populations are still lacking.

The aims of this study were to clarify the seasonal occurrences and distributions of larval mackerel and scad in the waters off NE Taiwan and their relation to the Kuroshio Current.

MATERIALS AND METHODS

Fish larvae and juveniles were collected by Bongo net in the area of 24.5~27.0°N and 121~123.5°E with oblique towing from 100-m depth to the sea surface at an average velocity of 20 m/min by the R/V *Hai-Chiang* operated by the Fisheries Research Institute, Taiwan (Fig. 1). In total, 93 nettings were conducted during March to May 2005. Conductivity-temperature-depth instrument (CTD) casting was also conducted from the surface to approximately 500-m depth to understand the temporal and spatial variations of temperature and salinity in the area. However, due to loss of function, CTD casting was not conducted during the cruise in May. Larval fishes collected were immediately stored in 70% alcohol and 5% formalin, respectively.

After species identification, we used traditional methods to calculate the species abundance (individuals (ind.)/1000 m^3), although it is more common to use the biomass of the fish to evaluate fish communities (Bibanchi, 1991). The dominant species always play important roles in determining the results of fish assemblage analysis (Lee, 1995a, b, c). Cluster analysis was used to compare similarity distances among study areas and to elucidate species assemblages. The species groups of fish larvae were analyzed by the Bray-Curtis similarity index (Bray and Curtis, 1956) and the unweighted pair group method using arithmetic averages (UPGMA) method (Sneath and Sokal, 1973). Relationships between biotic and abiotic factors were analyzed by means of a correlation matrix.

RESULTS

1. Distribution of isotherms and isohalines

The distribution of surface water temperatures gradually increased from 17 to 24 °C along a NW-SE direction of the study area in March, and from 22 °C in the northern portion to 26 °C in the southern portion in April (Fig. 2). Similarly, the surface salinity changed from 34.2 ~ 34.8 psu in both March and April and also showed a geographic cline, particularly near the coast, where the isotherms and isohalines were close together. This indicated that salinity and thermal fronts existed in the waters off NE Taiwan. In other words, distinct northward and southward oceanic fronts were found in March between 121.8 and 122°E where stations 8, 9, 10, 15, 16, 19, 20, 26, 28, and 34 were located. In addition, as indicated from the vertical profiles of temperature and salinity along 25.2°N, a cold eddy was found at station 15 (Fig. 3), and small fronts were located at stations 8, 11, and 14.

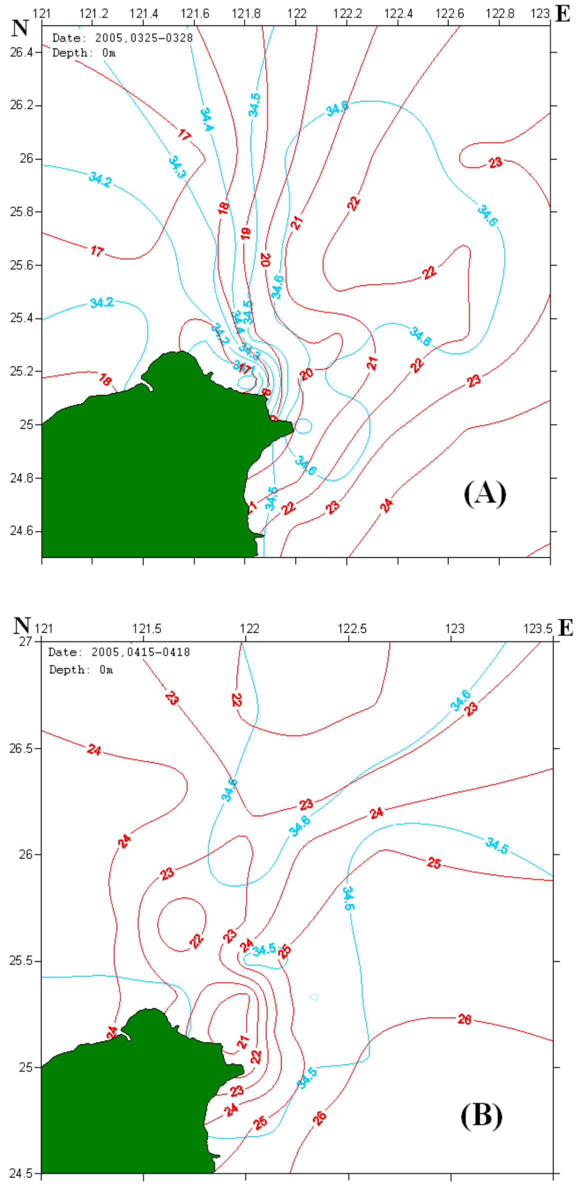

Fig. 2 Surface isotherms and isohalines in the waters off NE Taiwan in March (A) and April (B) 2005.

2. Species composition

In total, 4958 fish larvae representing 88 families and 187 species, and 9516 eggs were collected from 93 tows of a Bongo net at 36 stations during the 3 cruises from March to May 2005 (Table 1). *Scomber japonicus* (comprising 10.9% of the total catch), *Auxis* spp. (10.7%), *Trichiurus lepturus* (7.6%), *Benthosema pterotum* (7.2%), *S. australasicus* (7.1%), *Engraulis japonicus* (6.6%), and *Trachurus japonicus* (6.1%) were the most dominant, with these 7 species accounting for 56.2%

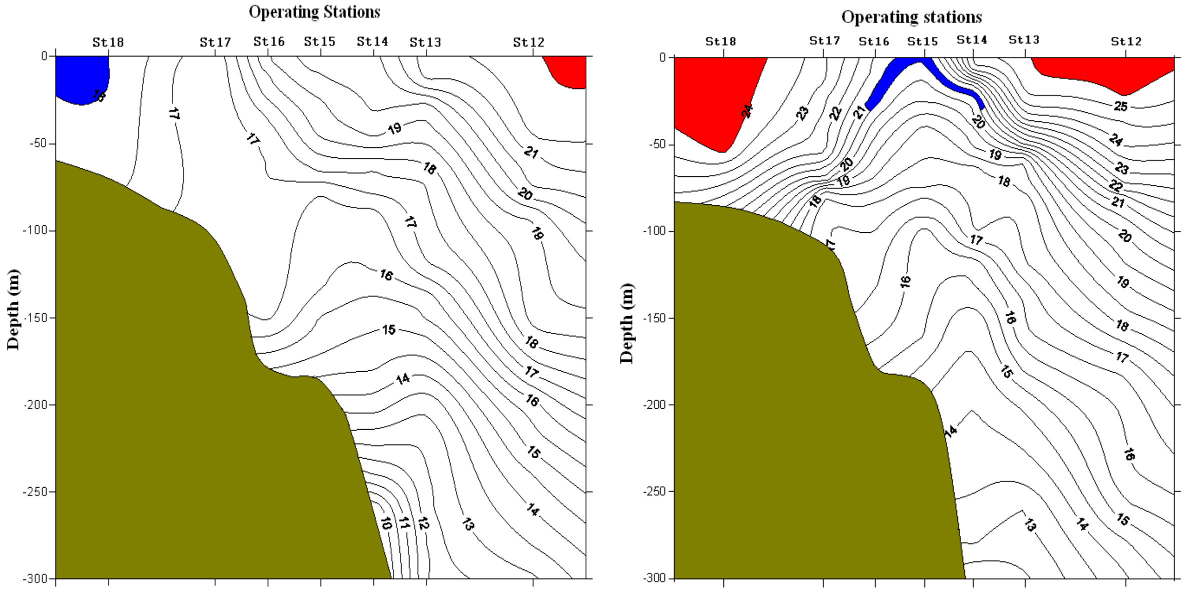

Fig. 3 Vertical isotherms along the latitude 26°20′N off NE Taiwan in March (left) and April (right) 2005.

of the total catch. Apparently, the species composition of larval fish assemblages were dominated by mackerel and scad as well as their bait (anchovy and lanternfish) in the waters off NE Taiwan in spring.

3. Spatial and temporal distributions of fish larvae

Six assemblage groups of fish larvae (A, B, C, D, E, and F) were found in the waters off NE Taiwan during March~May (Fig. 4, Table 1). Group A consisted of stations 30 and 31 (located in the northeastern part of the study area) in March and had no dominant species. Group B contained 24 stations (consisting of most portions of the study area) in March and 21 stations (in the northwestern part of the study area) in April and was dominated by *S. japonicus*, *S. australasicus*, *T. japonicus*, *E. japonicus*, and *T. lepturus*. Group C consisted of stations 1, 2, and 4 (in the southern part of the study area) in March; 1, 2, 3, 4, 6, 7, 12, 14, 21, 22, 23, and 24 (in the southeastern part of the study area) in April; and 24 stations (consisting of most portions of the study area) in May and was dominated by *Auxis* sp., *B. pterotum*, *T. lepturus*, and *Alepes* sp. Group D consisted of stations 1 and 2 in May and had no dominant species. Group E contained only station 5 in March and April, and stations 4, 5, and 12 (along the southeastern margin of the study area) in May and had no dominant species. Group F consisted of stations 13 (in the central portion) and 18 (along the western margin) in April, and stations 14 and 18 in May and had no dominant species. These results indicated that the dominant species of fish larvae changed drastically with month and location. In other words, the occurrence of fish larvae in this area underwent a seasonal succession, with the spatial distribution of fish larvae also changing as well.

Table 1 Species composition of fish larvae and juveniles in the 6 assemblage groups from the waters off NE Taiwan, spring 2005 (for the stations of assemblage groups A to F refer to Fig. 4)

Taxon	A	B		C			D	E			F		Total
	Mar.	Mar.	Apr.	Mar.	Apr.	May	May	Mar.	Apr.	May	Apr.	May	
ELOPIDAE													
Megalops cyprinoides						3							3
OPHICHTHIDAE													
unidentified sp.		2			1	9				1			13
NETTASTOMATIDAE													
unidentified sp.						1							1
CONGRIDAE													
unidentified sp.			3		1	14				1			19
CLUPEIDAE													
unidentified sp.			2		1	6				1	10		20
ENGRAULIDAE													
Encrasicholina punctifer						1				2			3
Engraulis japonicus		151	173		4								328
SALANGIDAE													
Salanx sp.							1						1
GONOSTOMATIDAE													
Cyclothone alba			2		7	6				6	1	1	23
Cyclothone pseudopallida						1							1
Cyclothone sp.		1				1							2
Gonostoma atlanticum		1					1						2
Gonostoma elongatum			1										1
Gonostoma gracile	2	14	6	1	18	1							42
Maurolicus sp.			1			1							2
Vinciguerria nimbaria		6	4	5	6	23				4			48
unidentified sp.						1							1
STERNOPTYCHIDAE													
Argyropelecus sp.					2							1	3
CHAULIODONTIDAE													
Chauliodus sp.		5	1	1	2	2				1			12
STOMIIDAE													
Stomias sp.			1		1				1			1	4
ASTRONESTHIDAE													
unidentified sp.			1		1		2			1			5
MELANOSTOMIIDAE													
unidentified sp.					1					2			3
AULOPODIDAE													
Aulopus sp.			1			10							11
SYNODONTIDAE													
Saurida sp.			23			12					4	1	40
Synodus fuscus										1			1
Synodus hoshinonis						2							2
Syndus sp.		1											1
Trachinocephalus myops		3	4		1	17				1			26
PARALEPIDIDAE													
Sudis atrox										2			2
Lestidium sp.		6				2		1		1			10
Lestrolepis sp.		4	10	1	9	6			1	11			42
Stemonosudis rothschildi						1							1

Table 1 continued

SCOPELARCHIDAE													
Scopelarchus sp.		1	1			1							3
NOTOSUDIDAE													
Scopelosaurus sp.			2			5	2			1	1	1	12
BATHYPTEROIDAE													
unidentified sp.				3									3
MYCTOPHIDAE													
Benthosema pterotum		21	81	7	27	212	1			4		2	355
Benthosema suborbitale		1		2			2						5
Diaphus spp.		2	9	4	7	9				9			40
Diogenichthys atlanticus	1			1									2
Diogenichthys laternatus		1	1		1	2				2			7
Diogenichthys sp.		10	8	1	10	12				2			43
Hygophum proximum		1			1	2				1			5
Lampadena nana			1										1
Lampadena sp.					1	1							2
Lampanyctus spp.		6	8	1	9	13	2						39
Myctophum asperum	1	14	6	2									23
Myctophum nitidulum		1	1										2
Myctophum obtusirostre			2	1		1				1			5
Myctophum orientale			3	1	4	3	3	1	1	5			21
Myctophum spinosum										1			1
Myctophum sp.			1										1
Notoscopelus sp.		1			1								2
Symbolophorus sp.					1	1	1						3
Taaningichthys minimus										1			1
Triphoturos microchir			1								1		2
unidentified spp.		5	6		15	10	2			3			41
MORIDAE													
unidentified sp.			5										5
BREGMACERIDAE													
Bregmaceros arabicus						1							1
Bregmaceros atlanticus					1								1
Bregmaceros macclellandii										2			2
Bregmaceros nectabanus			1										1
Bregmaceros sp.		13	27	1	4	50	3		1	1		2	102
CARAPODIDAE													
unidentified sp.	1				3					1			5
OPHIDIIDAE													
unidentified sp.						3							3
CAULOPHRYNIDAE													
unidentified sp.						1							1
TRACHIPTERIDAE													
unidentified sp.						1							1
HOLOCENTRIDAE													
unidentified sp.						2							2

Table 1 continued

CENTROPOMIDAE											
unidentified sp.								1			1
PERCICHTHYIDAE											
Synagrops japonicus					9						9
Synagrops philipinensis					1						1
Synagrops sp.		2		10	27			3			42
unidentified sp.	1				1						2
SERRANIDAE											
Epinephelus sp.	1				1						2
unidentified sp.	7	10	1	9	20	1	1	6			55
SYMPHYSANODONTIDAE											
Symphysanodon katayamai								1			1
TERAPONIDAE											
unidentified sp.					1						1
PRIACANRHIDAE											
Priacanthus sp.		2			9						11
APOGONIDAE											
Apogon sp.		2		1							3
unidentified spp.	7	1		2	17			2			29
SILLAGINIDAE											
Sillago sihima		1									1
Sillago japonica					3						3
Sillago macalata					1						1
MALACANTHIDAE											
unidentified sp.				1		1					2
CARANGIDAE											
Alpes sp.		6			157			1		2	166
Caranx sp.		14			8						22
Decapterus macarellus	1	1		1							3
Decapterus macrosoma		19		1	12	1					33
Decapterus maruadsi		11	1	4	18	2		1			37
Decapterus muroadsi		3		1							4
Decapterus spp.		1		2	11					1	15
Elagatis bipinnulata		1			3						4
Pseudocaranx sp.		2			1						3
Scomberoides sp.					1						1
Selar crumenophthalmus		1									1
Trachurus japonicus	173	125		3	1						302
unidentified spp.		3			14	1	1	3			22
CORYPHAENIDAE											
Coryphaena hippurus	1	3		1	8				1		14
MENIDAE											
Mene maculata		3	1		13		1	1			19
LEIOGNATHIDAE											
Leiognathus sp.	1	14		1	12	1			1	1	31
BRAMIDAE											
Brama sp.	2	1		3	2		1	7			16

Table 1 continued

EMMELICHTHYIDAE											
unidentified sp.		3		1	3			4			11
LUTJANIDAE											
unidentified sp.	2	1	1	2	23				1		30
GERREIDAE											
unidentified sp.		1									1
HAEMULIDAE											
Hapalogenys hitens		2									2
unidentified sp.	1			1	1						3
SPARIDAE											
Acanthopagrus schlegeli		2			1						3
Evynnis cardinalis					1						1
Pagrus major								1			1
NEMIPTERIDAE											
Nemipterus sp.		3		2	12						17
SCIAENIDAE											
unidentified sp.	5	28		3	80			4	1	5	126
MULLIDAE											
unidentified sp.		6		2	16			1	2		27
GIRELLIDAE											
Girella sp.		1									1
CHAETODONTIDAE											
Chaetodon sp.					3						3
POMACENTRIDAE											
Chromis sp.					7	2					9
unidentified spp.	2	20		2	4		1			1	30
CIRRHITIDAE											
unidentified sp.	1	1			2			3			7
CEPOLIDAE											
Owstonia sp.					1						1
unidentified sp.	3	4	1	1	2						11
MUGLIDAE											
Liza sp.	2	5		2	4						13
SPHYRAENIDAE											
Sphyraena sp.		4		4	6	1					15
LABRIDAE											
Cirrhilabrus temminckii					1						1
unidentified sp.	1	2	2	3	16	1		4			29
SCARIDAE											
Scarus sp.					10						10
CHAMPSODONTIDAE											
Champsodon sp.	1	2			7						10
TRITHONOTIDAE											
unidentified sp.		1						1			2
CREEDIIDAE											
unidentified sp.					4						4

Table 1 continued

PERCOPHIDAE													
Spinapsaron sp.			4										4
unidentified sp.		1	1			13				1			16
MUGILOIDIDAE													
Parapercis sp.						9						1	10
BLENNIIDAE													
unidentified sp.		8	1		1	2	2			1			15
AMMODYTIDAE													
Embolichthys mitsukurii		1	4		2	3				2			12
CALLIONYMIDAE													
unidentified sp.		3	18		2	24				3	2		52
GOBIIDAE													
unidentified sp.		4	7		1	53				2	2	1	70
ACANTHURIDAE													
Naso brevirostris			1										1
unidentified sp.					1	4	1			2			8
SIGANIDAE													
Siganus sp.				1		16							17
GEMPYLIDAE													
Gempylus serpens			2					1					3
Nealotus tripes		1											1
Nesiarchus nasutus										2			2
unidentified sp.		3						2					5
TRICHIURIDAE													
Benthodesmus sp.		4	3		3	1	1						12
Trichiurus lepturus	2	70	89	11	33	168	2		1		1	2	379
unidentified sp.		1		1		1							3
SCOMBRIDAE													
Auxis sp.		3	18		7	499	1			3			531
Euthynnus affinis			1							1			2
Katsuwonus pelamis					1								1
Rastrelliger sp.		1	4										5
Scomberomorus commerson						1							1
Scomberomorus niphonius		1				1							2
Scomberomorus sp.			1			6							7
Scomber australasicus	2	97	241			12						2	354
Scomber japonicus	2	446	88		4	2							542
Thunnus alalunga		1		2	2								5
Thunnus albacares						1							1
Thunnus obesus										2			2
Thunnus thynnus		2			1		1						4
unidentified sp.			1			9				2			12
CENTROLOPHIDAE													
Hyperoglyphe sp.							1						1
Psenopsis anomala			2										2

Table 1 continued

NOMEIDAE													
Cubiceps pauciradiatus		1					1						2
unidentified sp.		1				1	1						3
PARALICHTHYIDAE													
unidentified sp.		1	1			3							5
BOTHIDAE													
unidentified sp.		1	13	1		23			1	3			42
PLEURONECTIDAE													
unidentified sp.		1	2		1								4
CYNOGLOSSIDAE													
Cynoglossus sp.		1	9			35	1			1		1	48
Symphurus sp.				1		1							2
SOLEIDAE													
Aseraggodes sp.						25							25
MONACANTHIDAE													
unidentified sp.						2							2
TETRAODONTIDAE													
Lagocephalus sp.			1										1
Takifugu sp.		2	1	1		15				2			21
DIODONTIDAE													
unidentified sp.					1								1
Unidentified spp.		13	2	3	4	12	2						36
Total no. of individuals	11	1155	1237	62	269	1968	45	6	10	141	28	26	4958
No. of species	7	70	102	30	71	125	32	5	10	60	13	17	187
No. of families	5	42	61	20	46	70	21	4	10	41	13	16	88
No. of eggs	77	5537	1656	161	229	1562	43	18	7	168	27	31	9516

4. Spatial distribution of larval fish abundance

The spatial distributions of dominant larval fishes were species specific. In March (Fig. 5), eggs were abundant at station 20 (1366 ind./1000 m^3), followed by stations 12, 10, and 15 (with 779, 544, and 437 ind./1000 m^3, respectively). Total numbers of larvae were high at stations 20, 28, and 7 (with 212, 128, and 124 ind./1000 m^3, respectively). *E. japonica* was abundant at stations 28, 9, 26, and 20 (with 52, 39, 14, and 11 ind./1000 m^3, respectively); *T. japonicus* was abundant at stations 20, 8, and 28 (with 57, 21, and 18 ind./1000 m^3, respectively); *S. australasicus* was abundant at stations 8, 29, and 26 (with 57, 11, and 10 ind./1000 m^3, respectively); and *S. japonicus* was abundant at stations 20, 28, and 23 (117, 49, and 35 ind./1000 m^3, respectively).

In April (Fig. 6), eggs were abundant at stations 19, 20, and 25 (with 622, 423, and 252 ind./1000 m^3, respectively). Total numbers of larvae were high at stations 36, 30, and 32 (at 205, 108, and 104 ind./1000 m^3, respectively). *E. japonica* was abundant at stations 35, 26, 28, and 19 (with 50, 33, 26, and 23 ind./1000 m^3, respectively); *T. japonicus* was abundant at stations 36, 33, and 30 (with 41, 23, and 19 ind./1000 m^3, respectively); *S. australasicus* was abundant at stations 36, 32, and 30 (with 85, 56,

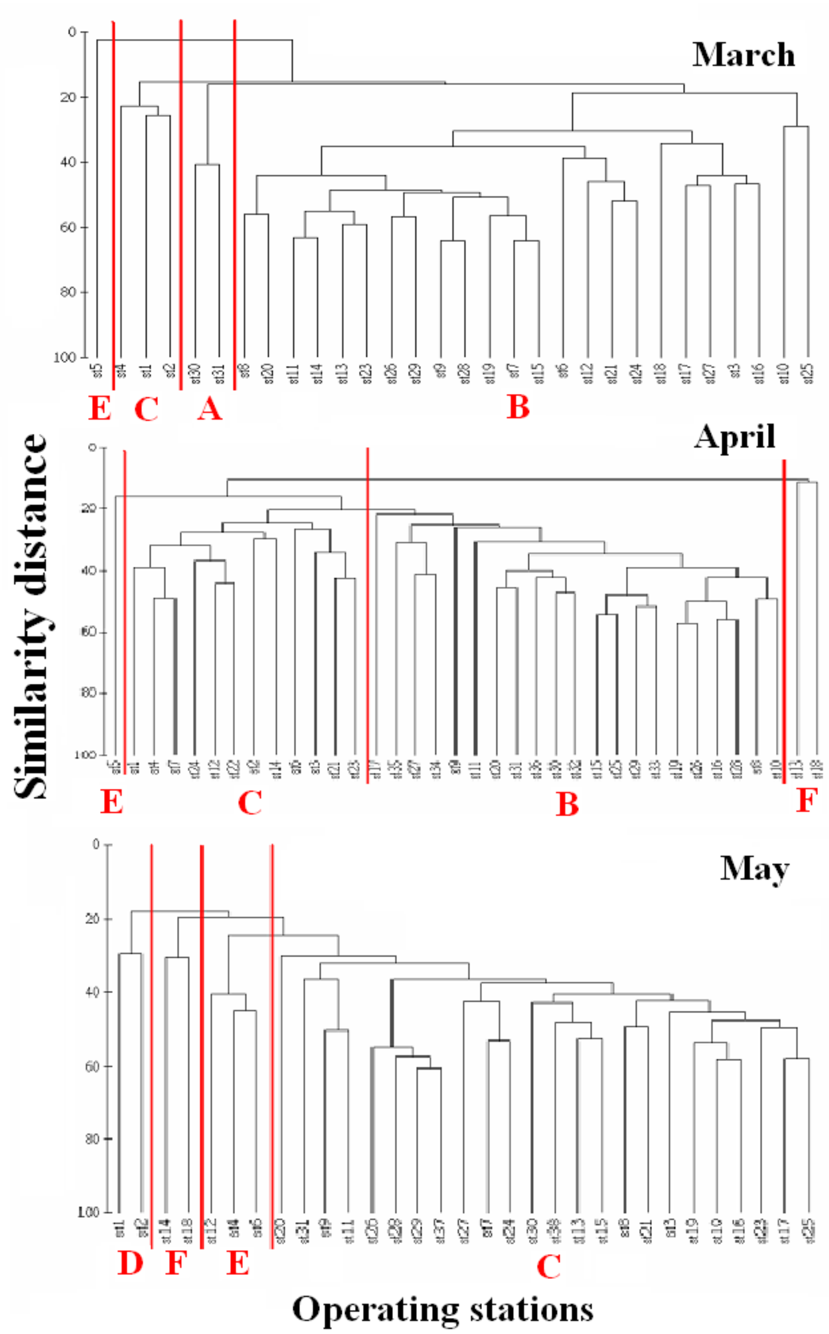

Fig. 4 Clustering of species compositions of fish larvae and juveniles among stations in the waters off NE Taiwan in spring 2005. For the species compositions of fish larvae of each of the station groups of A, B, C, D, E, and F, refer to Table 1.

and 30 ind./1000 m^3, respectively); and *S. japonicus* was only abundant at station 26 (with 35 ind./1000 m^3).

In May (Fig. 7), eggs were abundant at stations 4, 29, 19, and 30 (with 120, 116, 112, and 111 ind./1000 m^3, respectively). Total numbers of larvae were high at stations 29, 28, 26, and 15 (at 210, 198, 135, and 134 ind./1000 m^3, respectively). *B. pterotum* was abundant at stations 19 and 26 (with 39 and 25 inds./1000 m^3, respectively); *T. lepturus* was abundant at stations 28, 19, and 15 (18, 17, and 16 inds./1000 m^3, respectively). *Alepes* sp. was abundant at stations 29, 26 and 15 (with 17, 16, and 15 ind./1000 m^3, respectively); and *Auxis* sp. was abundant at stations 29, 15, and 30 (with 106, 43, and 34 ind./1000 m^3).

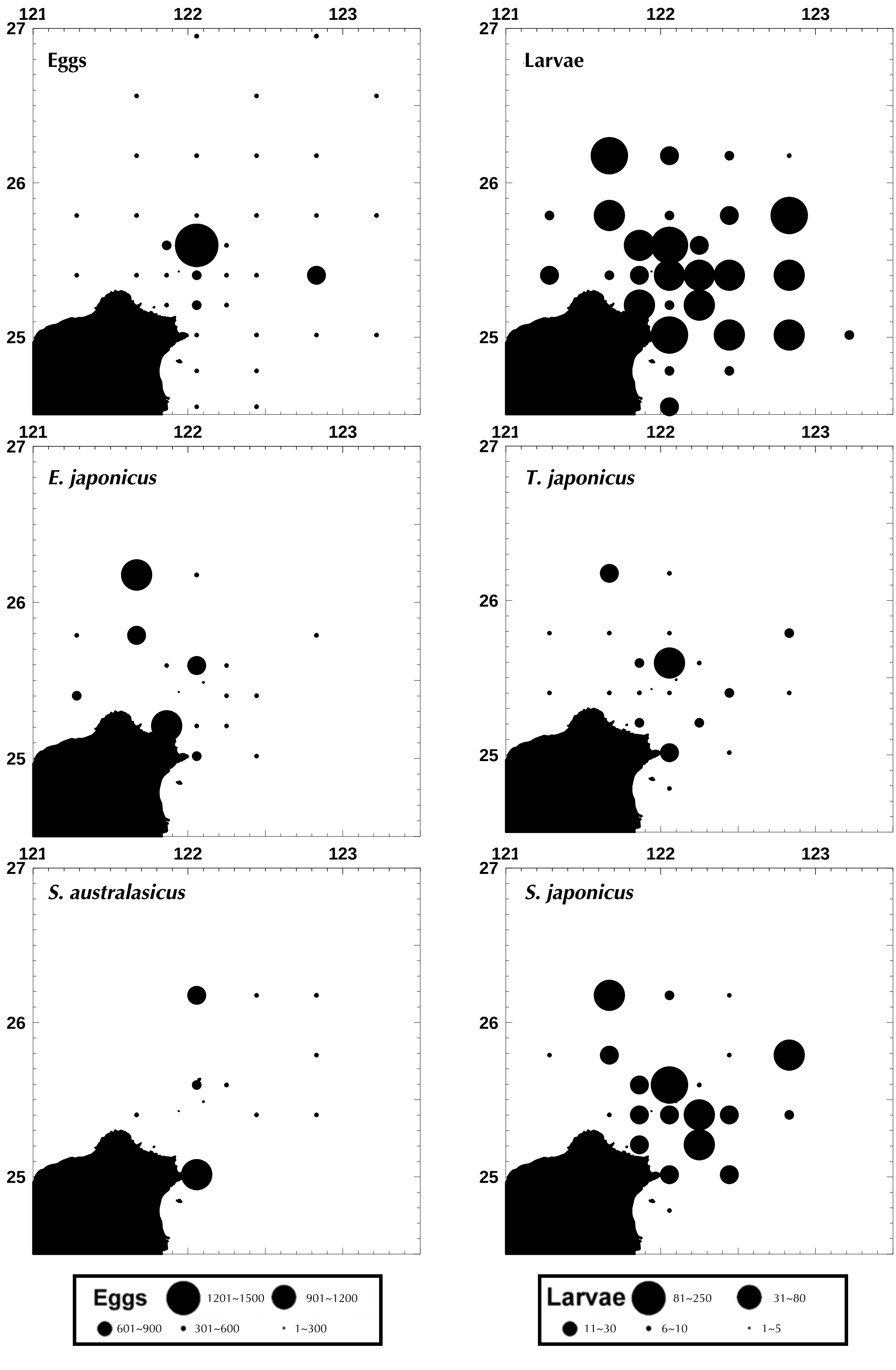

Fig. 5 Density distributions of fish eggs and dominant larval fishes in the waters off NE Taiwan in March 2005.

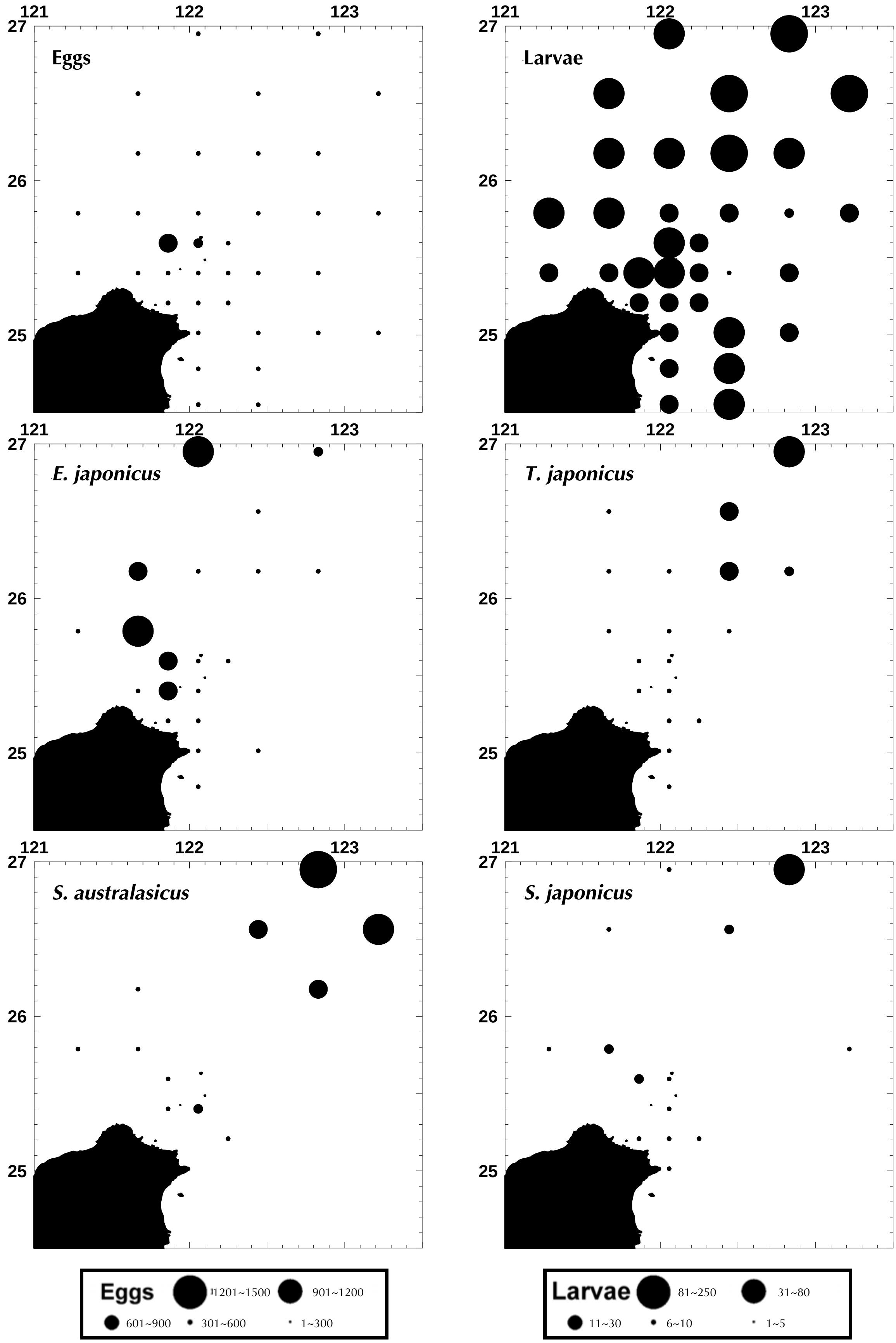

Fig. 6 Density distributions of fish eggs and dominant larval fishes in the waters off NE Taiwan in April 2005.

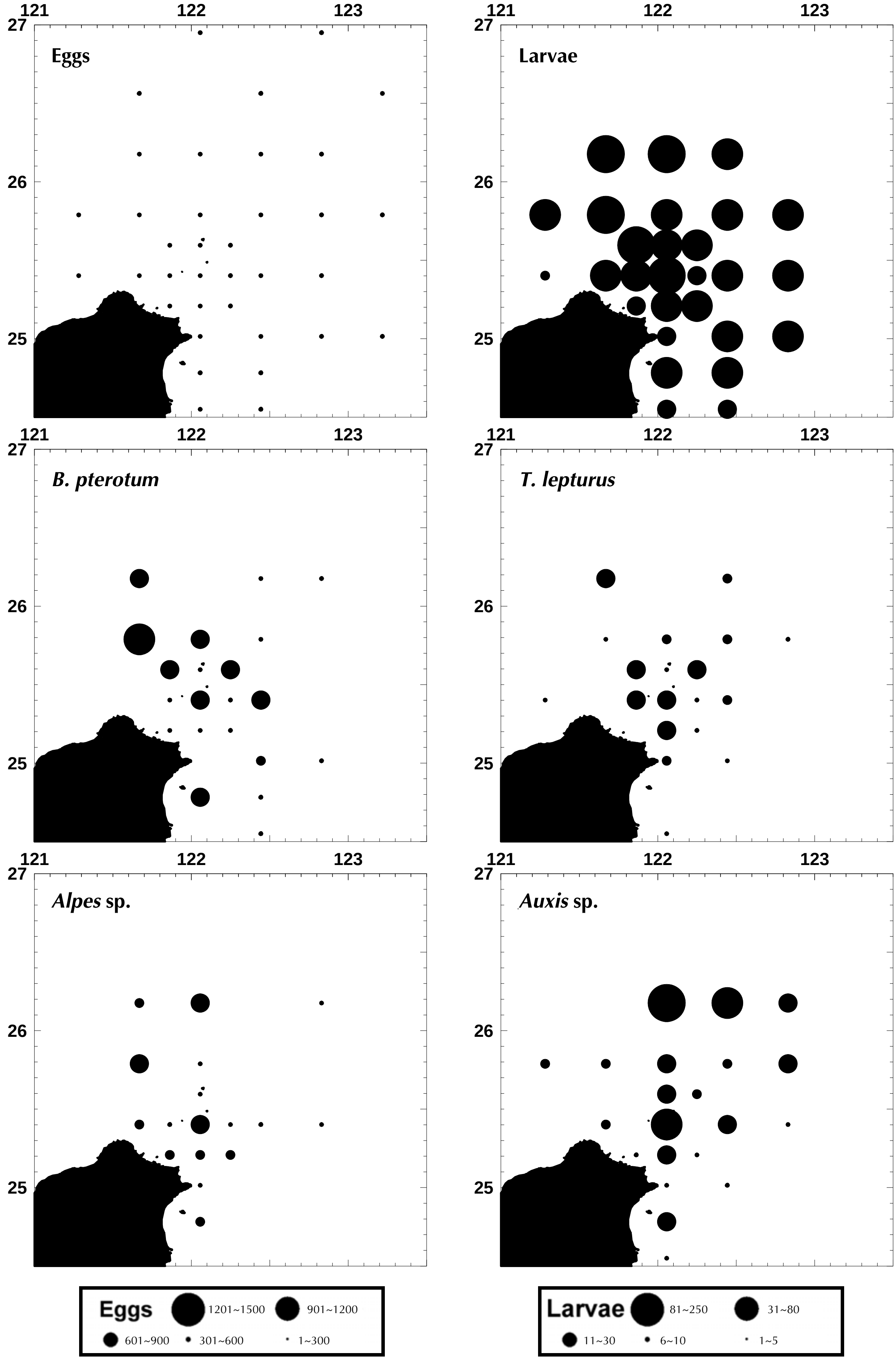

Fig. 7 Density distributions of fish eggs and dominant larval fishes in the waters off NE Taiwan in May 2005.

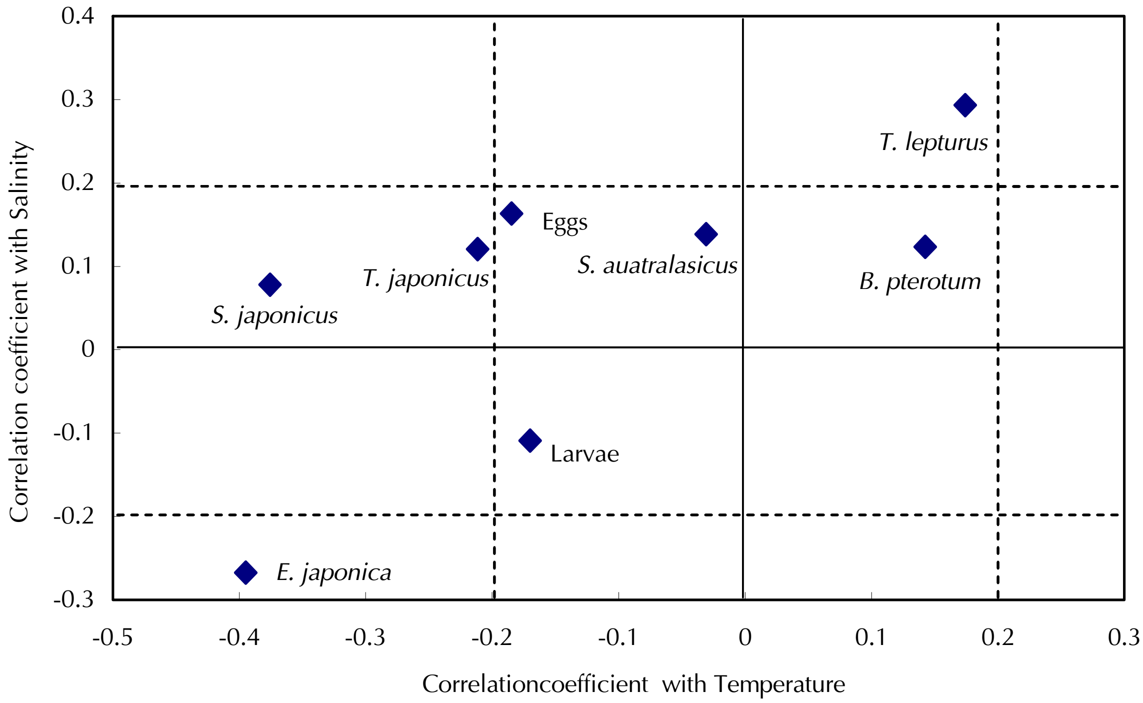

Fig. 8 Ordination of correlation coefficients between abundances and surface temperatures, and between abundances and surface salinities for total fish eggs and larvae as well as 6 dominant species in the waters off NE Taiwan in March and April 2005 (the dashed lines indicate correlations at the 5% significance level).

5. Relationships between fish abundances and sea surface temperatures and salinities

Relationships between the correlation coefficients of abundances of total eggs and larvae as well as the 6 dominant species to sea surface temperatures and salinities are shown in Fig. 8. *E. japonica* was significantly, negatively correlated with both temperature and salinity (p < 0.001 and 0.05, respectively); *S. japonicus* and *T. japonicus* were significantly, negatively correlated with temperature (p < 0.01 and 0.05, respectively); and *T. lepturus* was significantly, positively correlated with salinity (p < 0.05). Apparently, preferences for certain temperatures and salinities are species-specific for fish larvae.

DISCUSSION

The occurrence of dominant species and the spatial distributions of their abundances in the waters off NE Taiwan from March to May 2005 indicated that the species composition of fish larvae changed with month and station. This reflects the hydrographic characteristics of the area such as water temperature which may stimulate fish spawning.

We found that *S. japonicus* and *T. japonicus* mainly occurred near the area influenced by the Chinese Coastal Current with a temperature of 17 ~ 21 °C in March. In April, the Chinese Coastal Current becoming weaker and the Kuroshio Current stronger created upwelling of a cold eddy at depths of 30 ~ 40 m, the water temperature increased to 21 ~ 23 °C, and *S. australasicus* became the most dominant species with *S. japonicus* and *T. japonicus* relatively decreasing. This occurrence regime was also found in Yenliao Bay, northeastern Taiwan (Tzeng *et al*., 1997). This indicates that the water temperature preferences in the spawning season are species specific.

The waters off NE Taiwan are comprised of an oceanic front of the Kuroshio Current and Chinese

Coastal Current (Chern and Wang, 1989; Wong *et al*., 1991). Upwelling with enriched nutrients frequently occurs along the front (Liu *et al*., 1992). The isotherms in March and April indicated that the cold eddy at depths of 40~60 m in March was upwelling to the sea surface in April which may have been due to weakening of the Chinese Coastal Current with low temperature and low salinity and strengthening of the Kuroshio Current such that it caused upwelling to the surface. The movement of the cold eddy position may be one of the principal hydrographic factors affecting the distribution of fish larvae.

In general, productivity is higher in upwelling and oceanic front areas (Iles and Sinclair, 1982; Sabates and Olivar, 1996; Sournia, 1994). Fish eggs and larvae of dominant species were abundant at stations of 8, 9, 10, 12, 15, 20, and 28 where an oceanic front was found in March. However, eggs and larvae were more abundant in the northern part of the cold eddy and front than in the southern part in April. The mechanism of larval fish distribution in relation to the oceanographic structure is not clear and needs further study.

In conclusion, the occurrence of the fish larvae differed in terms of water temperature. The common mackerel, *S. japonicus*, and the scad, *T. japonicus*, occurred mainly at water temperatures of 16~21 °C, while the spotted mackerel, *S. australasicus*, occurred at 21~23 °C. Thus, monthly changes in water temperature can be used to predict the timing of recruitment of mackerel and scad on the East China Sea continental shelf.

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2005 年春季台灣東北部海域仔稚魚種類組成與分布

王友慈[1]・李嘉林[1*]・潘佳怡[2]・吳世宏[1]・曾振德[3]・程怡心[1]

[1]行政院農業委員會水產試驗所 海洋漁業組
[2]國立臺灣海洋大學 環境生物與漁業科學學系
[3]行政院農業委員會水產試驗所 企劃資訊組

摘要

為瞭解台灣東北部海域春季時鯖鰺仔稚魚出現及分布情形，於 2005 年 3~5 月間在該海域 (24.5~27.0°N, 121~123.5°E) 所規劃之 36 測站進行Bongo net仔稚魚網採集及利用溫深鹽儀測取水文基礎資料。本研究共計實施 3 航次 93 站次，計採獲仔稚魚標本 88 科 187 類 4,958 尾，其中白腹鯖 (*Scomber japonicus*)、花鰹 (*Auxis* spp.)、花腹鯖 (*Scomber australasicus*)、白帶魚 (*Trichiurus lepturus*)、日本鯷 (*Engraulis japonicus*)、七星魚 (*Benthosema pterotum*) 和真鰺 (*Trachurus japonicus*) 等 7 種的仔稚魚合佔總尾數的 56.2%。藉由仔稚魚密度 (individuals/1000 m^3) 及 Bray-Curtis相似性指數進行聚類分析的結果顯示，三、四及五月的仔稚魚群聚可劃分為 6 群，每個群的優勢魚種各有不同：3 月間，大部份的測站均以白腹鯖 (37.8%) 為主，真鰺與花腹鯖次之；4 月間，群組優勢種花腹鯖 (19.55%)、日本鯷 (14.03%) 及真鰺 (10.14%) 分布於該調查海域的西北部測站，然東南部的測站則以白帶魚和七星魚為主；5 月間，大部份的測站均以花鰹為主。由此可見，春季台灣東北部海域是鯖鰺的主要產卵場。仔稚魚出現的時間、空間變化非常明顯。仔稚魚出現的時間演替及空間分布特徵與成魚的產卵期及黑潮水團的月別變化有關。

關鍵詞: 仔稚魚、種類組成、鯖鰺魚類、臺灣東北部海域、黑潮

*通訊作者／基隆市和一路 199 號, Tel: 886-2-2462-2101; Fax: 886-2-2463-3110; E-mail: cllee@mail.tfrin.gov.tw