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SEASONAL DYNAMICS IN SPECIES COMPOSITION AND RICHNESS OF SMALL FISH ASSEMBLAGES IN THE INTERTIDAL AREA OF CHITO BAY, PENGHU, TAIWAN[1]

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Hong-Young Yan and Kun-Hsiung Chang (1985). Seasonal dynamics in species composition and richness of small fish assemblages in the intertidal area of Chito Bay, Penghu, Taiwan. *Bull. Inst. Zool. Acad. Sinica* **24**(1): 51-62. Small fish assemblages in the intertidal area of Chito Bay, Penghu were studied from July 1980 to June 1981. A total of 893 small fishes comprising 19 families, 28 species were collected. Among them, four species, *Scomberoides tol*, *Coelonotus liaspis*, *Acentrogobius criniger* and *Ctenogobiops maculosus* are new records to the fish fauna of Penghu Islands. Water temperature is the major environmental factor leading to the variation in species composition and richness. The small fish assemblage in each area can be regarded as a habitat community. Seagrass (shrimpgrass, *Halophila ovalis*, and eelgrass, *Thalassia hemprichii*) beds are the habitats associated with higher species richness. The significance of the seagrass beds for associated small fish assemblages is discussed.

It is well known that in temperate and subtropical zone utilization of embayments by small and adult fishes is markedly seasonal with high abundances corresponding to the warmer, highly productive months of spring through the autumn. Seasonal species typically spend one spring-autumn period in the shallows of a bay, where they grow at an accelerated rate in the warm, productive waters. (Cronin and Mansueti, 1971)

Worldwide seagrass beds are one of the most widespread and recurrent biotope types in the estuarine or coastal environments (Azuma and Harada, 1968; Rasmussen, 1973) Besides high biological productivity of the seagrass and associated flora, a rich fauna is always concentrated in the seagrass (Kikuchi, 1980). Chang *et al.*, 1981 reported that seagrass beds are widely distributed in the intertidal area of Chito Bay, Penghu Islands.

Penghu Islands (also known as Pescadores Archipelago) with their extended serrated coastlines and many shallow bays have an abundance of marine life. Recognition of the importance of those bays as feeding and nursery grounds for benthic macroinvertebrates and shrimps, and the need to assess existing or potential alternation by man, have resulted increased attention to these bay areas (Chang *et al.*, 1981; Hsieh *et al.*, 1981).

Knowledge of the fishes inhabiting Penghu

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Islands is largely confined to lists of large and adult specimens (Chen, 1969; Chu, 1956; Lee, 1967; Liang, 1948; Tsai, 1960). No information is currently available for the small (including juvenile) fish assemblages in the Penghu Islands. This lack of information provides the impetus for the present study.

The main purpose of the study is to assess in terms of abundance, diversity, and species composition and seasonal variation of the small fish community occurring in the shallow waters of Chito Bay in Penghu Islands, and key environmental factors that are influencing the small fish assemblages there are also discussed.

MATERIALS AND METHODS

From July 1980 to June 1981, monthly collections (except May 1981) of small fishes were made in shallow waters of the intertidal area of Chito Bay (23° 39' N, 119° 36' E) during low tide after dark. Fish sampling was performed with the use of a seine 2m wide by 1.5m long with 5mm mesh size. Water temperature (°C) and salinity(‰) were measured *in situ* at the time of collection.

The study site (Fig. 1) can be subdivided into five different types of habitat at ebb tide. A creek, about 5m wide and 20cm in depth, ran through Area A. The creek carried the sewage waste from the village. In the upstream region, the bottom was composed of fine sand; however, coral debris was the major component in the downstream area. At Area B, the major components of the bottom were fine sands with water less than 10cm deep. A creek 10–15m wide and 20–30cm deep ran into Area C: here the bottom was of gravels and coral debris, with sands on both sides of the creek. Area D, located at average low tide level, the bottom was covered with shrimp grass, *Halophila ovalis*, and eelgrass, *Thalassia hemprichii*. Sea pens, *Scytalium splendens*, were quite abundant here, Area E was located north-east of Area D, and was covered with more eelgrass than shrimp grass. Here water depth was 5-10cm, and this area was sandier than Area D. The total area of study sites was ca 2 km².

During monthly collections, seining was made about every 10–30 meters, the collected specimens were then picked up and preserved in 10% formalin in the field. About five seine hauls were made in each area. Preserved specimens were then brought back to the laboratory for further analysis. The specimens were identified after Flower and Bean (1929), Chen (1969), Masuda *et al.*(1975), and Chang *et al.*, (1979). Standard length (in mm) was measured to the nearest 0.1mm.

SPSS (Statistical Package for the Social Sciences) (Nie *et al.* 1975), Version 8.3 on CDC 6000/Cyber at The University of Texas at Austin Computation Center was used to compute simple and stepwise multiple correlation coefficients between the number of fish species, abundance and the monthly measures of water temperature and salinity.

Species diversity indices for monthly collected samples and for area-pooled samples were calculated from the Shannon formula (Hill, 1973; Pielou, 1966; Shannon and Weaver, 1963):

$$H' = -\sum_{i=1}^{S} \frac{N_i}{N} \ln \frac{N_i}{N}$$

Where N_i is the mumber of individuals in the taxon, and N is the total number of individuals of all taxa. S is the total number of taxa. The analysis of similarity between all pairs of small fish assemblage in different sampling areas was carried out by applying a modified version of Schoener's index of niche overlap (Schoner, 1968):

$$d=\left[1-\sum_{i=1}^{n} \frac{|X_i - Y_i|}{|X_i + Y_i|}\right]\times 100$$

where X_i and Y_i represented the abundance values (in number) for each species i for a total of n species on all pairs of habitats (Area A to Area E). This index theoretically ranges from 0 for two habitats with no species in common to 100 for two habitats with all species present on both habitats and in the same abundance categories. The

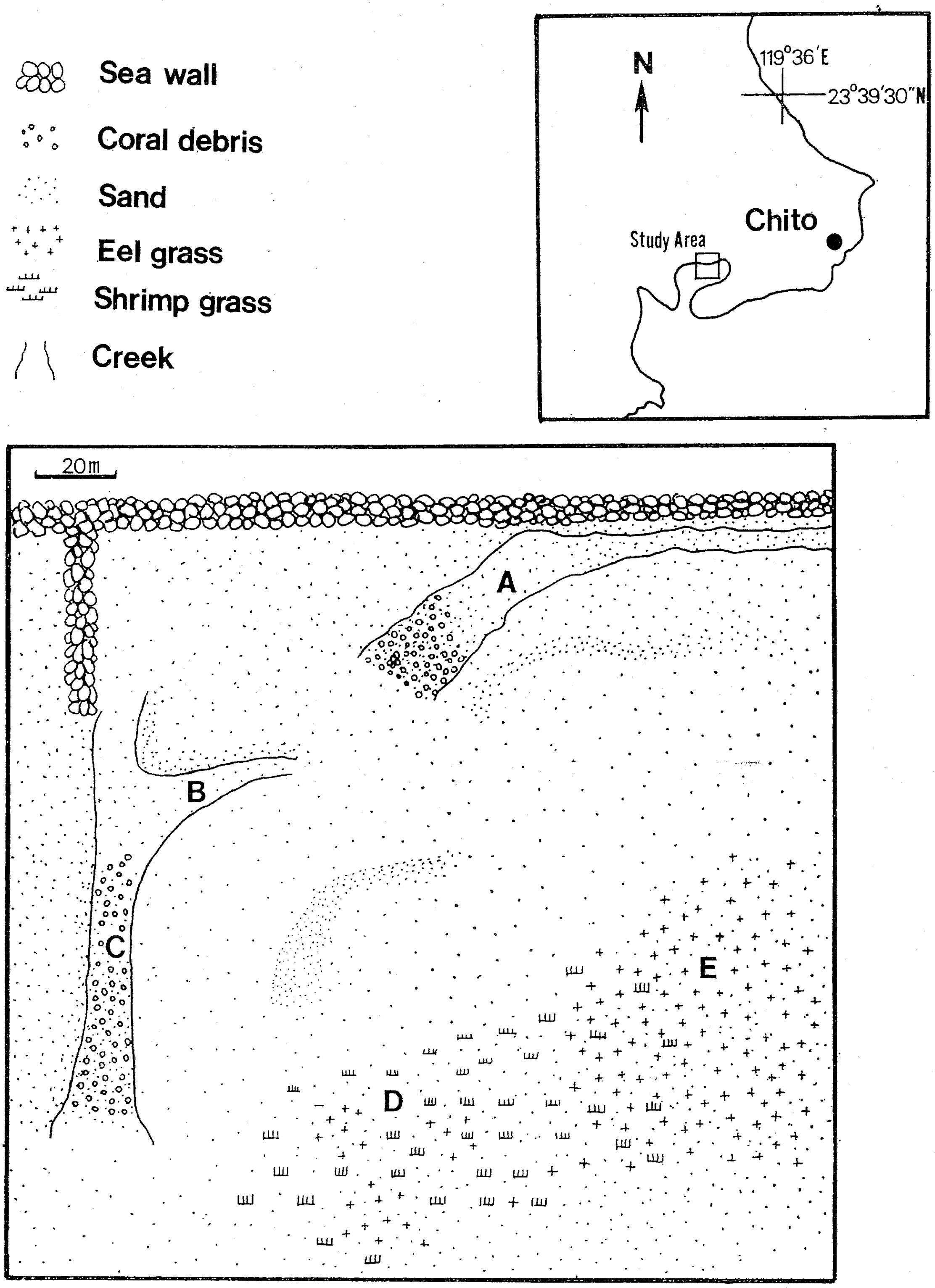

Fig. 1. Study area (Areas A-E) of Chito Bay, Penghu.

resulting indices of similarity were combined into a matrix and were further reduced by constructing a dendrogram based on the matrix values (Cody, 1974).

RESULTS

A total of 893 small fishes comprising 19 families and 28 species were taken during this study (Table 1, 2).

Of the 28 species collected, two species, *Gerres oyena*, and *Liza parva*, composed approximately half (49.9%) of the individuals. *Gerres oyena*, occurred almost all year round. It was distributed in five different habitats (Table 3), however, most of the collections were made in Area A. *Liza parva*, occurred throughout the year. Like *Gerres oyena*, it was widely scattered in five habitats, but 116 out of 186 individuals were collected from Area A.

Three species, *Siganus oramin*, *Terapon jarbua*, and *Acentrogobius criniger* each had around 6% of the total numbers. *Siganus oramin* was restricted to Areas of D and E, and no specimens were collected between February and April, 1981. *Terapon jarbua* occurred everywhere except in Area E, and September 1980 was the only month without this species in the collection. *Acentrogobius criniger* was found in Areas A, B, E, and specimens were collected in all months except November 1980 and January 1981.

Next in abundance (4.5-5% each) were *Liza pescadorensis*, *Pranesus insularum*, and *Stephanolepis japonicus*. *Liza pescadorensis*, occurred in October and November and was distributed in Areas A, B, and C. *Pranesus insularum* was collected only in October, November and December 1980, and was confined to Areas B and C. *Stephanolepis japonicus* occurred from July to October 1980, and again found in June 1981, during our last collecting period.

Lethrinus haematopterus, *Fugu niphobles*, and *Ctenogobiops maculosus* were three species which each comprised about 3% of the total numbers collected. *Lethrinus haematopterus* was collected only in July, August 1980 and June 1981 in Areas D and E. *Fugu niphobles* occurred almost all year round except in October 1980 and January 1981, and was restricted to Areas A, B, and C. *Ctenogobiops haematopterus* was collected in Areas A and E, between October and December 1980, and in February, March and June 1981.

Of the remaining 17 species of small fishes, each had about 1% or less of the total numbers collected. The occurence of all these fishes was restricted to certain months of the year. Their distribution was almost confined to Areas A, D, and E. *Pelatus quadrilineatus* was the only species that occurred in Areas B and C.

The monthly variation in the number of species and individuals collected (Table 1) indicates that August and October 1980 were the two months with highest number of species (15 species) collected. In July 1980 and in June 1981, however, 12 species were collected, and 11 species were collected in November 1980.

Stepwise multiple regression analysis revealed a significant correlation between number of species, abundance and water temperature (Table 4; Figs. 2, 3).

Area E ranked highest in the number of species collected (17 species), Area D ranked second with a total of 13 species. Area A ranked third for richness of species, however, its abundance was the highest among five habitats. Areas B and C were equally rich in number of species with Area B having slightly higher abundance. As for the species diversity, H′, Area D had the highest value, Area B was second, Areas A and E were tied third and fourth places and Area C had the lowest diversity index (Table 3).

The fish assemblage similarity dendrogram (Fig. 5) indicates that the first major division occurs between the fish assemblages of Areas D-E and Areas A-B-C. The similarity index, (d), between these two major divisions is only 18.2. The second dichotomy, within the

TABLE 1

Numerical abundance, standard length (SL) and mean standard length ($\bar{X}$) of small fish species in seine collections from Areas A–E, Chito Bay, Penghu. July 1980–June 1981

Species \ Time	Jul. '80	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. '81	Feb.	Mar.	Apr.	Jun.
	No. SL ($\bar{X}$)	No. SL ($\bar{X}$)	No. SL ($\bar{X}$)	No. SL ($\bar{X}$)	No. SL ($\bar{X}$)	No. SL ($\bar{X}$)	No. SL ($\bar{X}$)	No. SL ($\bar{X}$)	No. SL ($\bar{X}$)	No. SL ($\bar{X}$)	No. SL ($\bar{X}$)
Ophichthyldae											
Pisoodonophis cancrivorus							1 18.5 (18.5)			1 18.8 (18.8)	
Plotosidae											
Plotosus anguillaris				3 85.9-89.2 (86.5)							
Atherinidae											
Pranesus insularum				16 23.9-32.7 (25.8)	18 27.0-36.6 (29.5)	8 25.8-42.3 (35.7)					
Monacanthidae											
Stephanolepis japonicus	5 24.7-53.6 (30.8)	11 24.2-53.5 (39.4)	3 42.8-50.9 (46.4)	2 47.3-70.8 (59.1)							19 11.1-26.7 (21.3)
Tetradontidae											
Fugu niphobles	7 27.2-31.0 (28.5)	3 39.8-61.5 (45.6)	1 53.0 (53.0)		3 51.8-62.9 (56.4)	1 62.5 (62.5)		2 57.7-65.7 (61.7)	2 18.1-78.7 (48.4)	2 60.5-67.6 (64.1)	7 18.8-73.6 (27.0)
Fistularidae											
Fistularia petimba				1 220.8 (220.8)							
Scombridae											
Scomberoides tol		1 66.5 (66.5)		1 70.4 (70.4)	1 69.0 (69.0)						
Mugilidae											
Liga parva	25 20.8-57.2 (25.6)	13 29.1-42.3 (35.5)	25 29.6-60.8 (43.6)	7 46.7-54.8 (51.9)	7 46.7-61.0 (54.9)	11 45.0-70.8 (58.4)	6 16.3-62.9 (45.0)	15 11.7-55.6 (39.0)	24 16.2-57.0 (35.2)	20 24.2-59.8 (26.5)	33 15.6-22.3 (18.5)
Liza melinoptera							1 42.2 (42.2)				
Liza carinata						3 39.3-76.3 (54.5)					
Liza pescadorensis				37 30.3-35.4 (33.1)	8 31.7-38.5 (35.6)						
Syngnathidae											
Coelonotus liaspis	3 61.1-64.6 (62.9)	8 42.8-68.3 (65.4)		1 72.5 (72.5)							
Sphyranidae											
Sphyraena japonica		1 90.6 (90.6)									1 44.3 (44.3)
Sillaginidae											
Sillago maculata	4 51.0-67.6 (59.2)	2 54.7-76.1 (65.4)									
Gerreidae											
Gerres oyena	23 19.7-37.5 (24.6)	65 19.5-52.5 (32.5)	36 12.5-46.7 (35.6)	22 27.8-48.3 (40.0)	26 29.3-58.9 (43.4)	31 28.9-47.5 (45.2)	7 28.9-47.5 (40.6)	8 27.9-48.8 (42.3)	4 35.5-47.8 (40.2)		38 11.7-25.0 (15.8)
Lethrinidae											
Lethrinus haematopterus	9 16.3-19.5 (16.9)	13 24.0-30.6 (26.7)									7 18.5-29.8 (19.5)
Lutjanidae											
Lutjanus monostigma	3 19.3-28.0 (23.9)	1 56.0 (56.0)		1 82.9 (82.9)							
Teraponidae											
Terapon jarbua	6 27.2-70.0 (34.6)	7 30-48.8 (39.8)		3 21.1-62.6 (43.2)	3 34.5-63.5 (47.7)	9 26.5-85.2 (52.8)	3 25.6-28.2 (26.8)	4 35.3-72.8 (45.6)	3 25.2-46.3 (35.6)	5 37.3-80 (52.7)	12 14.2-67.0 (25.6)
Pelatus quadrilineatus		1 39.8 (39.8)	1 65.0 (65.0)	3 70.7-79.5 (75.3)							3 26.3-30.0 (28.3)
Carangidae											
Carnax deliecatissimus	9 33.3-42.3 (35.8)	1 21.3 (21.3)									
Gobiidae											
Oligolepis acutipinnis							6 19.4-41.8 (25.6)	3 35.0-39.8 (37.1)			
Acentrogobius sp.							1 50.4 (50.4)				
Acentrogobius criniger	6 17.5-40.3 (30.5)	3 49.4-51.8 (50.5)	15 37.5-60.5 (48.6)	17 40.0-63.7 (54.2)		1 53.0 (53.0)		1 53.2 (53.2)	5 54.8-67.7 (56.7)	4 28.3-36.0 (31.7)	2 55.3-58.3 (56.8)
Ctenogobiops maculosus				3 22.1-36:2 (29.6)	5 25.4-31.7 (30.6)	2 25.4-42.3 (33.9)		9 18.5-42.5 (36.2)	7 33.8-41.7 (38.1)		1 29.0 (29.0)
Glossogobius giuris brunnens					1 28.2 (28.2)						
Bathygobius fuscus					1 56.5 (56.5)						
Siganidae											
Siganus oramin	9 20.0-40.0 (32.4)	16 25.4-52.5 (40.8)	4 46.8-57.9 (51.9)	4 43.7-67.7 (56.2)	11 48.6-59.5 (57.7)	2 54.4-62.7 (58.6)	6 50.0-66.5 (61.4)				6 17.7-30.8 (22.5)
Labridae											
Cheilinus trilobatus											1 91.5 (91.5)
No. of species	12	15	7	15	11	9	8	7	6	5	12
No. of individual	109	146	85	121	84	86	31	42	45	32	130
H'	2.24	1.92	1.40	2.06	1.95	1.64	1.85	1.66	1.40	1.15	1.93

TABLE 2
Juvenile fish species taken from combined collections at all areas (Area A - Area E) in Chito Bay, during July 1980-June 1981, ranked by abundances

Species	Abundance	%	Rank
Gerres oyena	260	29.1	1
Liza parva	186	20.8	2
Siganus oramin	58	6.5	3
Terapon jarbua	55	6.2	4
Acentrogobius criniger	54	6.0	5
Liza pescadorensis	45	5.0	6
Pranesus insularum	42	4.7	7
Stephanolepis japonicus	40	4.5	8
Lethrinus haematopterus	29	3.2	9
Fugu niphobles	28	3.1	10
Ctenogobius maculosus	27	3.0	11
Coelonotus liaspis	12	1.3	12
Carnax deliecatissimus	10	1.1	13
Oligolepis acutipinnis	9	1.0	14
Pelatus quadrilineatus	8	0.8	15
Sillago maculata	6	0.6	16
Lutjanus monostigma	5	0.5	17
Plotosus anguillaris	3	0.3	18
Scomberoides tol	3	0.3	18
Liza carinata	3	0.3	18
Pisoodonophis cancrivorus	2	0.2	19
Sphyraena japonica	2	0.2	19
Fistularia petimba	1	0.1	20
Liza melinoptera	1	0.1	20
Acentrogobius sp.	1	0.1	20
Glossogobius giuris brunnens	1	0.1	20
Bathygobius fuscus	1	0.1	20
Cheilinus trilobatus	1	0.1	20

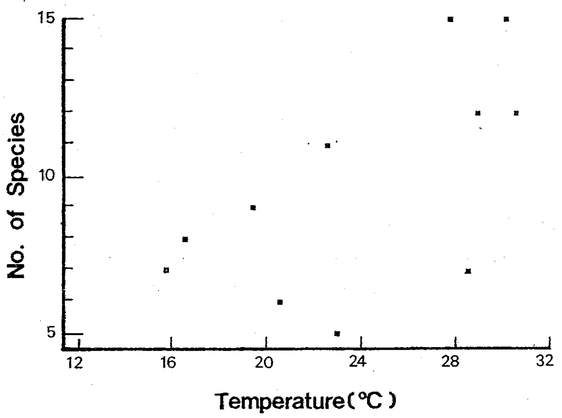

Fig. 2. Relationship of temperature and number of species collected in Chito Bay, Penghu. July 1980-June 1981. (r=0.622)

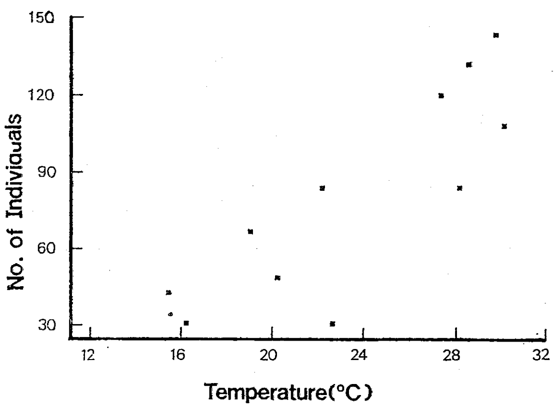

Fig. 3. Relationship of temperature and number of individuals collected in Chito Bay, Penghu. July 1980-June 1981. (r=0.847)

TABLE 3

Numerical abundance of juvenile fish species in seine collections from five different habitats (Areas A–E) in Chito Bay, Penghu Islands. July 1980–June 1981. H′: Diversity index

Species	Area A	Area B	Area C	Area D	Area E
Gerres oyena	192	30	21	10	7
Liza parva	116	32	18	10	10
Siganus oramin				38	20
Terapon jarbua	10	25	15	5	
Acentrogobius criniger	30	10			14
Liza pescadorensis	30	7	8		
Pranesus insularum			30	12	
Stephanolepis japoicus				29	11
Lethrinus haematopterus				10	19
Fugu niphobles	18	3	7		
Ctenogobiops maculosus	5				22
Coelonotus liaspis				12	
Carnax deliecatissimus				5	5
Oligolepis acutipinnis	1				8
Pelatus quadrilineatus		4	4		
Sillago maculata				1	5
Lutjanus monostigma					5
Plotosus anguillaris					3
Scomberoides tol				1	2
Liza carinata	3				
Pisoodonophis cancrivorus				2	
Sphyraena japonica					2
Fistularia petimba				1	
Liza melinoptera	1				
Acentrogobius sp.	1				
Glossogobius giuris brunnens					1
Bathygobius fuscus					1
Cheilinus trilobatus					1
H'	1.46	1.66	1.01	2.10	1.45
Number of species	11	7	7	13	17
Number of individuals	407	111	103	136	136

TABLE 4

Effects of water temperature (T), salinity (S) on number of species (R) and abundance (N) of juvenile fish in Chito Bay, analyzed by stepwise multiple regression analysis

Independent variable	No. of species (R) Contribution to R^2	No. of species (R) Partial F	No. of species (R) Order[a] entered in equation	Abundance (N) Contribution to R^2	Abundance (N) Partial F	Abundance (N) Order[b] entered in equation
Temperature (T)	0.387	5.685[c]	1	0.717	22.803[d]	1
Salinity (S)	0.103	1.611	2	0.007	0.189	2
Overall R^2, F	0.490	7.296[c]		0.724	22.992[d]	

a. The multiple linear regression equation is: $R=-66.059+0.763(T)+1.760(S)$
b. The multiple linear regression equation is: $N=-269.033+7.528(T)+5.216(S)$
c. Significant at 0.05 level; other values are not significant
d. Significant at 0.001 level; other values are not significant

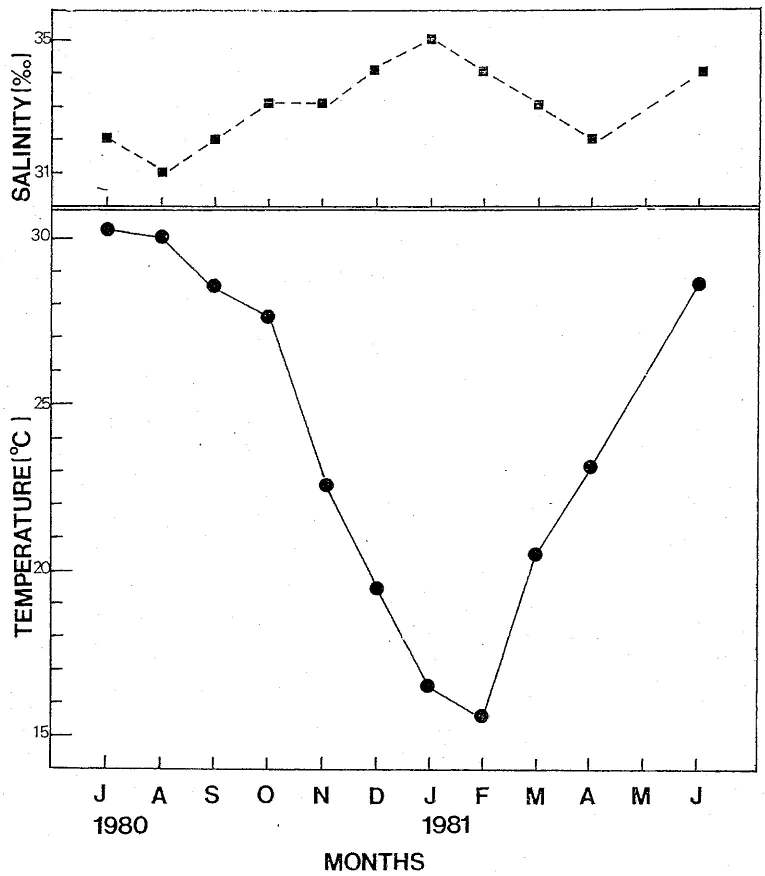

Fig. 4. Monthly temperature and salinity variations at study area in Chito Bay, Penghu. July 1980-June 1981.

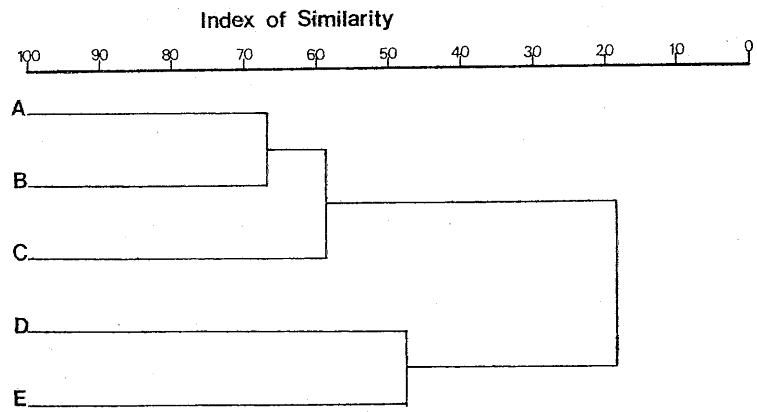

Fig. 5. Similarity dendrogram among the five small fish assemblages in Chito Bay, Penghu.

groups of Areas A-B-C, sets off the assemblages of Areas A-B from Area C. The similarity index between A-B and C is 58.7. Fish assemblages in Area A and B show the highest similarity value (67.0). The similarity index for fish assemblages in Areas D and E is 47.8.

DISCUSSION

The results of this study add four new records to the fish fauna list of Penghu Islands, these are: *Scomberoides tol*, *Coelonotus liaspis*, *Acentrogobius criniger*, and *Ctenogobiops maculosus*. It also indicates that the small fish populations of Chito Bay undergo seasonal variation not only in abundance (in number), but also in species composition. Just a small number of species (eight) accounted for a large proportion (82.9%) of the total number of individuals collected. Similar situations have been reported in many estuarine fish populations (Allen, 1982; Allen and Horn, 1975).

The collection data (Table 1) indicate that the following species of small fish use Chito Bay as their nursery ground, although they differ in their seasonal utillization of this area: *Pranesus insularum*, *Stephanolepis japonicus*, *Fugu niphobles*, *Liza parva*, *Liza pescadorensis*, *Coelonotus liaspis*, *Sillago maculata*, *Gerres oyena*, *Lethrinus haematopterus*, *Lutjanus monostigma*, *Terapon jarbua*, *Pelatus quadrilineatus*, *Oligolepis acutipinnis*, *Acentrogobius criniger*, *Ctenogobiops maculosus*, and *Siganus oramin*. The respective growth rate of each species during its occurrence in Chito Bay can be inferred from the change of mean standard length in the monthly samples (Table 1).

The year round collection of the small fish shows that in Chito Bay both number of species and abundance are seasonaly variable. The major factor in determining this seasonal variation in small fish assemblages would be temperature (Table 4; Figs. 2, 3). The general pattern of increased species diversity and abundance during the late spring through autumn period in the study area has been reported in many other studies of temperate bay-estuarine fishes (Allen, 1982; Allen and Horn, 1975; Dahlberg and Odum, 1970). Although many studies on estuarine fish populations have noticed summer depressions in abundance between peaks in spring and fall in other estuaries and bay areas (Azuma and Harada, 1968; Horn, 1980), no summer depression was observed in this study. The explanation for the September 1980 depression in both number of species and individuals is that the collection was made three days after a typhoon swept across penghu Islands. Moore (1978) documented that besides altering salinity conditions, hurricanes (typhoons) also exert a considerable scouring effect upon the community of bay fishes and invertebrates. Since total precitation in September 1980 in Penghu Islands was only 17.3 mm, and little variation in salinity was observed, the scouring effect from the typhoon might have been the major cause leading to the September depression.

Several causes can lead to the seasonal fluctuations of bay-estuarine fish populations, but temperature and salinity seem to be the two underlying factors (Azuma and Harada, 1968; Blaber, 1974). The significant correlations between temperature and monthly abundance and species richness in this study indicate the general importance of this factor to the small fish assemblages. Since only slight variation in salinity was observed during the study period, the salinity factor (Table 4) should not have greatly influenced the seasonal variation of fish abundance and species diversity in Chito Bay.

Areas D and E which are the two habitats with seagrass, *Halophila ovalis*, and *Thalassia hemprichii*; both had a higher number of species than the other three areas. The ecological importance of seagrass beds includes: (1) providing shelter and substrates to organisms; (2) reducing the ambient water movement created by currents and waves; (3) trapping sediments, some of which can be used by organisms in the seagrass beds; (4) reducing excessive illumination in the daytime, the shaded condition seems to be beneficial to animals living in the seagrass beds; (5) providing shelter and food for small-sized nekton; and (6) providing spawning sites for some fish and cephalopods which lay adhesive eggs (Dexter, 1950; Kikuchi, 1961; Kikuchi, 1980). Denser eelgrass beds in Area E can have more structural divergence of microhabitats in it which can offer better shelter for more small fish species ($n=17$) than Area D ($n=13$). Organic waster from sewage discharge in Area A can provide various forms of nutrients to small fish species; this effect might have resulted in Area A having a higher species richness ($n=11$) than Areas B and C, respectivly ($n=7$).

Sand and coral debris are the major components in the bottom of Areas A, B, and C. Seagrass beds are the major feature in Areas D and E. The fish assemblage similarity indices clearly indicate the difference between these two types of habitats. In this study, the small fish assemblage in each area can be regarded as a habitat community. Area B to some degree can receive sewage discharge from Area A, which may explain why the habitat communities in these two areas have a higher similarity index.

The community is the product of a long evolutionary history that has resulted in mutual co-adaptions for sharing the available resources in the general environment (Smith and Powell, 1971). Although no attempt has been made to reveal the overlap in the food niche among the small fish in this study; however, the small area involved, about 2km^2, is able to accommodate 28 species of fish annually, this shows that the fish assemblages in the Chito Bay have a minimum of direct interspecific competition.

Habitat complexity has often been implicated as an important determinant of species richness in aquatic habitats (Werner *et al.*, 1978). More productive habitats should allow for greater dietary specialization under conditions of evolutionary equilibrium (MacArthur and Wilson, 1972). Higher fish species diversity can be found in stable environments than in unstable environments (Horwitz, 1978; Kushlan, 1976; Mahon and Balon, 1977). Seagrass beds are among the ecosystems with high complexity, productivity, and stability (Orth, 1973). 17 species out of 28 species of small fish collected in this study are restricted in their distribution to habitats within seagrass beds (Areas D and E): the facts reflect the effect and importance of seagrass beds in attracting more species of small fish to them. Hence any kind of disturbance to the seagrass beds may result in the decline of the small fish assemblages there.

Rapid industralization of the coast, and increasing water pollution, thermal effluents, and dredging have led to the disappearance of the seagrass cover in Inland Sea of Japan (Seto Naikai) (Naikai Regional Fishery Research Laboratory, 1967), Great South Bay in New York (Briggs and O'Connor, 1971), Biscayne Bay in Florida (Roessler and Zieman, 1968), and Boca Ciega Bay in Florida (Taylor and Saloman, 1968). Disappearance of the seagrass cover can additionally cause errosion of surface substrates, and reduction of organic material content in the sediments (Wilson, 1949). As epifaunal and infaunal populations decling and their species composition change, the diversity and density of fish are also reduced (Oshima, 1954). With the fact that a long term and large scale mariculture project has been proposed for Chito Bay and other parts of the Penghu Islands, the authors here express their great concern for the conservation of seagrass beds in the Penghu Islands in order to prevent any deleterious impacts on the small fish assemblages associate with seagrass beds.

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澎湖歧頭灣潮間帶小型魚類種別及數量季節性變動之研究

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本研究自 1980 年 7 月至 1981 年 6 月在澎湖歧頭灣潮間帶共捕獲 893 尾小型魚類，分屬 19科 28種。其中 *Scomberoides tol, Coelonotus liaspis, Acentrogobius criniger* 及 *Ctenogobiops maculosus* 係爲澎湖魚類相的新記錄。經由複廻歸分析顯示水溫係決定此一地區小型魚類種別組成及數目的季節性變化的主要環境因子。本報告亦對海草床的生態重要性及其與棲息於其中的小型魚類的相關係加以討論。