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ECOLOGICAL STUDY ON SOME INTERTIDAL FISHES OF TAIWAN

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ABSTRACT

K. H. Chang, S. C. Lee, J. C. Lee and C. P. Chen (1973). *Ecological study on intertidal fishes of Taiwan.* Bull. Inst. Zool., Academia Sinica, 12(2): 45-50. By statistical analysis of the samples collected from Patoutzu and Maopitou which represent subtropical and tropical regions, respectively in Taiwan, it is suggested that the frequency distribution of species with different number of individuals in the intertidal fish community belongs to the logarithmic series distribution. Species compositions between the two communites examined are quite different. The results obtained from the study on diversity of the species reveal that the intertidal fish community is controlled by both the physical factors and biological accomodations, and the community of the tropic is more stable than that of the subtropic.

In the previous papers[1], the authers have made a preliminary report that 1,145 fishes of 63 species belonging to 28 families and 1099 fishes of 62 species belonging to 28 families were collected from Patoutzu and Maopitou, respectively (Fig. 1). The former represents subtropical region and the latter tropical region. At both localities, the tropical species were always dominant in distribution.

In the present paper, some important characteristics of the intertidal fish community, such as the pattern of distribution, trophic relationships, and especially the diversity of species are examined, because they may indicate the stability of a community[2].

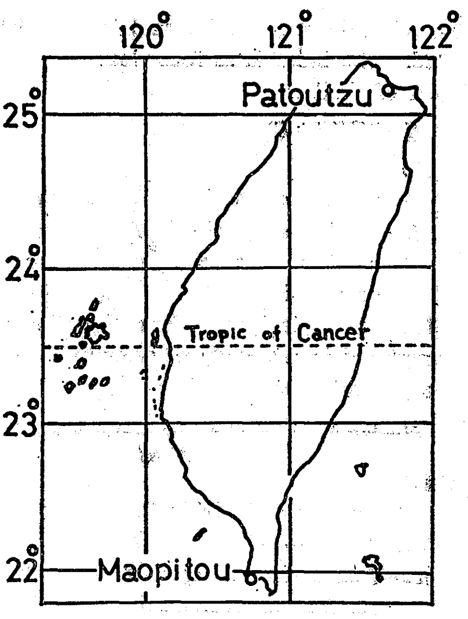

Fig. 1. Map of Taiwan, circles indicate the sampling stations.

MATERIALS AND METHODS

The data (Table 1) obtained from the previous study were employed for the analysis of the present study.

TABLE 1. Number of species and indviduals of each sample collected monthly from Patoutzu and Maopitou.

Locality / Month	Patoutzu		Maopitou	
	N	S	N	S
Mar.	125	17	45	16
Apr.	95	13	86	20
May	210	23	89	22
Jun.	151	31	301	31
Jul.	103	17	125	18
Aug.	202	28	110	23
Sep.	20	9	77	20
Oct.	152	10	120	18
Nov.	69	7	85	13
Dec.	18	11	63	14

* N=No. of individuals, S=No. of species

For comparison of the similarity in species composition between the two communities of different climatic regions, Sorenson's index[3] is adapted. The index is as following:

Index of similarity

$$S=2C/(A+B)$$

where

A=number of species in A community.

B=number of species in B community.

C=number of species common to both communities.

The methodologies of Information Theory[4,5] are employed in the study of diversity:

The general diversity index:

$$H=\log N-1/N\sum_r rn'_r(g_r+\frac{d}{dr}\log n'_r)$$

where

N=number of individuals.

$r=1, 2, 3, \cdots$

n'_r=frequencies of species with different number of individuals. (smoothed on the basis of logarithmic series).

$$g_r=\sum_r\frac{1}{r}-\gamma$$

$\gamma=0.577215\ldots$(Euler's constant)

The variety component, d-value[6] and evenness component, e-value[7] of the general diversity are also calculated:

The variety index

$$d=(S-1)/\log N$$

The evenness index

$$e=H/\log S$$

where

S=number of species

N=number of individuals

H=the general diversity index.

The frequency distribution of species with different number of individuals in each sample is checked with logarithmic series distribution[8]. Their goodness of fit are tested by Chi-square method.

RESULT

Though there are close simularities in the total number of individuals, species and families sampled at Patoutzu and Maopitou, their species

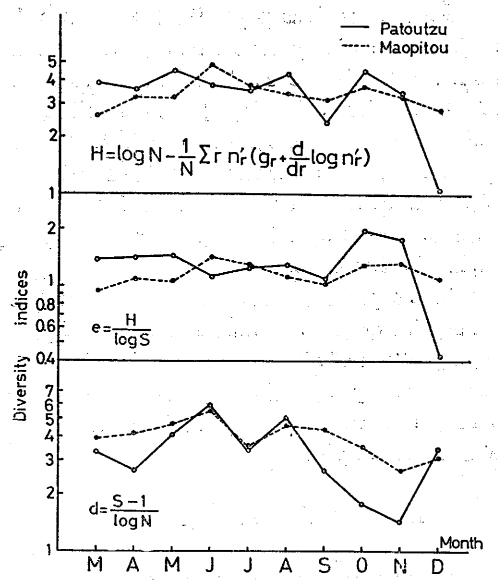

Fig. 2. Monthly fluctuations of the general diversity index H and its variety and evenness components: d-value and e-value.

compositions are quite different. Among all samples, there are only 28 species common to both. The similarity index $S=0.49$.

The general diversity index H shows greater fluctuation in Patoutzu but only slightly in Maopitou through the year (Fig. 2).

Comparing the seasonal variation of the variety index, it is evident that the d-values of these two communities change synchronously, especially in summer. But during spring and fall, the d-value of Patoutzu is considerly lower than that of Maopitou (Fig. 2).

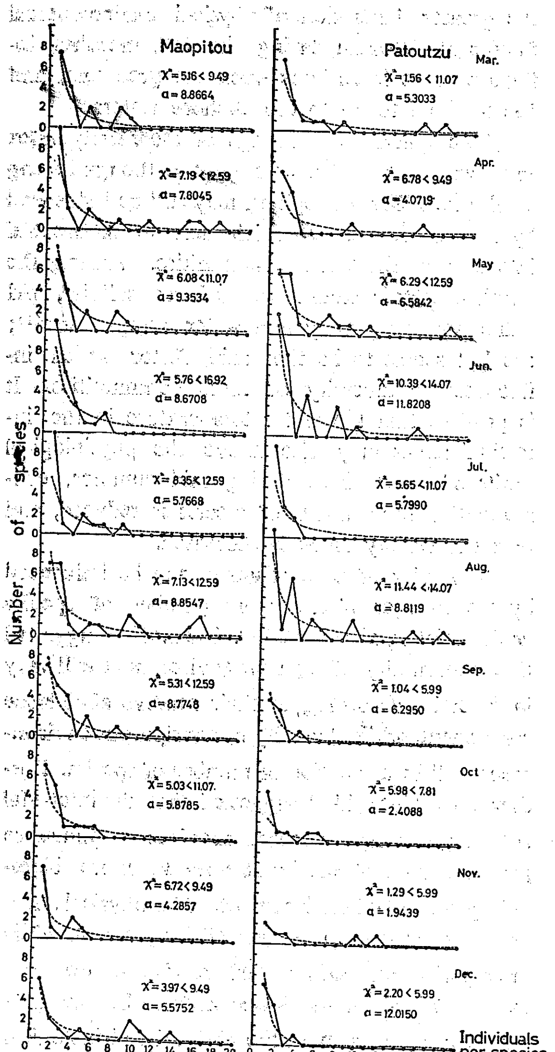

Fig. 3. Frequency distribution of species with different numbers of individuals.

The evenness index, e-value fluctuates slightly in Maopitou community through the year. But in Patoutzu community, there is a sharp decrease of e-value in autumn (Fig. 2).

The distribution patterns of individuals and species of each sample tested by Chi-square method show that they fit fairly well to the logarithmic series distribution (Fig. 3, Fig. 4).

From log-series distribution, another diversity index, α-value is also employed in measuring diversity[9]. It is similar to d-value in the pattern of seasonal fluctuation (Fig. 5).

By examining the stomach contents, the fishes were classified into piscivores, herbivores, and plankton feeders[10]. It seems that the intertidal fish community consist of more herbivores and plankton feeders, and of little piscivores, except the three samples of Patoutzu taken in October,

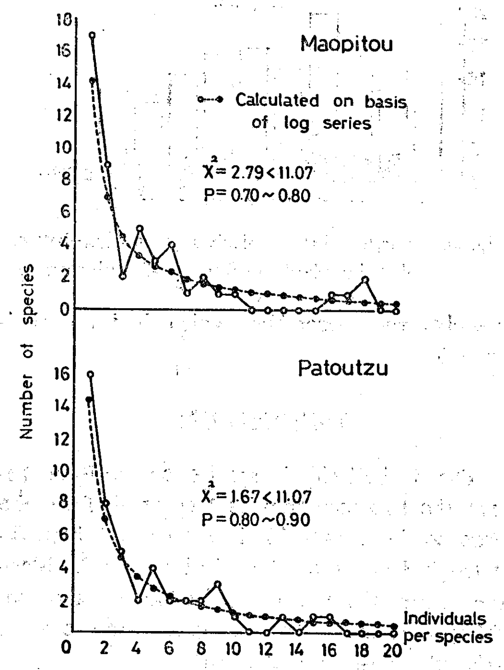

Fig. 4. Frequency distribution of species with different numbers of individuals. (pooled data)

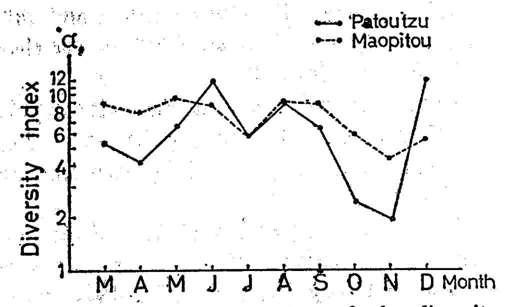

Fig. 5. Monthly fluctuation of the diversity index, α-value, calculated on basis of log-series distribution.

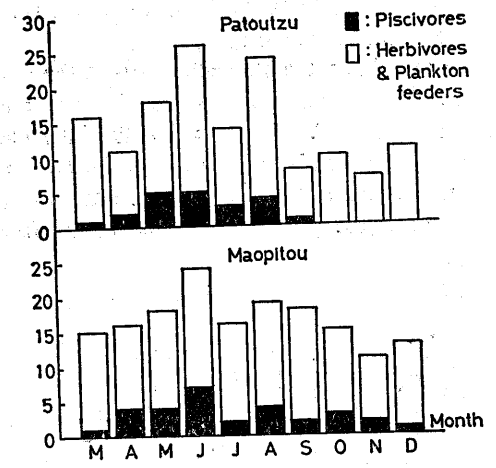

Fig. 6. Frequencies of piscivores and herbivores plus the plankton feeders of each sample.

November and December, which had no piscirores (Fig. 6).

DISCUSSION

The dissimilarity in species composition between the two communities may result from the difference in geographical distribution between the tropical and the subtropical species[1]. Maopitou community is composed of almost the tropical species, while Patoutzu community consists partly of the subtropical species.

The greater variation in diversity of community at Patoutzu may be due to the greater fluctuation of physical environmental factors in the subtropic than in the tropic. Much attention has been paid to the great change of the diversity of species at Patoutzu during autumn. Connell[11] pointed out that in the intertidal environment, the prey may be biologically controlled, while the predator be physically controlled. In this investigation, the piscivores are considered as predators which take the herbivores and the plankton feeders as their preys. It seems that the greater fluctuation of physical environmental factors at Patoutzu during the fall monthes influence more intensively upon the predators, and forced them to go to the offshore waters.

The synchronous change of the variety index suggests that the two communities though belong to different climatic regions, may still be influenced by a common factor, which acts in differential intensity on these two communities. Among the physical factors examined, such as salinity, pH value, specific gravity and water temperature[1]; the last seems to be the main factor which influences the diversity of these communities. It is possible that the water temperature in the intertidal zones may rise above the physiological limits of some fishes during mid summer, consequently, the number of species is reduced, and thus the variety index is decreased.

Diversity of a community may be influenced by the changes of either the number of species or the relative abundance[12]. Tramer[13] suggested that community of rigorous environment will vary in diversity according to their relative abundance component, while diversity in nonrigorous environment will be a function of number of species. Furthermore, Connell[14] suggested that the intertidal zone on a rocky seacoast provides a miniature gradient from physically stressed to more biologically controlled environment. The physical stress may control the upper part of the gradient, while interspecific competition and predation are controlling factors in the lower zones. In the present investigation, both the physical and biological factors really act on the intertidal fish community and result in the fluctuations of variety and evenness indices.

Others[12,13] have pointed out the increasing gradient of diversity and stability of community from the high latitude to the low latitude. It is evident that the intertidal fish community too showes this geographical gradient.

In addition to the difference of climatic factors, the difference in substratum between these two localities may also contribute some effects to diversity of community. The substratum of Maopitou consisting of coral reefs, may provide more shelters and food for fishes than Patoutzu, where is a rocky coast.

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臺灣潮間帶魚類生態之研究

張崑雄　李信徹　李健全　陳章波

臺灣北部的八斗子與南端的貓鼻頭分別屬於亞熱帶及熱帶。此二地潮間帶之魚類羣聚內種的組成差異甚大。羣聚內種與個體數量之關係是屬於對數系列分布。研究羣聚內種的分岐以及種間營養關係的結果，顯示潮間帶魚類羣聚受物理因子及生物節制兩種力量的影響，而且熱帶之羣聚較亞熱帶者爲穩定。