# The Surf Zone Ichthyofauna of the Penghu Islands, Taiwan

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A total of 1,925 larval and juvenile fishes belonging to 47 species were caught by bimonthly collections for a year with a small seine at five beaches of Makung, one of the Penghu Islands. Compared with the surf zone ichthyofauna of the western Japan, that of Makung was rather poor both in diversity and abundance, although most species occurring in a significant number were common to both the regions. The Penghu ichthyofauna was most diverse and abundant from April to June/July, poorest in February/March. *Hypoatherina bleekeri* was most dominant, followed by *Liza pescadorensis* and *Gerres oyena*. On the basis of seasonal occurrences and body length compositions, fish species could be grouped into two; those exploiting surf zones for a prolonged period and growing there, and those staying there for a short period of early life and recruited with new cohorts over the period of occurrence of each species.

**Key words:** ichthyo fauna; surf zone; Penghu Islands.

Since more than 350 years ago, Taiwan fishermen have been collecting milkfish (*Chanos chanos*) fry in wading depths along the beach.[1,2] It has been reported that surf zones of sandy beaches are biotopes of juveniles of many fishes including commercially important fishes besides the milkfish in various regions of the world.[3–6] There is, however, no report on juvenile fishes other than the milkfish occurring in surf zones of Taiwan. As the first report of a serial study on surf zone ichthyofaunas of Taiwan, we present the results on the topic obtained in Makung of the Penghu Islands.

## Study Site and Methods

Semimonthly collections were made with a small seine at five beaches of Makung island, Shi-Li, Long-Men, Chi-Kan, Wa-Tung, and Huo-Shao-Ping (Fig. 1) from February 1985 to January 1986. Makung is the biggest island of the Penghu Islands, formerly known as the Pescadores, which are located in the southern part of the Taiwan Straits.

The seine is a net of 1.3 by 5m made of 1-mm netting, with neither buoys or sinkers. Each side of the net is fitted to a bamboo stick. Two persons, each holding the stick, pulled the net walking backwards at a speed of 38 steps per minute in wading depths along 100m of beach. The lower margin of the net was kept well above the sea bottom and the upper quarter of it was in the air during the operation. The operation was repeated four times for one collection.

The specimens collected were preserved in 5% formalin on the spot to bring back to the laboratory for the examination. We followed Uchida et al,[7] Mito,[8] Okiyama,[9] and Cheng and Huang[10] for identification.

The northeast monsoon predominates from November to April, and the south and southeast winds blow from June to September, with the

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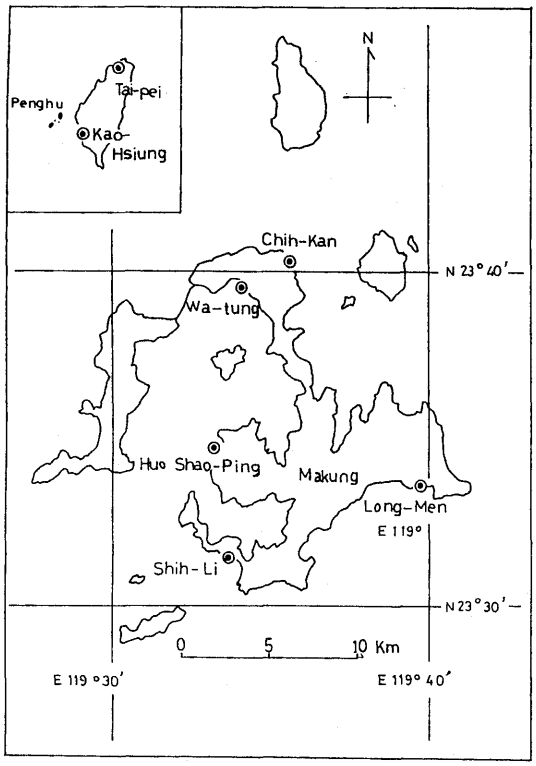


**Fig. 1.** A map of Makung, the Penghu Islands to show five beaches where semimonthly collections of larval and juvenile fishes with a small seine were made from February 1985 to January 1986.

remaining months being the stagnant season. The water temperature ranged from 19 to 29°C and the salinity from 24.6 to 34.3‰ (Fig. 2).

## Results and Discussion

### 1. Seasonal diversity and abundance of juvenile fishes

A total of 1,925 fish of 47 species from 32 families were collected (Table 1).

The most dominant was *Hypoatherina bleekeri*, followed by *Liza pescadorensis* and *Gerres oyena*. These three fishes made up 76.3% of the total number of fish collected. *Doederleinia berycoides*, *Sillago japonica*, *Chanos chanos*, *Atherion elymus*, *Trachynocephalus myops*, *Elops hawaiensis*, and *Microcanthus strigatus* were collected in a sizable number, collectively accounting for 15.3% of the total. The remaining 8.4% were shared by 37 species.

The species composition was most diverse from April to June (Fig. 2). Thereafter the number of species decreased to record the minimum of two species in March. The aggregate number of juvenile fishes collected showed a similar seasonal change, being abundant from April to July and very few in

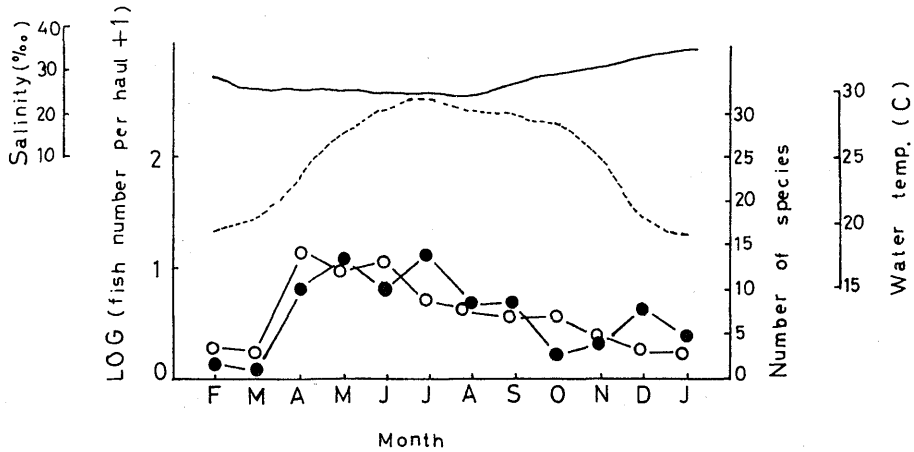


**Fig. 2.** Monthly fluctuations in number of fish per haul (solid dots) and number of species (open dots) occurring in the Penghu surf zones. Water temperature (dotted line) and salinity (solid line) at sampling stations over the study period are shown on the top.

**Table 1.** Larval and juvenile fishes collected at five beaches of Makung, the Penghu Islands, from February 1985 to January 1986.

| Species | Mar.-May | June-Aug. | Sep.-Nov. | Dec.-Feb. | Total | % | Range of TL (mm) |
|---|---|---|---|---|---|---|---|
| Family Clupeidae | | | | | | | |
| *Spratelloides gracilis* | 1 | | | | 1 | 0.05 | 7.5 |
| *Sardinella zunasi* | | | 10 | | 10 | 0.52 | 6.5-32.2 |
| Family Engraulidae | | | | | | | |
| *Stolephorus punctifera* | | 3 | | | 3 | 0.16 | 24.8-26.2 |
| Family Elopidae | | | | | | | |
| *Megalops cyprinoides* | | | 1 | | 1 | 0.05 | 30.5 |
| *Elops hawaiensis* | | 26 | | | 26 | 1.35 | 30.0-41.2 |
| Family Albulidae | | | | | | | |
| *Albula vulpes* | | 1 | | | 1 | 0.05 | 47.6 |
| Family Anguillidae | | | | | | | |
| *Anguilla japonica* | 2 | | | | 2 | 0.10 | 62.0, 360.0 |
| Family Chanidae | | | | | | | |
| *Chanos chanos* | 12 | 22 | 10 | | 44 | 2.29 | 10.5-23.3 |
| Family Gonorhynchidae | | | | | | | |
| *Gonorynchus abbreviatus* | | | | 1 | 1 | 0.05 | 32.0 |
| Family Synodontidae | | | | | | | |
| *Trachynocephalus myops* | 32 | | | | 32 | 1.66 | 23.0-25.0 |
| Family Exocoetidae | | | | | | | |
| *Hirundichthys oxycephalus* | 4 | | | | 4 | 0.21 | 7.2-12.0 |
| Family Atherinidae | | | | | | | |
| *Hypoatherina bleekeri* | 108 | 432 | 96 | 1 | 637 | 33.09 | 5.0-42.0 |
| *Atherion elymus* | 44 | | | | 44 | 2.29 | 52.0-52.8 |
| Family Mugilidae | | | | | | | |
| *Liza pescadorensis* | 288 | 65 | 43 | 196 | 592 | 30.75 | 19.1-52.1 |
| Family Percichthyidae | | | | | | | |
| *Doederleinia berycoides* | | 70 | | | 70 | 3.64 | 13.1-61.2 |
| Family Serranidae | | | | | | | |
| *Epinephelus amblycephalus* | | 1 | | | 1 | 0.05 | 19.5 |
| Family Apogonidae | | | | | | | |
| *Apogon lineatus* | 5 | | 1 | | 6 | 0.31 | 6.8-7.2 |
| Family Sillaginidae | | | | | | | |
| *Sillago japonica* | 32 | 14 | 9 | | 55 | 2.86 | 8.2-27.7 |
| Family Carangidae | | | | | | | |
| *Scomberoides lysan* | | 10 | | | 10 | 0.52 | 27.1-31.2 |
| *Trachinotus baillonii* | | 2 | | | 2 | 0.10 | 13.7, 65.1 |
| Family Gerreidae | | | | | | | |
| *Gerres oyena* | 15 | 186 | 38 | | 239 | 12.42 | 9.1-15.0 |
| Family Girellidae | | | | | | | |
| *Girella punctata* | 1 | | | | 1 | 0.05 | 3.5 |
| *Girella melanichthys* | 2 | | | | 2 | 0.10 | 37.8, 38.0 |
| Family Kyphosidae | | | | | | | |
| *Kyphosus lembus* | 3 | | | | 3 | 0.16 | 6.4-6.8 |
| Family Lutjanidae | | | | | | | |
| *Lutjanus vitta* | 1 | | | | 1 | 0.05 | 19.5 |
| Family Teraponidae | | | | | | | |
| *Terapon jarbua* | 4 | 8 | 5 | 1 | 18 | 0.95 | 11.8-15.2 |
| *Pelatus quadrilineatus* | | | 1 | | 1 | 0.05 | 29.9 |

**Table 1.** Larval and juvenile fishes collected at five beaches of Makung, the Penghu Islands, from February 1985 to January 1986 (Continued).

| Species | Mar.-May | June-Aug. | Sep.-Nov. | Dec.-Feb. | Total | % | Range of TL (mm) |
|---|---|---|---|---|---|---|---|
| Family Sparidae | | | | | | | |
| *Dentex tumifrons* | 2 | | | | 2 | 0.10 | 13.0-13.1 |
| *Sparus sarba* | | | | 2 | 2 | 0.10 | 15.0-15.2 |
| *Acanthopagrus schlegeli* | 15 | | | 1 | 16 | 0.83 | 15.0-21.1 |
| *Acanthopagrus latus* | 1 | | | 5 | 6 | 0.31 | 15.0-18.2 |
| *Chrysophrys major* | | | | 4 | 4 | 0.21 | 11.2-11.8 |
| Family Lethrinidae | | | | | | | |
| *Lethrinus haematopterus* | | 3 | | | 3 | 0.16 | 32.8-33.0 |
| Family Scorpididae | | | | | | | |
| *Microcanthus strigatus* | 24 | | | | 24 | 1.25 | 7.0-8.3 |
| Family Pomacentridae | | | | | | | |
| *Abudefduf sordidus* | 1 | | | | 1 | 0.05 | 26.8 |
| Family Scombridae | | | | | | | |
| Scombridae sp. 1 & sp. 2 | 4 | 1 | 1 | | 6 | 0.31 | 4.7-52.0 |
| Family Trichiuridae | | | | | | | |
| *Trichiurus lepturus* | 15 | | | | 15 | 0.78 | 6.5-6.8 |
| Family Gobiidae | | | | | | | |
| *Bathygobius fuscus* | | 2 | 1 | | 3 | 0.16 | 15.1-21.2 |
| *Pseudogobius masago* | | | 1 | | 1 | 0.05 | 6.7 |
| Family Paralichthyidae | | | | | | | |
| *Paralichthys olivaceus* | 1 | | | | 1 | 0.05 | 43.0 |
| Family Monacanthidae | | | | | | | |
| *Thamnaconus modestus* | | | 8 | | 8 | 0.42 | 6.9-7.2 |
| *Rudarius ercodes* | | 10 | | | 10 | 0.52 | 9.0-9.8 |
| Family Tetraodontidae | | | | | | | |
| *Sphoeroides pachygaster* | 1 | 3 | | | 4 | 0.21 | 27.0-39.0 |
| *Takifugu niphobles* | 1 | 2 | | | 3 | 0.16 | 15.0-62.1 |
| *Takifugu porphyreus* | | 6 | | | 6 | 0.31 | 23.0-23.5 |
| *Takifugu pardalis* | | 3 | | | 3 | 0.16 | 16.0-16.3 |
| Total | 619 | 871 | 224 | 211 | 1925 | 100.00 | — |

February and March. A slight increase in abundance was seen from November toward December, when 98% of the total were accounted for by *Liza pescadorensis*.

**2. Types of seasonal occurrence by species**

*Hypoatherina bleekeri* were collected in eight continuous months, from May to December, with a marked peak of occurrence in July (Fig. 3). The small catch in June may be incidental, and the main season of occurrence is considered to extend from May to September. *Gerres oyena* showed a similar trend of seasonal occurrence, though they were collected in a shorter period of six months. The occurrence of *Sillago japonica* started in April and extended to November. Larval occurrences of *Chanos chanos* and *Terapon jarbua* were first seen also in April, but ended in September and December, respectively. The catches of these three fishes in any month were mostly at low level of less than 0.5 fish per haul. The spawning season of these fishes is considered to be prolonged.

*Liza pescadorensis* occurred in nine months, but their occurrence was clearly separated into two with the peak in May and December, respectively (Fig. 3). This suggests that they have two spawning seasons.

Sparid juveniles appeared in months from January to May, and tetraodontids from May to August. Their spawning seasons may extend moderately long.

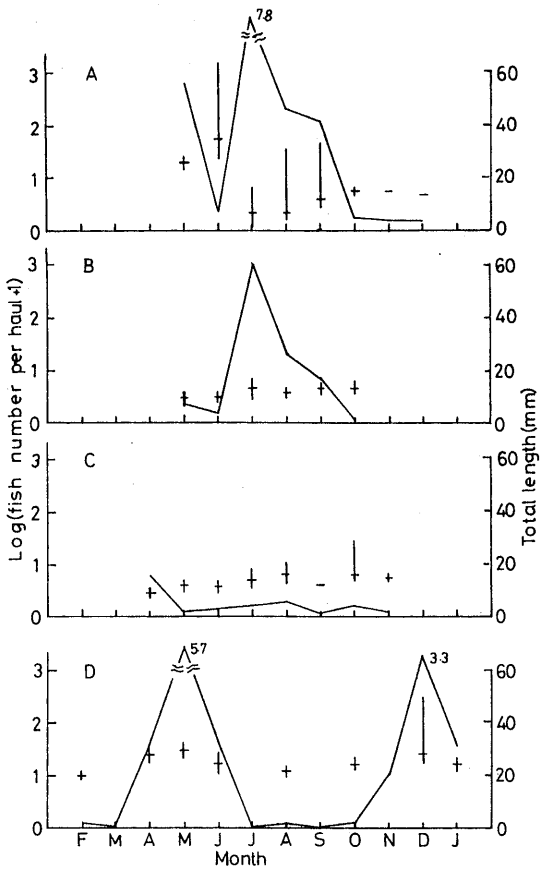


**Fig. 3.** Seasonal occurrences and sizes of four dominant species among larval and juvenile fishes in the Penghu surf zones. The means and ranges of total lengths are represented by horizontal and vertical bars, respectively. A : *Hypoatherina bleekeri*, B : *Geress oyena*, C : *Sillago japonica*, D : *Liza pescadorensis*.

The number of juveniles of *Doederleinia berycoides* amounted to 70, and all of this were obtained in June. This result may have been rather incidental, not suggesting a short spawning season, because the specimens collected showed a wide range of total lengths as shown later.

### 3. Size of specimens collected

Most of the specimens collected were those at larval and juvenile stages as may be presumed from Table 1, with few young in a limitted number of species.

Fish species occurring in the surf zones can be divided into two groups by the patterns of size distribution (Fig. 4), those with a narrow range and those with a wide range. *Gerres oyena* is a typical example of the former, and *Sillago japonica* can be included in this group. No clear increase in size with the advance of season was seen (Fig. 3). They probably stay in surf zones only for a short period at a late larval stage or early juvenile stage, and move to some other types of biotope, while the surfzone population is recruited with succeeding cohorts through the period of occurrence. *Chanos chanos*, sparids, elopids, and many of the fishes in Table 1 also belong to this group.

Total lengths of *Hypoatherina bleekeri*, *Liza pescadorensis* and *Doederleinia berycoides* ranged much wider. A few of the other fishes such as *Atherion elymus*, *Trachinotus baillonii* and *Takifugu niphobles* also showed a wide range of size distribution (Table 1). These fishes inhabit surf zones beyond the juvenile stage. However, the decided majority of the specimens consisted of small individuals within the size ranges. This reflects either the net avoidance by larger fish, the mortality with growth, or the change of main habitat with growth.

### 4. General discussion

The surf zone ichthyofauna of Makung fundamentally resembles that of southwestern Japan. Out of 47 species obtained during the present study, 26 are reported from the Japanese surf zones.[4,11,12] *Liza pescadorensis* is the sole species which dominated in the Penghu surf zones but has not been reported from the Japanese surf zones, where other mullets such as *Mugil cephalus*, *Liza carinata* and *Crenimugil crenilabis* are among high ranking species. Also, the absence of *Konosirus punctatus*, *Plecoglossus altivelis*, *Salangichthys microdon*, etc. characterizes the Penghu surf zones from Japanese ones.

The ichthyoplankton of the Penghu surf zones was found to be rather poor both in diversity and abundance. Against 47 species

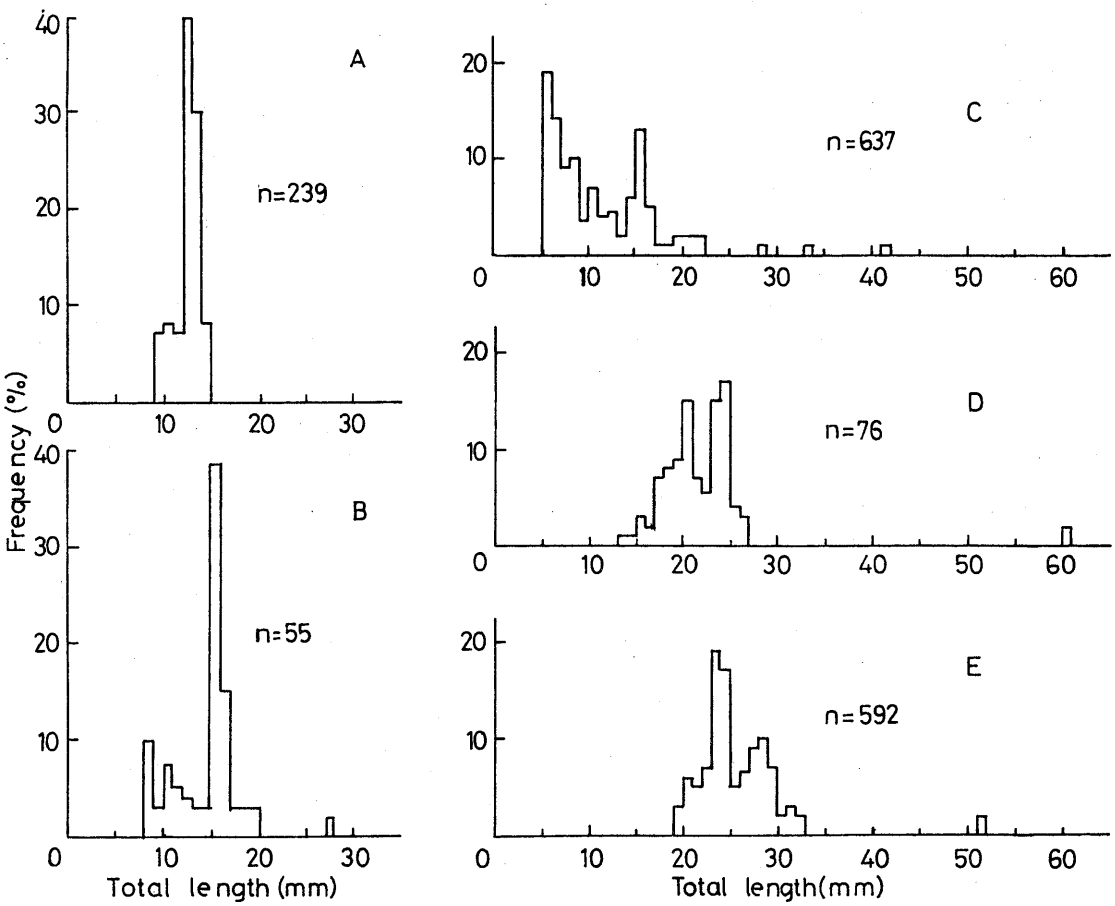


**Fig. 4.** Length distributions of five dominant species among larval and juvenile fishes in the Penghu surf zones. *Gerres oyena* (A) and *Sillago japonica* (B) showed a narrow range of total lengths, while the lengths of *Hypoatherina bleekeri* (C), *Liza pescadorensis* (D) and *Doederleinia berycoides* (E) ranged widely.

in the present study, 64, 70 and 91 species were reported from the beaches of the west coast of Kyushu, Miyazaki Prefecture and Tosa Bay, respectively.[4, 12] The sampling gear and method in these studies were almost the same as ours.

Fish juveniles collected during the present study were far much less than we expected, the number of fish per haul averaged over the study period being 4.01. Monthly average catches in Tosa Bay surf zones ranged from 16 to 1,400 fish per haul, and in 15 months out of 24 months of study period the catch per haul exceeded 100 fish.[4] Also in Miyazaki surf zones the average catch of 138 fish per haul was recorded.[12]

The paucity of juveniles of the milkfish (44 fish in all) and sparids (altogether 30 fish) among others in the Penghu surf zones is rather strange. The beaches on the southwest coast of Taiwan, only about 50km away from the Penghu Islands, make fishing grounds for the milkfish fry for pond culture. Even at a beach of Tanegashima island located at lat. 32°30'N, catches of milkfish fry exceeding 30 fish per haul were often recorded.[13] As the milkfish spawns in the tropical and subtropical waters with warm and clear water,[14, 15] stronger influences of the coastal water of the Chinese continent must restrain the occurrence of the fish at the Penghu beaches.

Three sparid fishes, *Acanthopagrus schlegeli*, *A. latus* and *Sparus sarba*, are reported to occurr in a much larger number in surf zone samples at Japanese beaches.[4] Even instances of a catch of more than 1,000 fish by a single

haul are recorded. In our study of the surf zone ichthyoplankton at two beaches on the northwest coast of Taiwan, Chi-Ying and Kuan-Yin, *A. schlegeli* and *A. latus* collectively accounted for 50.0% of the total number of fish collected (unpublished). Recently local fishermen are collecting sparid juveniles for culture at these beaches. We have presently no interpretatiion for the reason why the sparid juveniles were very few in our samples from Makung.

The sampling gear used in the present study is only for "pelagic components".[4] Since the importance and interest of the studies on "demersal components" of the surf zone fishes have been well documented,[3, 5] such studies must be carried out also in Taiwan as early as possible.

**Literature cited**


1) Miyagami, K. (1921): Milkfish culture. Dept. Industry, The Government-General Taiwan, Publication (251), 122pp. (in Japanese).

2) Lin, S. Y. (1968): Milkfish farming in Taiwan - A review of practice and problems. Taiwan Fish. Res. Inst., Fish Culture Rep., (3), 63pp.

3) McLachlan, A. (1983): Sandy beach ecology - A review. pp. 321-380 *in* A. McLachlan and T. Erasmus (eds.) Sandy beaches as ecosystems. Dr. W. Junk Publishers, the Hague.

4) Senta, T. and I. Kinoshita (1985): Larval and juvenile fishes occurring in surf zone of western Japan. Trans. American Fish. Soci., **144**, 609-618.

5) Senta, T., M. H. Amarullah and M. Yasuda (1988): Invitation to the study of juvenile fishes occurring in surf zones. pp. 131-146 in Y. B. Go (ed.) Proc. Symp. on Develop. Mar. Reso. and Intern. Coop. in the Yellow Sea, East Chaina Sea. Cheju, Korea.

6) Brown, A. C. and A. McLachlan (1990): Ecology of sandy shores. Elsevier, Amsterdam, xii+328pp.

7) Uchida, K., S. Imai, S. Mito, S. Fujita, M. Ueno, Y. Shojima, T. Senta, M. Tafuku, and Y. Dotu (1958): Studies on the eggs, larvae and juveniles of Japanese fishes, series 1. Second Laboratory of Fisheries Biology, Dept. Fish., Fac. Agri., Kyushu University, Fukuoka, Japan. 89pp., 86 pls. (in Japanese)

8) Mito, S. (1966): Fish eggs and larvae. *In* S. Motoda (ed.), Illustration of marine plankton of Japan, Vol. 7, 74pp. Soyo-sha, Tokyo. (in Japanese)

9) Okiyama, M. (ed.) (1988): An atlas of the early stage fishes of Japan. Tokaidaigaku Shuppankai, Tokyo, xii+1154pp. (in Japanese)

10) Cheng C. C. and C. C. Huang (eds.) (1985): Reports on fish larvae research. COA Fish. Series, (2), 1-279. (in Chinese)

11) Kinoshita, I. (1984): Occurrence of larval and juvenile fishes in the surf zones facing Tosa Bay. Aquabiology, **13**, 409-415. (in Japanese)

12) Akazaki M. and Y. Taki. (1989): Larvae and juvenile fishes occurring in surf zones in Miyazaki Prefecture-I. Monthly change of number of species and the number of specimens of larvae and juveniles. Bull. Fac. Agri., Miyazaki Univ., **36**, 119-134. (in Japanese)

13) Senta, T. and A. Hirai. (1981): Seasonal occurrence of milkfish fry at Tanegashima and Yakushima in southern Japan. Japan. J. Ichthyol., **28**: 45-51.

14) Schuster, W. H. (1960): Synopsis of biological data on milkfish, *Chanos chanos* (Forskål), 1775. FAO Fish. Biol. Synop., (4), 64pp.

15) Senta, T., S. Kumagai and N. M. Castillo (1980): Occurrence of milkfish, *Chanos chanos* (Forsskål) eggs around Panay island, Philippines. Bull. Fac. Fish., Nagasaki Univ., (48), 1-11.

# 澎湖諸島の砕波帯に出現する仔稚魚

楊　正義・千田　哲資

澎湖諸島馬公島の5ヶ所の砂浜海岸において，小型曳網による仔稚魚の採集を周年にわたり毎月2回おこなった。採集された仔稚魚は総計47種1,925個体で，西日本の砂浜海岸に比べて種組成は類似するものの種数・個体数ともにかなり少なかった。トウゴロウイワシ・ボウコボラ・クロサギが優勢で，この3種で全個体数の76%を占めた。種数・個体数ともに4～6/7月に豊富で，2～3月に最少であった。トウゴロウイワシ・クロサギ・シロギスなどは6～8ヶ月の長期にわたって継続して出現した反面，ボウコボラはそれぞれ5月と12月にピークのある2つの出現期を示した。砕波帯に長期間滞在し，そこで生長することが推測される魚種は少なく，多くの魚種においては採集された標本の全長範囲は狭く，出現期を通じて平均体長はほぼ一定しており，仔稚魚期の短期間に限って砕波帯を利用していると考えられた。