The Journal of Shimonoseki University of Fisheries 42 (2) 101−108 (1994)

Seasonal Change in Fish Communities of a Mud Flat Area at the Mouth of the Kutanabe-gawa Brook, Yamaguchi

Kei Takizawa*

In order to exemplify the seasonal cycle of biota around mud flats I conducted fish sampling by a cod hoop net (*fukuro-machi-ami*) in the vicinity of Umashima Strait, the western Inland Sea. Specimens were collected every spring tide from January 6, 1981 to December 20, 1983 at the river mouth of the Kutanabe-gawa brook (33°55′N, 132°4′E).

Seventy-four catches contained 21,130 specimens comprised 40 species within 33 genera. *Mugil cephalus* registered the maximum percentage of the sample, and next to it followed *Acanthogobius flavimanus, Acanthogobius lactipes, Chaenogobius castaneus,* and *Leucopsarion petersi.* Monthly numbers of individuals and species showed seasonal variation with main annual peaks in early summer and in early autumn, respectively. Almost all the species were comprised of young, and in 22 species, young monopolized. In 15 species I recorded the adult stage and in six, the juvenile.

Seasonal change in the appearance of fishes was investigated by the criteria of the monthly averaged water temperature at which each species occurred. I detected that all the species may be classified into some characteristic groups, depending upon the threshold in water temperature (8°C and 20°C). The sedentary species is tolerant of the water temperature from less than 8°C to more than 27°C.

1 Introduction

The most inner part of inlets in temperate zone sustains mud flat. There the periodic alternation of the medium stuff between sea water and air brings climatic change; moreover, the discharge of freshet or precipitation modifies the quality of surrounding water variously. Also, water temperature elevation there is more maginified than that in the offshore area. Thus, mud flats have complicated circumstance, and they entail to sustain many a occupant which seems us to utilize the specific area and time efficiently and to totally build up a tight food chain system that yields the various kinds of resources for fisheries operated in the adjacent waters.[1-4] In order to exemplify the seasonal cycle of biota around mud flats I conducted fish sampling by a cod hoop net (*fukuro-machi-ami*) at the mouth of Kutanabe-gawa brook in the vicinity of Tana Marine Biological Station (T.B.S.), Shimonoseki University of Fisheries, which locates just ahead of small inlet attached to the Umashima Straight of the western Inland Sea.[5] The sampling gear contained small number of specimen; therefore it is hard to discern the dynamics of fish population. Neverthe-

水産大学校研究業績 1466号，1993年９月29日受付.
Contiribution from Shimonoseki University of Fisheries, No. 1466. Received Sep. 29, 1993.
* Laboratory of Fisheries Resources, Department of Biology and Aquaculture, Shimonoseki University of Fisheries. (滝澤 敬：水産大学校増殖学科水産資源学講座).

less, the data would enable us to adumbrate a facet of life history of the fish taxa caught, specially on the early stages: around mud flat area how they utilize in terms of predation, growth or reproduction. This is our second report on evaluating the productive process of aquatics around the water adjacent to Umashima Strait and mainly documents the populational (numerical) and morphometric realm.[4)]

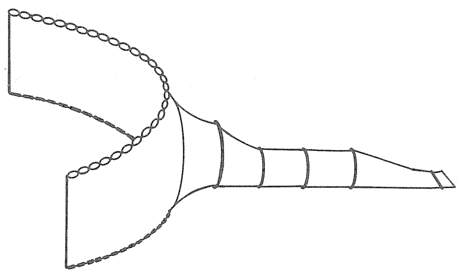
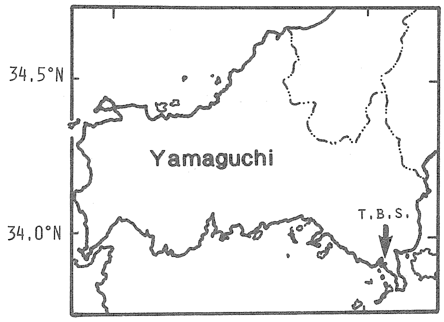


Fig. 1. Scheme of the sampling gear *fukuro-machi-ami*. The material is nylon netting with 2.0 millimeters mesh size.

2 Apparatus and Methods

The sampling gear comprises wing net, flapper and pocket (Fig.1). The main material of each component is nylon netting with 2.0 millimeters mesh size. The wing net takes the shape of a rectangle with 6.8 m width and 1.5 m height and has a 1.1 m diameter hole at the center at which the pocket part is introduced. It equips rubber floats and head rope stitched along the head edge and has foot rope with linked lead sinkers. The entrance of the pocket figures a truncated cone of 1.3 m height and 1.1 and 0.57 m diameters, and a cylindrically stitched netting of 3.0 m height is seamed with it. The other end of the pocket is facilitated to be tied up with rope at the onset of sampling and to be untied when a catch is harvested. The flapper takes the shape of a truncated cone with 0.8 m height and 0.8 and 0.22 m diameters. This is installed in the entrance of pocket and stitched there. Wire rings are the auxiliary to form the submerged gear and to retain the catch. To this end three rings are arranged at the seams of the pocket with the wing net and the flapper, and at the other part of the pocket to sustain the wire ring which is stitched at the terminal of flapper. Namely the inner ring of the flapper is connected to the outer ring of the pocket with several ropes. The pocket is bound with two other wire rings at the 1.8 and 2.6 m distances from the terminal of pocket.

Specimens were collected every spring tide from January 6, 1981 to December 20, 1983 at the river mouth of the Kutanabe-gawa brook



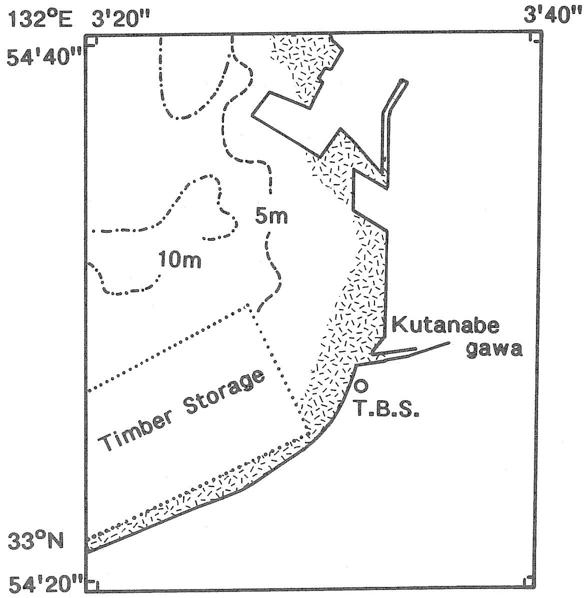


Fig. 2. Map of the experimental area. The bottom topography beneath the timber storage is unknown.

which measures 4.5 m width (Fig.2). Flood tides upstream this brook over a distance of ca. 50 m from the river mouth in spring tide. The sampling gear was set in evening and landed in the next morning. The gape of wing net faced the inlet in order to collect fishes that move upward in the brook.

Seventy-four catches are fixed by 10 % formalin solution immediately after landing and fish specimens are named and measured at T.B.S. All the data were then allocated monthly and every taxonomic group was counted in number.

The water temperature cited here is the arithmetic mean of the monthly cumulated data which were monitored daily at T.B.S. (Fig.3).

3 Results

Seventy-four catches contained 21,130 specimens, comprised 40 species within 33 genera. *Mugil cephalus* registered the maximum percentage of the sample, and next to it followed *Acanthogobius flavimanus, Acanthogobius lactipes, Chaenogobius castaneus,* and *Leucopsarion petersi* in this turn. Among them *Acanthogobius flavimanus* was sampled most frequently appearing every single month except February 1983. Annual collection number of specimen in 1982 was less than those in 1981 and 1983. In annual base, the maximum abundance in monthly catch appeared in May (1981) or June (1982 and 1983) when *Mugil cephalus* overwhelmed in number (Fig.4). Likewise, the minimum abundance occurred in January (1981) or February (1982 and 1983) when the water temperature was reduced below 10°C. In these durations the taxa in catch were decreased in number and restricted to 9 species, most of which seem to annually reside around (Fig.5).

Here I delineated the occurrence of each species. Thereby, depending upon the descriptions on physique size (total length: TL) and spawning season of each species,[6-10] I decided and classi-

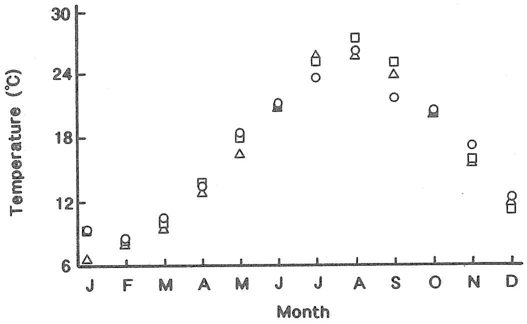


Fig. 3. Variation of monthly averaged surface water temperature monitored at Tana Marine Biological Station, January 1981 to December 1983. Triangles: 1981; circles: 1982; squares: 1983.

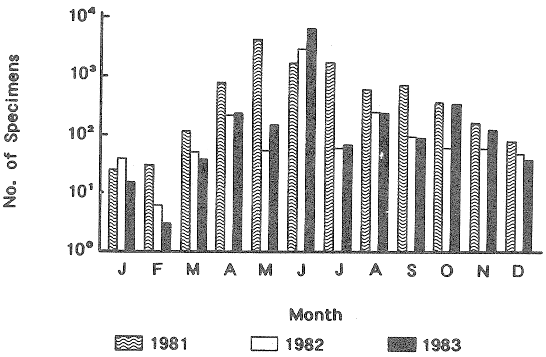


Fig. 4. Monthly changes in total specimen number collected by *fukuro-machi-ami* at the mouth of the Kutanabe-gawa brook, January 1981 to December 1983.

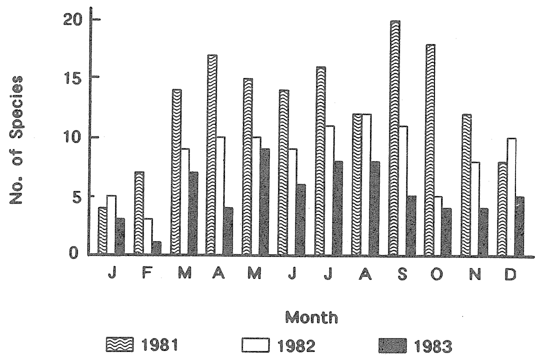


Fig. 5. Monthly changes in number of species collected by *fukuro-machi-ami* at the mouth of the Kutanabe-gawa brook, January 1981 to December 1983.

fied the development stages of individuals into three: juvenile, young and adult.

Sardinops melanosticta (Temminck et Schlegel): Adult of 134-190 mm TL appeared in November and December 1981. This species matures in winter season and around Umashima strait, the vicinity of this mud flat, egg and larva emerged in January 1990 and in January 1989 respectively (own observation).

Engraulis japonica (Houttuyn): Young of 62-106 mm TL appeared in May and October 1981. This species has two spawning groups: one matures in spring and the other in autumn. Around this area the egg and larva emerged from May to August (own observation).

Carassius carassius langsdodorfii Temminck et Schlegel: Young of 59-90 mm TL appeared singly in April and May 1981 and in June 1983.

Anguilla japonica Temminck et Schlegel: Every winter season juvenile (38-60 mm TL) of several to few decades in number appeared. In April 1981 and in April 1982 young appeared and in September and November 1982 adult appeared. This species matures in autumn.

Conger myriaster (Brevoort): Young and adult of 175-372 mm TL often appeared in the autumn.

Oryzias latipes (Temminck et Schlegel): Adult of 21-38 mm TL appeared in August and September 1981.

Allanetta bleekeri (Günther): Young of 19-69 mm TL appeared in August and September 1981.

Mugil cephalus Linne: Juvenile and young of 17-264 mm TL appeared annually. The smaller individuals (< 30 mm TL) appeared during March-July, concentrated in May or June; otherwise, the larger (> 90 mm TL) appeared except July. Namely, hatched out in late autumn and avoiding the low water temperature (< 8°C) period, the individuals of the early stages recruit into the mud flat. Among the individuals that could tolerate the water temperature less than 10°C, the minimal sized one had 77 mm TL.

Sphyraena pinguis Günther: Young of 51-101 mm TL appeared in July and September 1981.

Leiognathus nuchalis (Temminck et Schlegel): Young of 25-86 mm TL appeared in September 1981 and in November 1982.

Lateolabrax japonicus (Cuvire et Valenciennes): Young of 70 mm TL appeared in July 1982.

Sillago sihama (Forskål): Young and adult of 19-132 mm TL appeared from June to October. Individuals of less than 40 mm TL appeared in September and October 1981, when individuals of larger than 80 mm TL which indicates a criteria for matured size were sampled coincidentally. Around this area egg and larvae emerged from June to October (own observation).

Therapon oxyrhynchus Temminck et Schlegel: Young of 17-42 mm TL appeared in September and October 1981.

Therapon jarbua (Forskål): Young of 14-72 mm TL appeared from August to October 1981 and in September 1982.

Acanthopagrus schlegeli (Breeker): Young of 24-81 mm TL appeared sporadically during the periods the water temperature was elevated in 1981 and 1982. This species mature in early summer season and the TL ranges shifted down when water temperature attained the peak. Around this area egg emerged in May (own observation).

Acanthopagrus latus (Houttuyn): Young of 14-25 mm TL appeared in November and December 1981 and in December 1982. The spawning season and the appearance in this area shows a clear contrast to those of its congener *Acanthopagrus schlegeli* previously mentioned.

Callionymus punctatus Langsdorff: Young of 109 mm TL appeared in October 1981.

Gobius gymnauchen Breeker: Young of 25-46 mm TL appeared in June and July 1981 and in December 1982.

Gobius pflaumi Breeker: Young and adult of 13-96 mm TL appeared sporadically. The larger individuals (> 40 mm TL) appeared in May 1982; otherwise, the smaller (< 40 mm TL) appeared in September 1981, and in August and December 1983.

Mugilogobius abei (Jordan et Snyder): Young and adult of 19-48 mm TL often appeared except for the low water temperature period.

Acanthogobius lactipes (Hilgendorf): Young and adult of 15-81 mm TL appeared. This species resides here annually and spawns in July or August (own observation).

Acanthogobius flavimanus (Temminck et Schlegel): Young and adult of 22-231 mm TL appeared. The larger individuals (> 100 mm TL) seem to reside annually and the smaller (< 40 mm TL) chiefly appeared in the autumn.

Glossogobius giuris fasciato-punctatus (Richardson): Young of 143-182 mm TL appeared in August and September 1981 and in June 1982. This species spawns from July to September.

Chaenogobius castaneus (O'Shaughnessy): The minimum size in TL was 10 mm and the maximum was 60 mm. They appeared here annually and concentrated from May to June with the smaller individuals less than 30 mm in TL, and except for this period the larger individuals (> 40 mm TL) appeared.

Chaenogobius urotaenia urotaenia (Hilgendorf): Young of 28-34 mm TL appeared in April and May 1982.

Tridentiger obscurus (Temminck et Schlegel): Young and adult of 22-101 mm TL appeared annually, showing no manifest periodicity in abundance. The smaller individuals less than 30 mm TL appeared from August to November.

Tridentiger trigonocephalus (Gill): The minimum size in TL was 13 mm and the maximum was 77 mm. This species often appeared except for the low water temperature period and the smaller individuals (< 30 mm TL) appeared in August or September.

Luciogobius guttatus Gill: Young of 40-68 mm TL appeared from February to April 1981 and in April and October 1982.

Eutaeniichthys gilli Jordan et Snyder: Young of 39 mm TL appeared in April 1981.

Leucopsarion petersi Hilgendorf: Adult of 39-53 mm TL appeared in March and April 1981. The catch in April 1981 was enough large to be recorded as the fifth abundant individual number.

Chromis natatus (Temminck et Schlegel): Young of 104 mm TL appeared in August 1982.

Rudarius ercodes Jordan et Fowler: Young and adult of 16-60 mm TL appeared from April to October.

Fugu niphobles (Jordan et Snyder): Juvenile and young of 18-71 mm TL appeared from July to September.

Sebastes inermis Cuvier et Valenciennes: Young of 24 and 26 mm TL appeared in April 1981 and in March 1982 respectively.

Sebastes schlegeli Hilgendorf: Young of 32-223 mm TL appeared. Among them the smaller individuals (32-56 mm TL) appeared in July 1981 and in July and August 1983; otherwise, the larger (198 and 223 mm TL) appeared in December 1982.

Hexagrammos otakii Jordan et Starks: Young and adult of 47-232 mm TL appeared. This species often appeared except for the low water temperature period and the smaller individuals (< 60 mm TL) appeared from March to May.

Platycephalus indicus (Linne): Young of 14-99 mm TL appeared from May to July and in September and October 1981, and in March 1982.

Pseudoblennius cottoides (Richardson): Juvenile and young of 20-34 mm TL appeared from March to May 1981 and in March 1983.

Limanda yokohamae (Günther): Young of 32-123 mm TL appeared except for late spring-summer season.

Kareius bicoloratus (Basilewsky): Young of 23-144 mm TL appeared except for the low water temperature period.

4 Discussion

In the Inland Sea 252 piscine species are re-

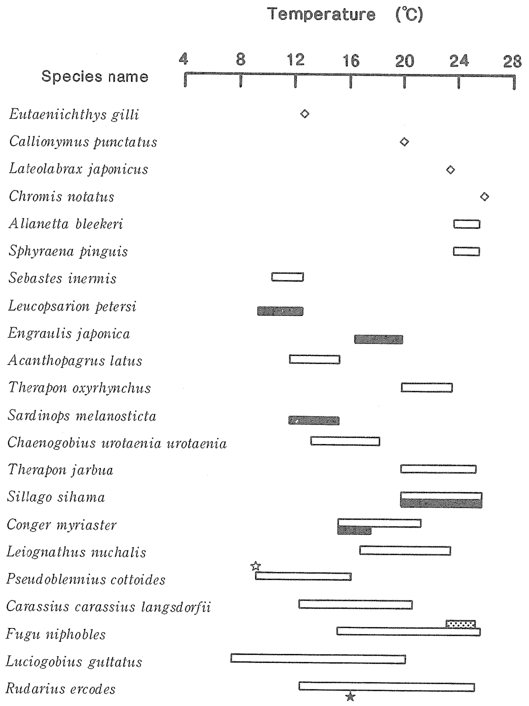


Fig. 6. Data points (symbols) and ranges (rectangles) of the averaged water temperature of the months (shown in Fig.1) when each species was sampled. Open star and dotted rectangles: juvenile; squares and open rectangles: young; closed stars and closed rectangles: adult. This arrangement of species depends upon the mode that the narrower range or the lower temperature of occurrence they showed, the previously they were enrolled.

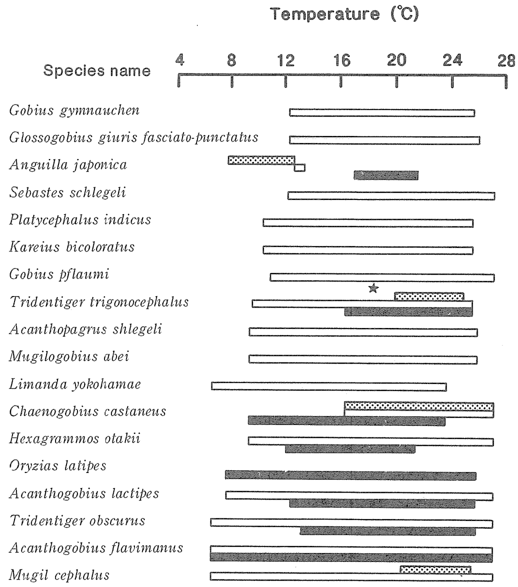


Fig. 6. (continued)

corded to dwell;[11] therefore about one-sixth of them appeared here. Almost all the species were comprised of young, and in 22 species out of the 40 young monopolized.

In 15 species I recorded the adult stage. Among them *Sardinops melanosticta, Engraulis japonica, Oryzias latipes* and *Leucopsarion petersi* specimens comprised adult exclusively, and except *Oryzias latipes* the emergence points were contained in their spawning seasons, whereas the others, except *Sillago sihama,* were mainly occupied with the young, showing the periodic appearance of adult. *Sillago sihama* was mainly dominated with adult, appearing just coincident to its spawning season. *Acanthogobius flavimanus* and *Chaenogobius castaneus* showed that young and adult coincided nearly throughout their appearance durations. Except *Anguilla japonica,* in which the reproduction mode in conjunction with its catadromous migration inheres, these species were presumed to reside here for maturation and subsequent spawning.

Juvenile was recorded in six species. Among them *Mugil cephalus, Fugu niphobles* and *Pseudoblennius cottoides* did not contained the adult stage; therefore I speculate that here they carried mainly the early life histories. On the other hand, *Anguilla japonica, Chaenogobius castaneus* and *Tridentiger trigonocephalus* contained adult and juvenile. Especially *Tridentiger trigonocephalus* appeared in the developmental stages from juvenile to adult concurrently.

Seasonal change in the appearance of fishes was investigated by the criteria of the monthly averaged water temperature at which each species occurred.[12] Fig.6 shows the minimal to maximal water temperature ranges within which each species appeared, classified with the developmental stage. Fig.6 indicates that all the species may be classified into some characteristic groups, depending upon the thresholds in water temperature (8°C and 20°C). Namely, the first group contains *Anguilla japonica, Oryzias latipes, Mugil cephalus, Acanthogobius lactipes, Acanthogobius flavimanus, Tridentiger obscurus, Luciogobius guttatus* and *Limanda yokohamae* which are conceived to be the eurythermal species tolerant of the temperature ranging from less than 8°C to more than 20°C. This group overwhelmed in number of specimen. Except *Anguilla japonica* that may only traverse this area as juvenile, their abundance showed peaks at water temperature more than 16°C and decayed at less than 8°C. In addition, being disappeared at the water temperature more than 24°C subtilizes *Anguilla japonica, Tridentiger obscurus* and *Limanda yokohamae* from others in this group.

The species which belong to the eurythermal group but disappeared at the water temperature reduced below 8°C were the second group, that includes *Acanthopagrus schlegeli, Gobius pflaumi, Mugilogobius abei, Chaenogobius castaneus, Tridentiger trigonocephalus, Hexagrammos otakii, Platycephalus indicus* and *Kareius bicoloratus*. They may migrate into any mildly conditioned areas, avoiding the low water temperature.

The species which appeared only when the circumstance provided the elevated temperature above 20°C were the third group, that contains *Allanetta bleekeri, Sphyraena pinguis, Lateolabrax japonicus, Sillago sihama, Therapon oxyrhynchus, Therapon jarbua, Callionymus punctatus* and *Chromis notatus*. This group contains most the species whose occurrence is temporary, and may be categorized as the stenothermal species which characterize the variety in the summer phase of the fish community mentioned above.

Apart from the temperature threshold mentioned above, the last group I comprehended as another stenothermal species on account that their appearances were recorded with the temperature regime within 5°C. It contains six species such as *Sardinops melanosticta, Engraulis japonica, Acanthopagrus latus, Eutaeniichthys gilli, Leucopsarion petersi* and *Sebastes inermis*. Among them, the water temperature of 16°C subtilizes *Engraulis japonica* from others. Namely the former occurred separately in the spring and autumn seasons; on the other hand the latter appeared around either the onset or the cessation of the winter season.

Fourteen species contained specimens of the multi developmental stage. Juvenile and/or adult were likely to be more restricted in the occurrent temperature regime than young. In *Anguilla japonica* and *Chaenogobius castaneus*, however, the occurrent temperature regime shifted through the development, and in *Mugil cephalus* and *Acanthogobius lactipes* that was unchanged between young and adult.

Seven genera contained two congeners each; therefore the interspecific relationships in the occurrent temperature between congeners were investigated. I found that except *Sebastes* whose congeners showed the common temperature regime less than 0.5°C, the congeners in each genus appeared at similar temperature, and the tendency was typical in *Acanthogobius*. As mentioned above, *Acanthopagrus* did not show the temporal concurrence even though the congeners indicated the common temperature regime more than 4°C.

I have imparted the seasonal change of fishes residing around the mud flat through surveying their response to ambient water temperature but it is not clear enough to demonstrate how this area functions to sustain their life histories and the fauna. For this I am now designing an investigation on stomach ingredients, morphologic characteristics or gonad maturation. Another point of our interest is to evaluate the effects of the sampling location and the gear we adopted on collecting specimens: whether or not the sampling design may fulfill to trace the community and the population structure of fishes in the mud flat area. We conclude this issue can be tested through the comparison of the alternative equipments and that of locations for sampling these species.

This work was originally managed by Dr. Toru Takai, whose excellent planning enabled a very demanding sampling programme to be achieved. Also, I wish to thank him for commenting on the manuscript. The research was accomplished through the technical assistance of gear design and data procedure by Toshio Yoshioka and Koichi Miki.

References

1) T. Nakabo: *Bull. Seikai Reg. Fish. Res. Lab.*, **54**, 209-229, 1980.
2) K. Tatara: *Bull. Nansei Reg. Fish. Res. Lab.*, **13**, 135-169, 1981.
3) T. Nakabo: *Bull. Seikai Reg. Fish. Res. Lab.*, **59**, 47-70, 1983.
4) K. Takizawa, T. Iwasa, and M. Miyama: *J. Shimonoseki Univ. Fish.*, **39**, 29-36, 1990.
5) Y. Kaneda: Nippon Gyogu Gyohou Zusetu, Seizando Shoten, Tokyo, 1977, pp.259-264.
6) M. Nakamura: Nippon no Koi-ka Gyorui, Midori Shobo, Tokyo, 1969, pp.271-274.
7) H. Masuda, K. Amaoka, C. Araga, T. Ueno and T. Yoshino: The Fishes of the Japanese Archipelago, Tokai University Press, 1985, p.82.
8) A. Ochiai and M. Tanaka: Gyoruigaku, 2nd ed., Koseisha Koseikaku, Tokyo, 1986, pp.377-1140.
9) M. Abe: Illustrated Fishes of the World in Colour, Hokuryukan, Tokyo, 1987, pp.1-1029.
10) M. Okiyama: An Atlas of the Early Stage Fishes in Japan, Tokai University Press, Tokyo, 1988, pp.1-1154.
11) Coastal Oceanography Research Committee, the Oceanographical Society of Japan: Coastal Oceanography of Japan, Tokai University Press, Tokyo, 1985, pp.676-680.
12) M. Uda: Kaiyo Gyojogaku, Koseisha Koseikaku, Tokyo, 1960, pp.33-47.

百済部川河口の浅海砂泥域における魚類群集の季節変化

滝澤　敬

山口県熊毛郡平生町の百済部川河口の浅海砂泥域に棲息する魚類群集の季節変化を調べるために，1981年１月から1983年12月までの大潮時に袋待網を敷設した。74回の調査で，33属・40種・21,130個体の標本が採集された。各年とも，出現個体数が多いのは５・６月で，出現種数が多いのは８・９月であった。採集された魚類の多くは若魚で，稚魚は６種，成魚は15種で認められた。本水域に棲息する各魚種は水温の変化に対応して季節的消長を繰り返し，おもに８℃および20℃の月平均水温を境にして魚種組成が変化することが確かめられた。