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# Seasonal occurrence and abundance of larval and juvenile fishes in a Philippine surf zone

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**Abstract:** Larval and juvenile fishes, collected by a milkfish fry sweeper from the surf zone off Panay Island, Philippines, from May 1986 to September 1987, numbered 18,282 individuals, representing 38 families of 13 orders, with 13 specimens unidentified. The most abundant taxon was *Ambassis* spp. (8,216 individuals, accounting for 44.94% of the total), followed by *Sillago sihama* (3,490 ind., 19.09%). Three occurrence patterns were apparent: year-round (e.g., *Ambassis* spp., *Gerres* sp. 1 and 2), dry-season only (*Sillago aeolus*, *Gerres* sp. 3) and rainy-season only (*Chanos chanos*, *Lates calcarifer*). Although no clear trend in seasonal abundance (represented by number of individuals per day) was obvious, more species were represtned during dry-season months, generally from November to April, than during the rainy season. The cluster analyses based on the similarity index of Jaccard's coefficient of community (species' composition only) and Pianka's $\alpha$-index (species' composition and abundance) between each month indicated that fish assemblages in the dry season were relatively stable, those in the rainy season being more changeable. A more or less drastic change in fish assemblages was apparent during seasonal transitions, based on the similarity indices between consecutive months.

## 1. Introduction

Surf zone and sandy beach habitats have recently been attracting the attention of marine biologists because of their role as nursery grounds for fishes. Accordingly, biological information on larval and juvenile fishes in the surf zone was compiled from a symposium hosted by the Japanese Society of Fisheries Science in September 1997 (SENTA and KINOSHITA, 1998). In this, KINOSHITA (1998) stressed the significance of surf zones as nursery grounds for fishes. Although many studies have been conducted on surf zone fish assemblages, most have concentrated on coasts of temperate regions, such as North America, South Africa, North Sea and Japan (SENTA, 1998), with only few on assemblages in the surf zones of tropical or subtropical regions (BAGARINAO and TAKI, 1986: Panay Island, Philippines; YANG and SENTA, 1993: Makung Island, Penghu Islands, Taiwan). Clearly, there exists a need for more information on fish assemblages in the surf zones of the latter regions. The composition of fish larvae and juveniles occurring in the surf zone of Panay Island, Philippines, are examined herein, seasonal changes in abundance and species' composition being analyzed in detail.

## 2. Materials and Methods

Specimens examined in this study were collected from the surf zone along the beach at Tigbauan, Iloilo, southern part of Panay Island, Philippines, from 18 May 1986 to 28 September 1987. During this period, fishes were collected with a milkfish fry sweeper (see MORIOKA *et al.*, 1993) for 91days, the frequency of collections ranging from 1 day (August 1986) to 12 days (December 1986) per month. On each sampling day, fishes were collected by operating the fry sweeper five times for about 50 m parallel with the beach line at a depth of 1–1.5 m. Fishes collected were fixed with 5% fromalin and

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preserved in 70% ethylalcohol at the Aquaculture Department, Southeast Asian Fisheries Development Center (SEAFDEC), Tigbauan, Iloilo, Philippines. Sorting, identification and measurement (SL to the nearest 0.1 mm) of the samples were undertaken in the Laboratory of Ichthyology, Tokyo University of Fisheries, Japan, in 1992 and 1993. Identifications were based mainly on OKIYAMA (1988), being made to the familial, generic or specific levels. In many cases, multiple species included in families or genera (being the lowest identified level) were not subject to finer distinction, being labelled spp. In the study, seasonal changes in abundance of individuals and species' compositon were analyzed by month, based on the mean number of individuals collected per day and number of species collected each month, respectively. The coefficient of community (JACCARD, 1902: cited in KIMOTO and TAKEDA, 1989) and Pianka's $\alpha$-index (PIANKA, 1973: cited in KIMOTO and TAKEDA, 1989) were used as indices indicating similarities in species' composition and species' composition with individual abundance, respectively, UPGMA being used for a clster analysis. All of the specimens used in this study are deposited in the Museum, Tokyo University of Fisheries, under the catalog numbers MTUF-P (L) 333-802.

### 3. Results

Fishes collected during the survey from May 1986 to September 1987 numbered 18,282 individuals, representing 38 families of 13 orders, with 13 unidentified specimens representing three further species (Table 1). All of the specimens collected were at the larval or juvenile stage, ranging from 1.8 mm (*Lates calcarifer*) to 78.0mm (Syngnathidae sp.) SL. The most abundant taxon (taxa) in terms of individual number was *Ambassis* spp. (8,216 individuals, accounting for 44.94% of the total collected), followed by *Sillago sihama* (3,490, comprising 19.09%), three species of *Gerres* (1,731 individuals (9.47%) of sp. 3, 1,250 (6.84%) of sp.2 and 1,035 (5.66%) of sp.1), *Sillago aeolus* (705, comprising 3.86%) and *Chanos chanos* (600, comprising 3.28%). The 10 top-ranking taxa occupied 95.66% of the overall total collected, whereas nine taxa were represented by only one specimen and 15 taxa by 2-5 specimens (Table 1).

Figure 1 shows seasonal occurrences of the 8 top-ranking taxa (the rainy season extending generally from May to October and the dry season from November to April). Three different occurrence patterns were apparent. *Ambassis* spp., *Gerres*sp. 1 and 2, and Mugilidae sp. 2 occurred throughout survey period, with no noticeable seasonal fluctuations. On the other hand, *Sillago sihama*, *S. aeolus* and *Gerres* sp. 3 were collected much more abundantly during the dry season. In particular, *S. aeolus* showed remarkable seasonality, its occurrence being restricted to the dry season form December to April (see also KATO *et al.*, 1997). In contrast, *Chanos chanos* were more abundant in rainy season months. Similar patterns were seen in some less-abundant taxa not included in Figure 1. *Megalops cyprinoides*, *Terapon jarbua* and Gobiidae spp. showed year-round occurrence, Atherinidae spp. and Teraponidae sp. were more abundant during the dry season, and Leiognathidae spp. and *Lates calcarifer* occurred mainly in the rainy season.

As shown in Figure 2, the month with the greatest number of individuals collected per day was October 1986 (483.9 ind./day), followed by July 1986 (465.0), September 1986 (323.7) and December 1986 (303.0), whereas those with the least number of individuals collected per day were May 1986 (29.0), June 1986 (33.8), July 1987 (56.0) and September 1987 (57.3). Although the mean number of individuals collected per day in the 1986 (May-October) and 1987 (May-September) rainy seasons was 236.6 and 88.9, respectively, the mean number in the 1986/1987 dry season (November 1986-April 1987) was 190.0, there being no obvious seasonal differences in the number of individuals collected per day (Fig.2).

The month in which the greatest number of species was recorded was December 1986 (30 species), followed by June 1987 (22), April 1987 (21) and January 1987 (20) (Fig.2). On the other hand, the lowest number of species (8) was recorded in May, June and August 1986. The mean number of species in the 1986 (May-October) and 1987 (May-September) rainy seasons was 10.0 and 14.2, respectively, compared

Table 1. Fishes collected from the surf zone off Panay Island, Philippines, from May 1986 to September 1987

| | Number of indiv. | Size range(SL, mm) | Composition of total collection(%) | Rank(based on no. of indiv.) |
|---|---|---|---|---|
| Elopiformes | | | | |
| Elopidae | | | | |
| *Elops hawaiensis* | 2 | 30.1, 31.9 | —— | 14 |
| Megalopidae | | | | |
| *Megalops cyprinoides* | 91 | 19.8–28.8 | 0.50 | |
| Anguilliformes sp. | 1 | 64.0 | —— | |
| Clupeiformes | | | | |
| Clupeidae spp. | 105 | 9.6–20.1 | 0.57 | 13 |
| Engraulidae spp. | 126 | 13.0–30.6 | 0.69 | 10 |
| Gonorynchiformes | | | | |
| Chanidae | | | | |
| *Chanos chanos* | 600 | 9.1. 13.1 | 3.28 | 7 |
| Stomiiformes | | | | |
| Gonostomatidae sp. | 1 | 21.6 | —— | |
| Myctophiformes spp. | 4 | 6.8–31.3 | —— | |
| Lophiiformes | | | | |
| Antennariidae spp. | 3 | 4.3–9.4 | —— | |
| Atheriniformes | | | | |
| Atherinidae sp. | 34 | 9.5–31.3 | 0.19 | 18 |
| Beloniformes | | | | |
| Hemiramphidae spp. | 4 | 15.5–19.9 | —— | |
| Exocoetidae sp. | 7 | 11.1–17.0 | —— | |
| Syngnathiformes | | | | |
| Syngnathidae spp. | 2 | 52.5, 78.0 | —— | |
| Scorpaeniformes | | | | |
| Playcephalidae spp. | 4 | 9.5–10.1 | —— | |
| Perciformes | | | | |
| Centropomidae | | | | |
| *Lates calcarifer* | 12 | 2.8–8.1 | 0.07 | |
| Ambassidae | | | | |
| *Ambassis* spp. | 8216 | 3.0–28.9 | 44.94 | 1 |
| Teraponidae | | | | |
| *Terapon jarbua* | 125 | 8.8–15.9 | 0.68 | 11 |
| Teraponidae sp. | 117 | 8.3–15.6 | 0.64 | 12 |
| Apogonidae spp. | 49 | 5.3–8.1 | 0.27 | 17 |
| Sillaginidae | | | | |
| *Sillago aeolus* | 705 | 8.9–26.0 | 3.86 | 6 |
| *Sillago sihama* | 3490 | 6.3–22.9 | 19.09 | 2 |
| Carangidae spp. | 27 | 5.8–26.4 | 0.15 | 19 |
| Leiognathidae spp. | 77 | 6.4–22.0 | 0.42 | 16 |
| Lutjanidae | | | | |
| *Lutjanus* sp. | 1 | 18.5 | —— | |
| Gerreidae | | | | |
| *Gerres* sp. 1 | 1035 | 10.0–20.3 | 5.66 | 5 |
| *Gerres* sp. 2 | 1250 | 7.3–18.0 | 6.84 | 4 |
| *Gerres* sp. 3 | 1731 | 5.5–11.5 | 9.47 | 3 |
| Haemulidae sp. | 1 | 25.3 | —— | |
| Sparidae sp. | 5 | 9.4–10.8 | —— | |
| Sciaenidae spp. | 2 | 3.9, 8.6 | —— | |
| Pempheridae sp. | 1 | 5.8 | —— | |
| Ephippididae spp. | 3 | 8.9–25.0 | —— | |
| Scatophagidae | | | | |
| *Scatophagus* sp. | 1 | 9.0 | —— | |
| Pomacentridae sp. | 1 | 12.6 | —— | |
| Mugilidae sp. 1 | 89 | 8.5–32.9 | 0.49 | 15 |
| Mugilidae sp. 2 | 206 | 6.9–30.5 | 1.13 | 8 |
| Labridae sp. | 1 | 6.8 | —— | |
| Trichonotidae sp. | 3 | 16.9–17.5 | —— | |
| Gobiidae spp. | 130 | 5.0–28.9 | 0.71 | 9 |
| Siganidae | | | | |
| *Siganus* sp. | 1 | 17.3 | —— | |
| Sphyraenidae | | | | |
| *Sphyraena* sp. | 2 | 21.6, 27.8 | —— | |
| Cetrolophidae spp. | 2 | 7.6, 10.0 | —— | |
| Tetraodontiformes | | | | |
| Tetradontidae spp. | 2 | 5.6, 15.4 | —— | |
| Unidentified sp. 1 | 2 | 4.1, 4.8 | —— | |
| Unidentified sp. 2 | 9 | 8.8–11.3 | —— | |
| Unidentified sp. 3 | 2 | 4.0, 4.4 | —— | |

with 21 in the 1986/1987 dry season (November 1986–April 1987), there being an apparent tendency for more species to occur in the dry season than in the rainy season (Fig.2).

The cluster analysis based on the similarity index of Jaccard's coefficient of community between each month indicated that a cluster was formed by the six dry-season months from November 1986 to April 1987, plus May 1987 and July 1986 (Fig.3). Although other two clusters were formed by rainy-season months (May, June and August 1986; and September and October 1986 plus June–September 1987), the latter cluster together formed a natural grouping with the dry-season cluster. The similarity index of Jaccard's coefficient of community between consecutive months was also high in the dry-season months from November–December 1986 to April–May 1987, the index ranging from 0.548 to 0.739 (Fig.4). On the other hand, the index was hovered between 0.385–0.529 and 0.407–0.522 during the 1986 and 1987 rainy sea-

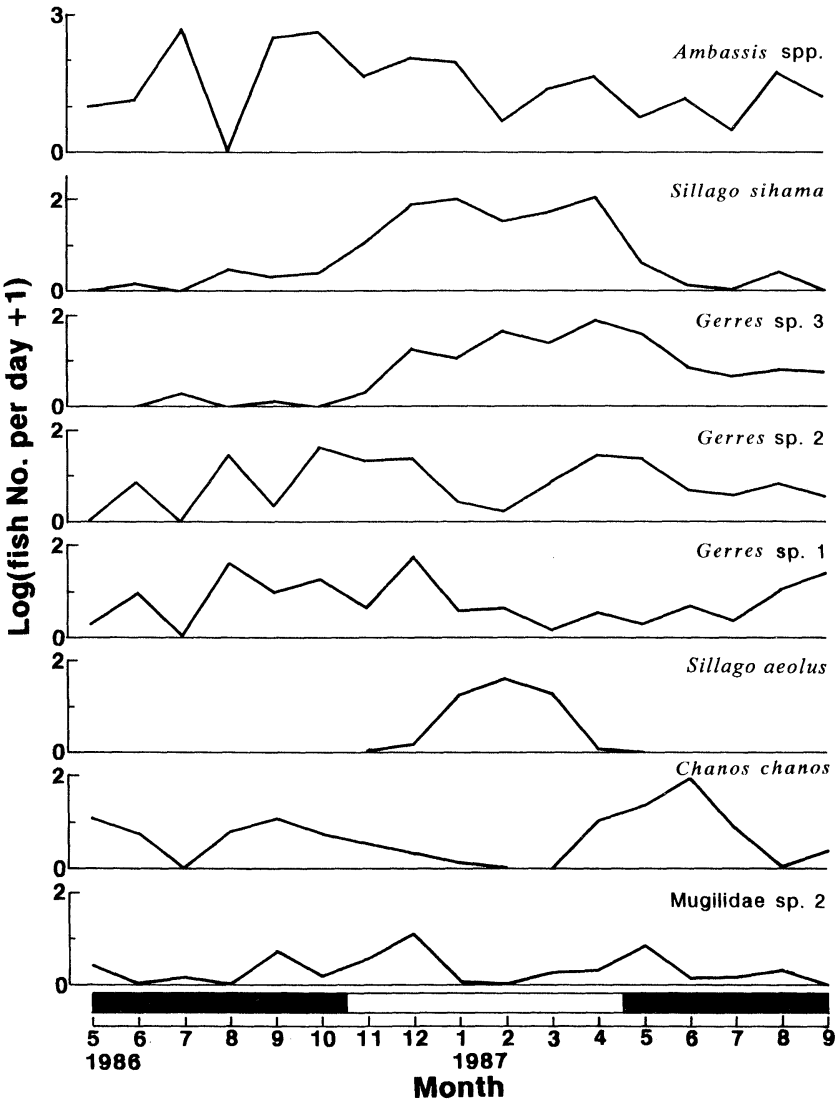


Fig. 1. Monthly changes in abundance of major fish species collected from the surf zone off Panay Island, Philippines, from May 1986 to September 1987.

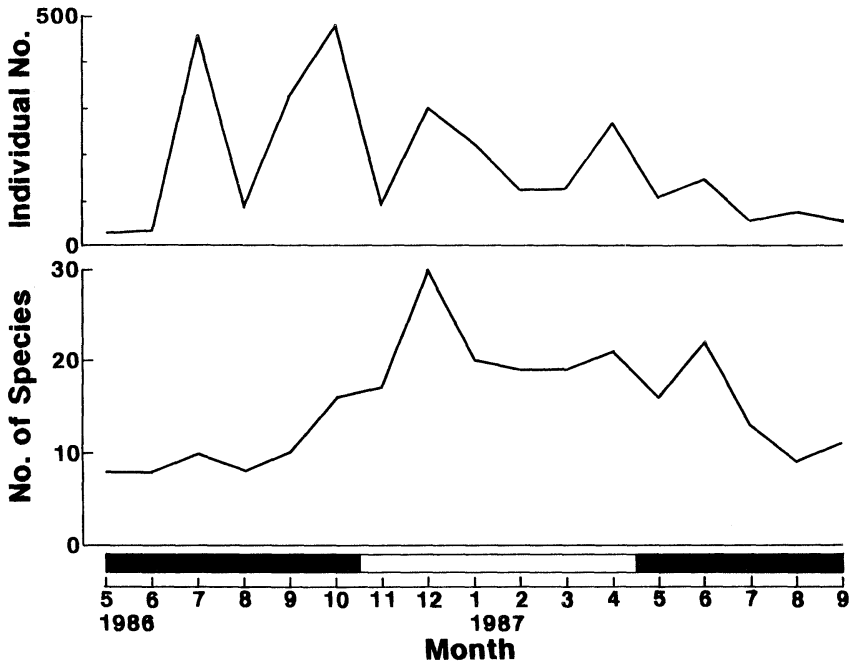


Fig. 2. Monthly changes in number of individuals and species of fishes collected from the surf zone off Panay Island, Philippines, from May 1986 to September 1987.(Number of individuals expressed as mean number collected per day for each month; number of species equals that recorded each month.)

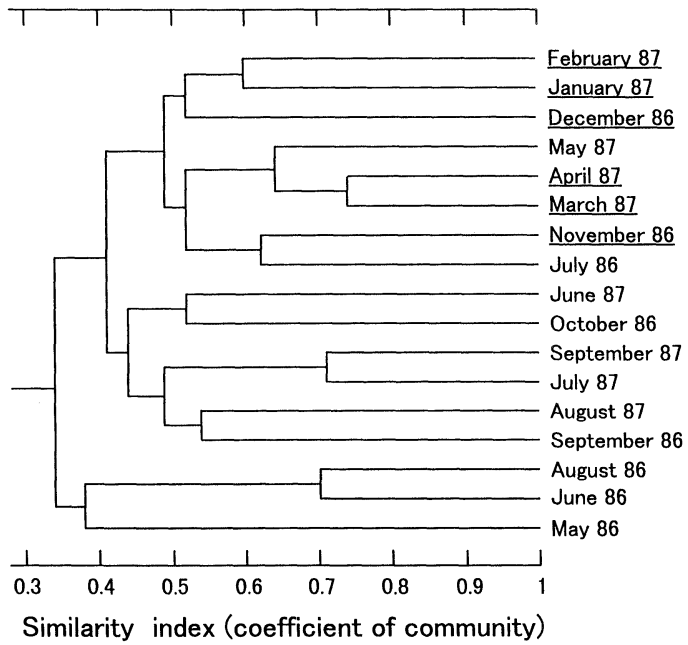


Fig. 3. Dendrogram of sampling months, based on the similarity index of Jaccard's coefficient of community, for fishes collected from the surf zone off Panay Island, Philippines, from May 1986 to September 1987(Dry-season months underlined.)

sons, respectively. The greatest monthly drop in the index (from 0.682 to 0.407) was seen between April–May and May–June 1987.

The similarity index of Pianka's $\alpha$-index, on the hand, showed the dry-season months from December 1986 to April 1987 as forming a culster (Fig.5). Although a second cluster was formed by the rainy-season months of June, July, September–November 1986 and August 1987, this was closely grouped with the dry season clusters. Other rainy-season months formed two cluster (May 1986 and 1987 and June 1986; August 1986 and September 1987), with July 1987 being grouped only with the overall cluster. The similarity indices of consecutive dry-season months from September–October 1986 to March–April 1987 remained at high values, except for that of January–Feburuary 1987 (0.517), ranging from 0.821 to 0.994 (Fig.4). By comparison, indices for rainy-season months fluctuated; higher values were observed in May–June–July 1986, and April May–June and August–September 1987, and lower values in July–August–September 1986 and June–July–August 1987. The greatest jump in the index occurred between August–September and September–October 1986, increasing from 0.029 to 0.994, whereas subsequent values decreased gradually overall, from March–April (0.935) to July–August (0.093) 1987.

## 4. Discussion

Fishes representing 38 families, in addition to three unidentified species, were collected in the present study from the south coast of Panay Island, Philippines, whereas BAGARINAO and TAKI (1986) reported 47 families from the northern west coast of the same island. Fish assemblages

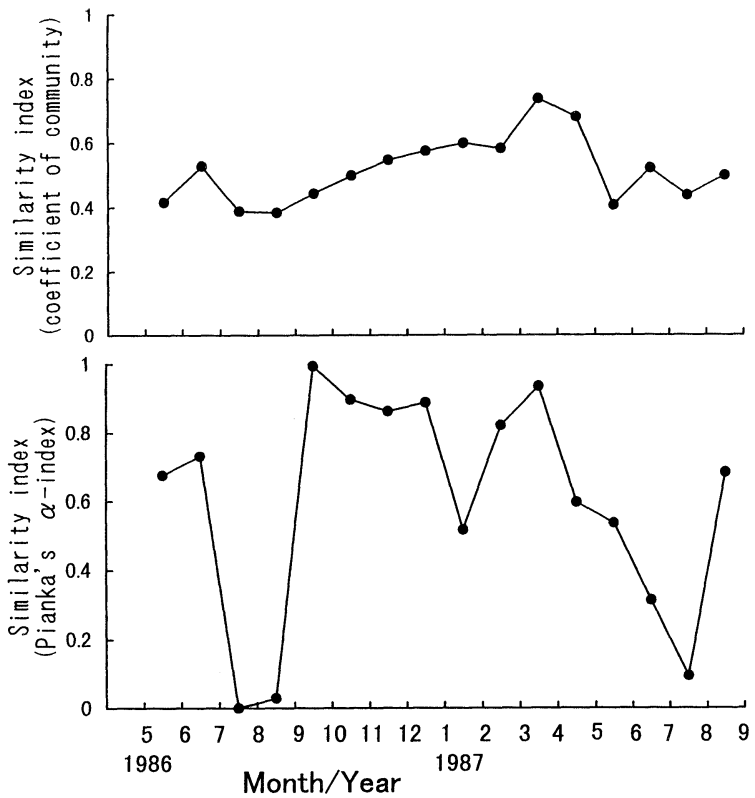


Fig. 4. Similarity index between consecutive months, based on Jaccard's coefficient of community(above)and Pianka's $\alpha$-index(below), for fishes collected from the surf zone off Panay Island, Philippines, from May 1986 to September 1987(Note dry season extended from November to April).

reported from surf zones so far as follows: forty nine families from Tosa Bay, Shikoku, Japan (KINOSHITA and HAMADA, 1983: cited in KINOSHITA, 1984), 52 families from Kyushu, Japan (SENTA and KINOSHITA, 1985), 32 families Makung Islalnd, Penghu Islands, Taiwan (YANG and SENTA, 1993), 29 families plus unidentified specimens from Gulf of Mexico (RUPLE, 1984) and 16 families plus unidentified specimens from South Africa (WHITFIELD, 1989).

Temperate water studies have indicated that the number of individuals and species occurring in the surf zone is greater in spring and summer than in autumn and winter (SENTA and KINOSHITA, 1985; WHITFIELD, 1989). YANG and SENTA (1993) also reported that the surf zone fish assemblages in a subtropical region (Taiwan) were most diverse and abundant in spring and summer (April to July) and poorest in late winter (February and March).

In terms of aundance of individuals per day, no obvious seasonality was detected in this study. BAGARINAO and TAKI (1986) also found that the average catch per sample did not change markedly with season.

As to the number of species, collections during the dry season (November to April) produced a greater number than those during the rainy season, contrary to the results of BAGARINAO and TAKI (1986), in which the greater number of species were seen in June to September. The sampling site of BAGARINAO and TAKI (1986) was located on the northern part of the west coast of Panay Island, subject to southwesterly monsoon winds, such plus the heavy surf being considered to cause a passive accumulation of fish larvae and juveniles. However, the sampling site of the present study was located on the south coast of Panay Island, where southwesterly monsoonal infulences are slight. During the monsoon season from June to September, the fish faunas reported by BAGARINAO and TAKI (1986) and this study deiffered considerably: the number of taxa reoprted only in the former study being 21, whereas the vice versa being 4; and four taxa collected in the monsoon season in the former

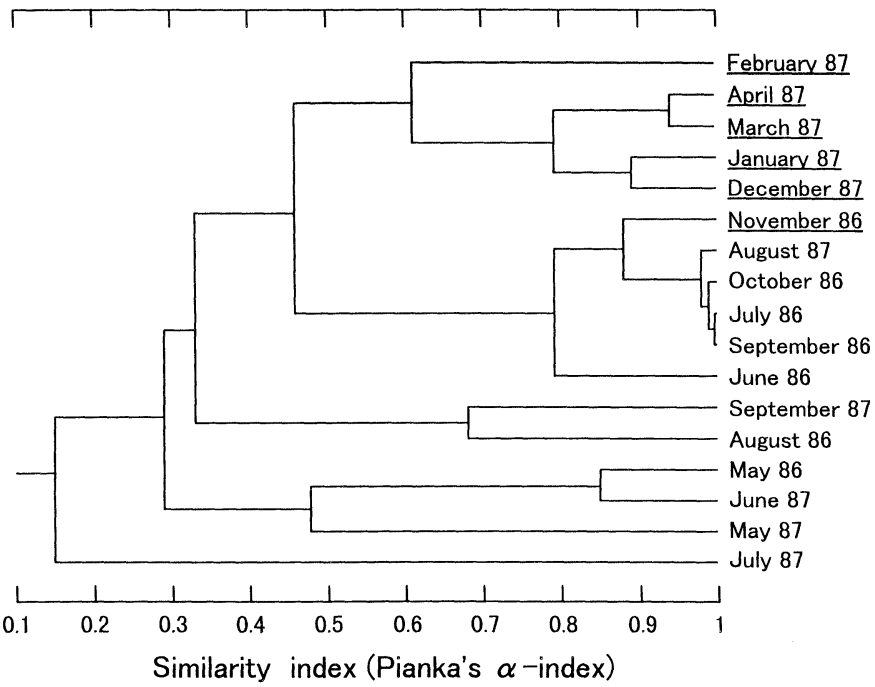


Fig. 5. Dendrogram of sampling months, based on the similarity index of Pianka's $\alpha$-index, for fishes collected frome the surf zone off Panay Island, Philippines, from May 1986 to September 1987(Dry-season months underlined.)

study being recorded only during dry season in the latter study. To clarify factors affecting fish assemblages in surf zone, environmental influences such as monsoon, wind and heavy surf, in addition to bioloical aspects of fishes, need to be examined further.

The dry-season months from November 1986 to May 1987 (species' composition) or from December 1986 to April 1987 (abundance and species' compositon) formed clusters in this study, indicating some stability of the fish assemblages during these periods. The occurrence of assemblage stability is further supported by the high similarity index values between consecutive months from November-December 1986 to April-May 1986 (species' composition) and September-October 1987 to March-April 1987 (abundance and species' composition). On the other hand, the rainy-season months formed disordered clusters, irrespective of year, some being grouped with the dry-season cluster. Furthermore, in the rainy season, the similarity indices of consecutive months were either low (species' composition) or fluctuated in a disoredered manner (abundance and species' compostion), suggesting that the fish assemblages at that time were changeable, unlike those characterizing the dry season.

At the transition between seasons, differences between the indices of consecutive months were variable. From the dry season to the rainy season, the greatest difference was seen between April-May and May-June 1987 (sepecies' composition), the index for abundance and species' compostion decreasing gradually from March-April to July-August 1987. From the rainy season to the dry season, the greatest difference occurred between August-September and September-October 1986 (abundance and species' composition). These results indicated that the fish assemblages changed more or less drastically at the transition between seasons.

Surf zone habitats are considered important for fish larvae and juveniles. Although BROWN and MCLACHLAN (1990) stated that biological studies of sandy beaches were lagging well behind those of rocky shores, information on species' composition and abundance of fish larvae and juveniles occurring in the surf zone has been accumulated by many authors (see SENTA, 1998). KINOSHITA (1984, 1998) indicated the possibility of surf zone habitats as feeding grounds for fish larvae and juveniles, although the site of the present study was considered unsuitable for the milkfish, *Chanos chanos*, following a comprehensive study of that species by MORIOKA *et al.*, (1993, 1996). On the other hand, KATO (1994) studied juvenile feeding habits of two sillaginid species from the same site and concluded that both required a period of surf zone existence for successful development. These studies suggest the need for species-by-species' evaluation of surf zone requirements during their development. Furthermore, in order to understand the relative importance of surf zone, it is important to compare the fish assemblages of such with those of other inshore habitats, such as estuaries, sandy beaches and reefs, as demonstrated by BENNETT (1989), who compared the abundance of juveniles in a surf zone with those in other inshore marine habitats in South Africa.

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