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Seasonal occurrence and abundance of the moonfish, *Monodactylus argenteus*, in surf zones and rivers of the northern coast of Bali, Indonesia

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Abstract : The seasonal occurrence, abundance and size distribution were examined on larval and juvenile moonfish, *Monodactylus argenteus*, collected from different habitat types, surf zones and lower river reaches, along the northern coast of Bali, Indonesia, by a push-net made of "mosquito net" from 3 January 1995 to 28 January 1996. Body sizes were almost discrete between surf zone (n=110, 3.7–5.5 mm SL) and river (n=47, 4.7–49.1 mm SL) specimens, the body size of around 5.5 mm SL corresponding to the transitional stage between postflexion larva and juvenile. Surf zone specimens occurred year-round, but river specimens did not occur in the dry season in Bali, from May to August. Although no apparent growth was observed among the surf zone specimens, the body size tended to increase in river specimens. These results suggest that the surf zone would provide a short-lived nursery ground for moonfish, rivers being used for subsequent growth.

Keywords : *Monodactylus argenteus; occurrence; larvae; juveniles; Indonesia.*

1. Introduction

The moonfish, *Monodactylus argenteus*, is widely distributed in tropical and warm-temperate Indo-Pacific coastal waters, from east Africa and the Red Sea to western South Australia and north to Japan (RANDALL, 1983; HATOOKA, 1993; WHITFIELD, 1998; MISKIEWICZ, 2000). Larvae and juveniles are known to inhabit lower salinity waters such as estuaries and lower river reaches (HAYASHI, 1989; WHITFIELD, 1998), and their morphological development has been well described by KINOSHITA (1988) and MISKIEWICZ (1998). However, no detailed studies are available on their occurrence patterns in these habitats. In the course of our study on larval and juvenile fishes occurring in the surf zones and lower river reaches in Bali, Indonesia, we collected many specimens of *M. argenteus* from both habitat types. This study examined the seasonal occurrence, abundance and size distribution of *M. argenteus* in both habitats along the northern coast of Bali, Indonesia. Morphometric changes with growth of some body parts are also described.

2. Materials and methods

Specimens used in this study (n=157, 3.74–49.1 mm SL) were collected from the surf zone and river at two sites, Lovina and Banyalit beaches (distance apart about 1 km) on the northern coast of Bali, Indonesia, from 3 January 1995 to 28 January 1996. The river sampling sites were located just inside the river mouth. Sampling was conducted with a push-net made of "mosquito net", operated for about 30 min on each sampling day. The total number of sampling days was 54 in the surf zones at both Lovina and Banyalit, and 64 and 65 days in the rivers at those localities, respectively. Collected samples were fixed with 5% formalin and transferred to 70% ethyl alcohol for preservation. All the specimens used in this study had a completely flexed notochord, standard length

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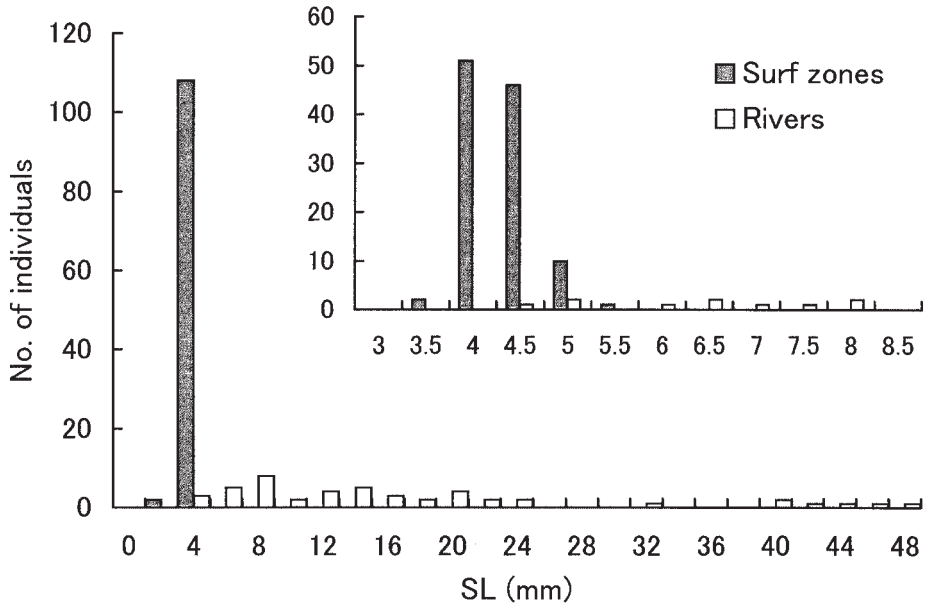

Fig. 1. Standard length, SL, distribution of larvae and juveniles of *Monodactylus argenteus* collected from the surf zones and rivers of the northern coast of Bali, Indonesia, from January 1995 to January 1996. Inset shows detailed distribution between 3–8 mm SL.

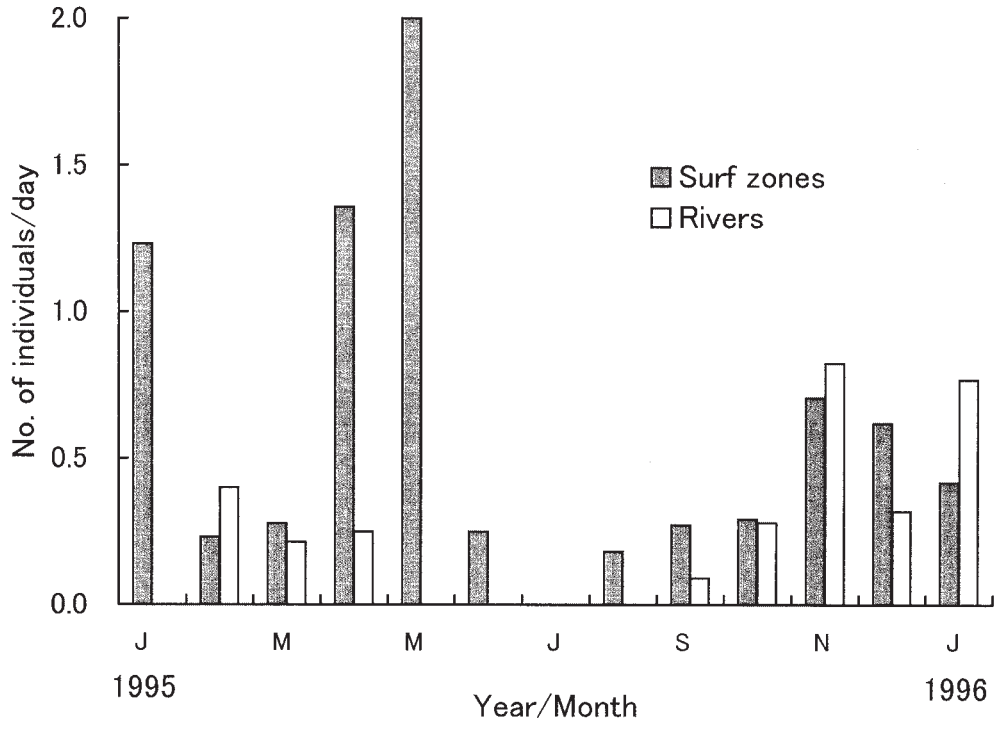

Fig. 2. Number of larval and juvenile *Monodactylus argenteus* collected per day (shown as monthly averages) from the surf zones and rivers of the northern coast of Bali, Indonesia, from January 1995 to January 1996.

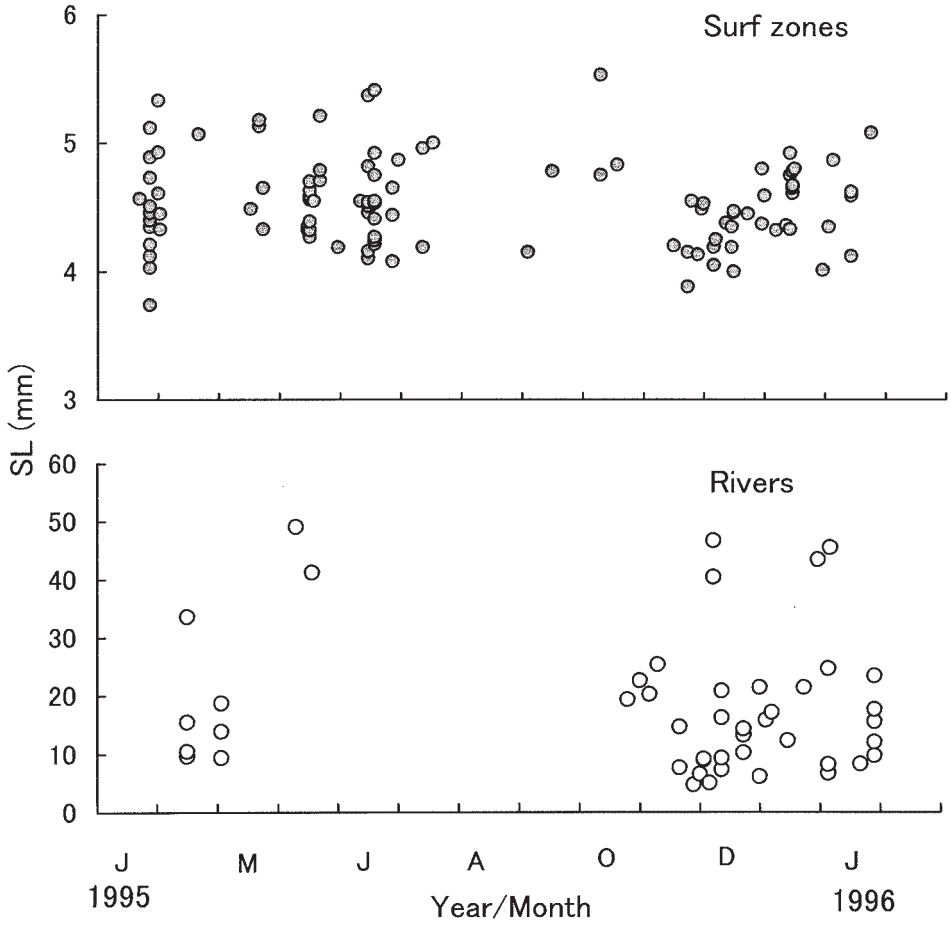

Fig. 3. Standard lengths (SL) of *Monodactylus argenteus* larvae and juveniles collected from the surf zones and rivers of the northern coast of Bali, Indonesia, from January 1995 to January 1996.

(SL) therefore being measured from the snout tip to the posterior edge of the hypural plate. The head length, body depth and pelvic fin length were measured (expressed as percentages of SL) on 20 (3.9–5.5 mm SL) and 42 (6.1–49.1 mm SL) specimens collected from the surf zones and rivers, respectively. Measurement methods followed LEIS and TRNSKI (1989). Water temperature and salinity ranged from 30.0–35.0℃ and 27–33‰ in the surf zones, and from 28.0–35.7℃ and 0–27‰ in the rivers, respectively. The salinity was usually less than 10‰ in the rivers, the only exceptions being 17, 20 and 27‰ on three days in November and December at Banyalit. All of the specimens were deposited in the Museum, Tokyo University of Fisheries (MTUF-P (L)).

3. Results

The numbers of larvae and juveniles collected were 54 (3.7–5.5 mm SL, mean±SD=4.5±0.4 mm SL) and 56 (4.1–5.4 mm SL, 4.6±0.3 mm SL) from the surf zones at Banyalit and Lovina, respectively, and 38 (5.1–49.1 mm SL, 16.9±11.6 mm SL) and 9 (4.7–40.5 mm SL, 21.8 ±13.9 mm SL), respectively, from the rivers at those localities. No significant differences were detected in mean SL between the Banyalit and Lovina surf zones and rivers (t-test, $p>0.05$). Therefore, analyses of occurrence and body size in this study were compared between the surf zone and river specimens.

Body sizes were almost discrete between the surf zone (n=110, 3.7–5.5 mm SL) and river (n=47, 4.7–49.1 mm SL) specimens (Fig. 1),

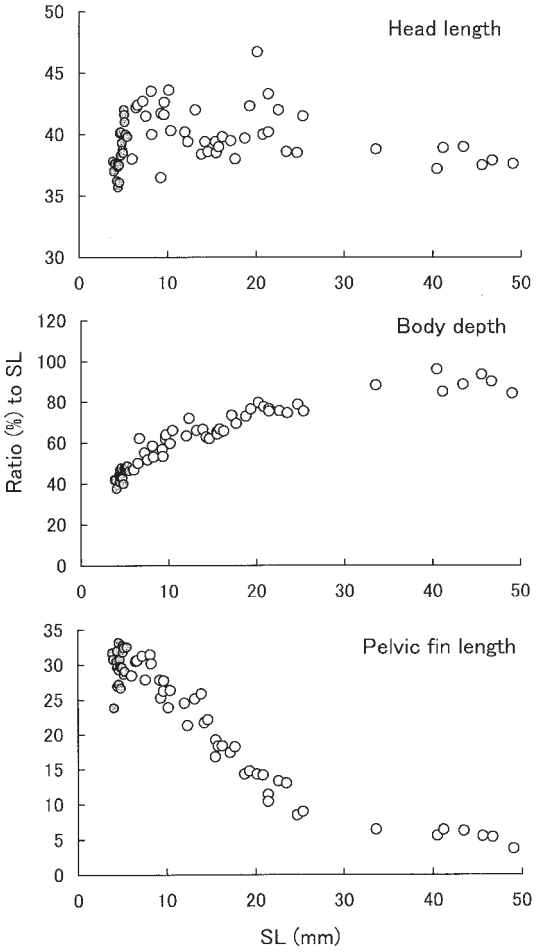

Fig. 4. Changes in body proportions, shown as percentages of standard length (SL) of *Monodactylus argenteus* larvae and juveniles collected from the surf zones (closed circles) and rivers (open circles) of the northern coast of Bali, Indonesia, from January 1995 to January 1996.

number of overlapping specimens between these localities (4.7–5.5 mm SL) being 33 and 3 in surf zone and river, respectively, an overall overlap rate of 22.9% (36/157). The largest surf zone specimen (5.5 mm SL) was a juvenile with completed fin ray complements, the remainder (≦5.4 mm SL) being postflexion larvae. On the other hand, the three smallest river specimens (4.7 and two 5.1 mm SL) were postflexion larvae, the others (≧6.1 mm SL) being juveniles.

Surf zone specimens occurred year-round, except for July, with a peak in May, the end of rainy season (Fig. 2) . On the other hand, the occurrence of river specimens was limited to the period from February to April in 1995 and from September 1995 to January 1996. The period from May to August, when river specimens did not occur, corresponds to the dry season in northern coast of Bali.

The SL of each specimen was plotted against sampling days (Fig. 3). No apparent growth cohorts were observed among the surf zone specimens. On the other hand, body size tended to increase from February to April and October to December in the river specimens, although the number of larger specimens was low.

Although head length varied from 35–45% SL, it increased from 35.7 to 42.0% SL with growth in the surf zone specimens (Fig. 4). The ratio decreased gradually thereafter, becoming stable at 37–39% SL in specimens >30 mm SL. Initially, body depth increased rather rapidly from 37.6 to 48.8% SL in the surf zone specimens, the rate becoming much less thereafter until 30 mm SL (Fig. 4). In the specimens >30 mm SL, body depth became stable at about 90% SL. The pelvic fin length increased rapidly in the surf zone specimens and decreased rapidly in the river specimens, with a peak of 32.7% SL in a 5.1 mm SL surf zone specimen (Fig. 4). The rate of decrease lessened thereafter in specimens >30 mm SL.

4. Discussion

Moonfish larvae occurred year-round in the surf zone in this study, indicating the possibility of spawning occurring throughout the years. HAYASHI (1989) reported juveniles of about 7 mm SL in mangrove areas of the Ryukyu Islands at the end of August and SENOU and SUZUKI (1980) noted that larvae occurred in river mouths at the Yaeyama Islands during Spring and Summer. On the other hand, larvae were caught entering Lake Macquarie, New South Wales, Australia, from December to May, with a peak abundance between February and April (MISKIEWICZ, 1987; cited in MISKIEWICZ, 1998) . These observations indicate that the spawning season of moonfish is limited to Spring and Summer in sub-tropical and temperate waters of both the northern and southern hemispheres.

Although the smallest specimen collected in

this study was a 3.7 mm SL individual from the surf zone, MISKIEWICZ (1998) collected a 3.2 mm SL larva by plankton tow in coastal waters off Lake Macquarie, New South Wales, and indicated that hatching larvae were smaller than 2.1 mm SL. Therefore, it is considered that the larvae present in the surf zone are likely to have spawned in nearby coastal waters, subsequently migrating (passively and /or actively) to the surf zone. Moonfish larvae disappeared from the surf zone and appeared in river samples at around 5.5 mm SL, which corresponds to the transitional stage between postflexion larva and juvenile, and to the peak ratio of pelvic fin length to SL.

It seems likely therefore that the surf zone provides a short-lived nursery ground for moonfish, rivers being used for subsequent growth. However, the moonfish juveniles did not occur in the river during the dry season from September to April, although the larvae occurred in the surf zone throughout the years. The river would not provide a suitable nursery ground for the juveniles during the dry season because of inadequate volume of water. Therefore, these results suggest a possibility that other nursery grounds than rivers would exist for moonfish juveniles during the dry season.

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