Japanese Journal of Ichthyology
Vol. 32, No. 2 1985

魚類学雑誌
32巻2号 1985年

Bathymetric Distribution and Feeding Habits of Two Sympatric Cheilodactylid Fishes at Miyake-jima, Japan

Mitsuhiko Sano and Jack T. Moyer

(Received December 14, 1984)

Abstract Habitats including depth, diurnal activity patterns, and diets of the two cheilodactylid fishes *Cheilodactylus zonatus* and *C. zebra* were studied at Igaya Bay, Miyake-jima, Japan. Both species occurred at nearly equal densities in identical habitats and depths. They preyed on benthonic organisms from early morning to shortly before sunset, when feeding activities decreased remarkably and intraspecific social behavior greatly increased. Gut analyses showed a high degree of dietary overlap, but proportions of food items in their diets differed slightly. *C. zonatus* was more of a food generalist than *C. zebra*, showing a higher niche breadth value. *C. zebra* tends to feed on epifauna, especially gammaridean amphipods and decapods, while *C. zonatus* takes both epifauna and infauna including polychaetes.

The morwongs, Cheilodactylidae, are Indo-Pacific reef fishes which, for the most part, occur in temperate waters and are antitropical in distribution (Randall, 1981, 1983). These fishes constitute a conspicuous component of the temperate reefs of New Zealand, Australia, South Africa, and Japan (Randall, 1983). Some of the southern hemisphere species are commercially exploited. In Japan there are three species, all in the subgenus *Goniistius* (Randall, 1983). Of these, *Cheilodactylus quadricornis* Günther occurs in deep water (Masuda *et al.*, 1980). The others, *C. zonatus* Cuvier and *C. zebra* Döderlein, are shallow water representatives, with the former occurring abundantly along the main islands of Honshu, Kyushu, and Shikoku. *C. zebra* is less well-known, though not rare, and is said to occur in somewhat deeper waters (Kimura and Suzuki, 1980; Masuda *et al.*, 1980).

According to Randall (1983), the species of the subgenus *Goniistius* are said to feed nocturnally, remaining relatively inactive throughout the daytime.

Our preliminary observations at Miyake-jima (34°05′N, 139°30′E), one of the Izu Islands of Japan, where *C. zonatus* and *C. zebra* are abundant, suggested a broad overlap in nearly all aspects of habitat including depth, and considerable diurnal activity. Our study of feeding habits of these two species was initiated to quantify specific aspects of their coexistence that have hitherto appeared as passing references in literature with different intent (e.g. Randall, 1983; Masuda *et al.*, 1980).

Methods and material

Field work was carried out from September 5 to September 28, 1984, at Igaya Bay on the northwest side of the island. This site has been described by Moyer and Nakazono (1978), Moyer and Zaiser (1981), Moyer and Yogo (1982), and Tribble (1982). Comparative observations were made along an ancient lava flow at Tsubota on the southeast side of the island and along a fresh, one-year-old lava flow at Awabe, on the south coast. SCUBA was used for all underwater observations, amounting to more than 46 man-h.

Data collection involved four phases: (1) simultaneous censuses of both species over an identical course; (2) diurnal behavioral activity analyses of both species; (3) collection of specimens for analysis of food habits; and (4) gut content analysis. The first three phases were conducted in the field at Miyake-jima and the latter at the Laboratory of Fisheries Biology, University of Tokyo. Methods for each phase are described below.

Population census. A linear course 318 m in length along a volcanic cliff ranging in depth from 3 to 26 m was followed by two divers simultaneously in mid-morning over a duration of three days at the Igaya Bay study site. Depths were categorized at 4 m intervals, i.e. 0–4, 4–8, 8–12, 12–16, 16–20, >20. All individuals of both species were recorded independently by each diver in each depth category.

Diurnal activity analysis. Activities were analysed by two methods. First, all individuals of both species were tallied by a single diver either as "feeding" or "non-feeding" during mid-morning census dives, both while following the census course at the foot of the cliff and while returning to shore over sand and rubble, 20–40 m from the base of the cliff. The entire course covered approximately 635 m and ranged in depth from 3 to 26 m. "Feeding" is defined as actual substrate biting or filtering of sand and debris through the gill rakers and operculum. "Feeding" was not tallied unless it was occurring at the initial moment of observation.

In addition, six behavioral categories were identified as follows: (1) foraging, (2) resting, (3) social, (4) swimming, (5) cleaning, and (6) other. "Foraging" refers both to actual feeding and intraspecific inspection of the substratum for food. "Resting" is defined as motionless periods of time on the substratum or in mid-water with no identifiable social function. "Social" refers to interspecific and intraspecific interactions of any kind other than cleaning symbiosis. "Swimming" is defined as an obvious movement from one location to another with no clear function other than a purposeful change of location; e.g., a change of foraging locations, a movement from feeding grounds to shelter, or a change of location after a severe agonistic encounter (clear- ly distinguishable from "fleeing", which we categorized as "social"). "Cleaning" refers to interactions with the obligate cleaners *Labroides dimidiatus* and *L. bicolor*, even though these were sometimes agonistic in nature. The final category, "other", involved rubbing of various parts of the body against the substratum in apparent attempts to remove parasites, yawning, etc.

Having defined behavioral patterns, three 15-min observations were made by a single diver for each species at each of three distinct times of day: AM (between 0800–0900 h), Noon (1100–1300 h), and PM (1630–1730 h), and total time in seconds for each behavioral pattern was tallied during each 15-min observation. This was accomplished as follows: the first large (>200 mm SL) individual sighted on each activity analysis was observed continuously for the entire 15-min watch, and each behavioral pattern was timed with an underwater stopwatch and tallied immediately on a plastic slate at its termination. The subsequent patterns were timed and tallied consecutively in immediate sequence until the 15-min observation was terminated. "PM" observations came near sunset, at the beginning of the crepuscular day-night changeover period. All activity analyses were recorded from the Igaya Bay study site.

Specimen collection. After the census six specimens of *C. zonatus* and eight of *C. zebra* were collected from the Igaya Bay study site using either monofilament nets or multipronged spears. All specimens were taken between 1 h prior to sunset to 15 min after sunset. Thus, any food in the gut would have been ingested diurnally. Immediately after collection specimens were placed in 10% formalin and the gut contents preserved by injecting 100% formalin directly into the body cavity.

Gut content analysis. Diets of *C. zonatus* and *C. zebra* were determined by gut content analysis. The standard length was measured for each specimen in the laboratory. Food items from the gut contents were sorted and identified to genus or species when possible under a binocular microscope. Each sorted item was weighed in wet condition to the nearest 0.01 g.

To evaluate the relative importance of each food item of each species, the following two methods were used: percentage occurrence of food items and percentage composition of each item by wet weight, which was calculated by dividing the sum total of the individual weight for the item by the total weight.

Niche breadth (B) and niche overlap (C_λ) for diets of the two species were calculated by the formulae of Levins (1968) and Horn (1966), respectively:

$$B=\frac{1}{\sum_{h=1}^{s} p_{ih}{}^2},$$

$$C_\lambda=\frac{2\sum_{h=1}^{s} p_{ih}\cdot p_{jh}}{\sum_{h=1}^{s} p_{ih}{}^2+\sum_{h=1}^{s} p_{jh}{}^2}$$

where p_{ih} and p_{jh} are the proportions of a particular item h in the diets of species i and j, respectively and s is the total number of food items in the diet. B is more than 1.0 and larger values indicate wider use of food resources. C_λ varies from 0, when species i and j share no food item, to 1.0, when all items are the same. B has been commonly used to measure niche breadth of species (e.g. Keast, 1978;

Table 1. Bathymetric distribution of *Cheilodactylus zonatus* and *C. zebra* over a 318 m course at the Igaya Bay study site. Values indicate mean number of fish per diver observed during three censuses.

Species	Depth in meters						
	0–4	4–8	8–12	12–16	16–20	>20	Total fish
C. zonatus	0.5	5.0	10.5	16.0	6.0	4.5	42.5
C. zebra	0	5.0	11.0	12.0	13.5	12.5	54.0

George and Hadley, 1979; Macpherson, 1979, 1981; Worgan and FitzGerald, 1981; Matthews *et al.*, 1982) and C_λ to measure similarity in the diets between different species (e.g. Zaret and Rand, 1971; Bray and Ebeling, 1975; Gascon and Leggett, 1977; Baker-Dittus, 1978; Greenfield, Greenfield and Brinton, 1983). In these calculations items less than 0.1% of the diet by weight were given the value 0 and inorganic material such as sand was excluded.

Results

Census. Although *C. zebra* appeared to be more common than *C. zonatus* at depths below 16 m at Igaya Bay (Table 1), statistical analysis showed no significant difference in number of individuals by depth between the two species ($x^2=6.46$, df=5, $0.20<P<0.30$). In addition, a single census over a 300 m course between depths from 16 to 37 m at Tsubota disclosed *C. zebra* only to depths of 18 m, whereas four individuals of *C. zonatus* were observed at 37 m. A similar census at Awabe disclosed both species to be abundant at the 22 m deep end of the transect. Our data clearly indicate that depth ranges of the two species were nearly identical, with *C. zonatus* overlapping *C. zebra* at both ends of the depth scale. Population densities of *C. zonatus* and *C. zebra* did not differ significantly (see Table 1, *C. zonatus*=42.5 per diver, *C. zebra*=54.0, $x^2=1.37$, df=1, $0.20<P<0.30$).

Diurnal activity analysis. Many feeding individuals of both species were observed during the mid-morning census dives (Table 2), and general diurnal activity patterns were very similar for both. That is, the greatest amount of foraging occurred in the morning, decreasing slightly by noon, and diminishing remarkably near sunset, when social behavior showed a great increase (Tables 3, 4). Observations 30 min after sunset disclosed the fact that both species resumed foraging, however data were not collected on the intensity of late crepuscular foraging activities. M. Hayashi (pers. comm.) reported "sleeping" *C. zonatus* observed on night dives at seaweed beds around Tenjin-jima, Yokosuka, on the Pacific coast of central Japan, between 2000–2200 h in August, 1976.

Table 2. Numbers of feeding and non-feeding fish of *Cheilodactylus zonatus* and *C. zebra* over linear course (635 m) during mid-morning at the Igaya Bay study site. Fish were tallied as "non-feeding" unless observed actually biting the substratum or filtering material through operculum at the initial moment of observation.

Species	Total number of fish observed	Number of feeding fish	Number of non-feeding fish
C. zonatus	50	22 (44.0%)	28 (56.0%)
C. zebra	70	36 (51.4%)	34 (48.6%)

Social behavior differed in type as well as in frequency between daytime and the crepuscular period. Daytime behavior included flight from the aggressive territorial damselfish *Stegastes altus* and chases of or flight from conspecifics and congeners that approached foraging individuals. Feeding was only momentarily interrupted at such times. In contrast, crepuscular social interactions were almost exclusively with conspecifics and involved stereotyped displays presumably associated with courtship. Although small individuals continued to forage at such times, large fish (>230mm SL) foraged rarely as sunset approached. G. Stroud (pers. comm.) observed a single spawning of *C. zebra* at the Igaya Bay study site shortly after sunset. Increased conspecific social interactions, reduced foraging, and Stroud's spawning observation, along with resumed foraging 30 min after sunset suggest that spawning occurs around sunset in both species. The increase of "resting" of *C. zebra* at sunset (Table 4) results mainly from a

Table 3. Activity allocations of *Cheilodactylus zonatus* over three 15-min (900 sec) observations at each of three designated times of day at the Igaya Bay study site. Values indicate total time in seconds for each behavioral pattern of a single fish during each 15-min observation. See text for definitions of three designated times and behavioral patterns.

Time		Foraging	Swimming	Social	Cleaning	Resting	Other
AM		863	10	27	0	0	0
		839	40	12	0	9	0
		857	8	28	0	7	0
	Total	2,559	58	67	0	16	0
Noon		863	0	8	29	0	0
		785	31	21	0	61	2
		760	59	33	8	39	1
	Total	2,408	90	62	37	100	3
PM		580	155	90	55	18	2
		0	2	896	0	0	2
		0	244	647	0	6	3
	Total	580	401	1,633	55	24	7
	Grand total	5,547	549	1,762	92	140	10

single 15-min observation of what may have been a sick or abnormal individual. With the exception of that observation, both species appeared least active around noon (Tables 3, 4).

Considering all behavioral activities, no noticeable temporal or motor differences were detected between *C. zonatus* and *C. zebra*. Our data indicate that both species feed actively throughout the daytime, greatly reducing feeding at sunset when intraspecific social behavior becomes the major focus of activity.

Feeding behavior. At the Igaya Bay site, *C. zonatus* and *C. zebra* are biotically sympatric, feeding in seemingly identical habitats in close proximity to one another. Interspecific agonistic encounters appeared to result from disputes over feeding sites; interspecific aggression was minimal during the crepuscular period when intraspecific social interactions were most common for both species. Food was taken from algal-covered and relatively bare boulders and rocks, from living and dead corals, small rocks, cobble, and sand. Unlike the "strong suction" feeding method described by Randall (1983), both *C. zonatus* and *C. zebra* thrust their bodies forward rapidly and take forceful, often repeated bites at the substratum. When the prey was on a hard substratum, clearly audible "clicks" accompanied each bite. Sand and other debris were then filtered through the gill rakers and out through the operculum. Feeding individuals of both species were thus frequently followed by labrids (*Thalassoma cupido*, *Pseudolabrus japonicus*, *Coris dorsomaculata*, *Stethojulis interrupta*) and the pomacentrid *Pomacentrus coelestis* that fed either on organisms flushed from cover by the feeding cheilodactylids or expelled through the operculum. Usually a close 3–5 sec inspection of the substratum preceded the thrust-and-bite attack on the benthonic prey.

Gut content analysis. Of the six *C. zonatus* (142–276 mm SL: mean 218) and the eight *C. zebra* (152–280 mm SL: mean 218) collected, all had guts full of food, including a variety of small benthonic invertebrates. The diet of *C. zonatus* consisted largely of gammaridean amphipods, polychaetes, isopods, sponges, and decapods, while *C. zebra* consumed relatively more gammaridean amphipods and decapods and less polychaetes, isopods, and sponges than *C. zonatus* (Table 5, Fig. 1). Gammaridean amphipods constituted the major prey of both species, but were relatively more important to *C. zebra*. These prey made up 70.0% of the gut content weight for *C. zebra*, compared to 42.2% for *C. zonatus*. Although both species fed on many of the same food items, some difference was found in the proportions of the food items in the diets (Table 5, Fig. 1).

The niche breadth values (B) calculated for the diets of both species indicate that *C. zonatus* had a higher niche breadth (8.09) than *C. zebra* (3.96).

Table 4. Activity allocations of *Cheilodactylus zebra* over three 15-min (900 sec) observations at each of three designated times of day at the Igaya Bay study site. Values indicate total time in seconds for each behavioral pattern of a single fish during each 15-min observation. See text for definitions of three designated times and behavioral patterns.

Time		Foraging	Swimming	Social	Cleaning	Resting	Other
AM		810	0	90	0	0	0
		830	34	36	0	0	0
		898	0	2	0	0	0
	Total	2,538	34	128	0	0	0
Noon		718	29	58	55	40	0
		735	45	10	52	56	2
		777	74	3	16	30	0
	Total	2,230	148	71	123	126	2
PM		620	65	110	60	45	0
		0	239	646	0	15	0
		32	105	230	0	533	0
	Total	652	409	986	60	593	0
	Grand total	5,420	591	1,185	183	619	2

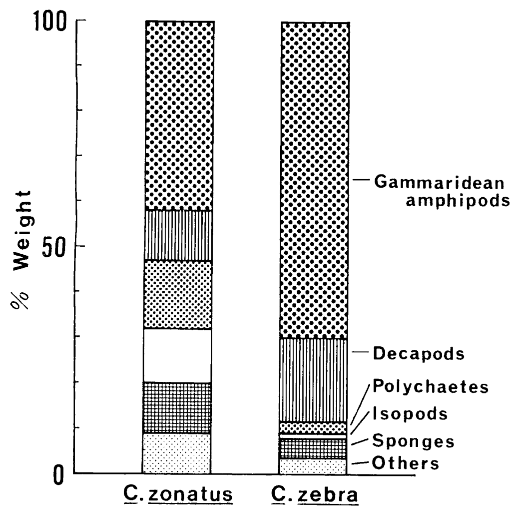

Fig. 1. Percentage composition of food by higher taxonomic group in wet weight for *Cheilodactylus zonatus* and *C. zebra* at the Igaya Bay study site.

The dietary overlap value (C_λ) between the two species was high, 0.787.

Discussion

Water depth has been recognized as an important component of habitat partitioning among related marine fishes representing several genera (Ross, 1977; Hixon, 1980; Larson, 1980). According to Masuda *et al.* (1980) and Kimura and Suzuki (1980), *C. zebra* is said to inhabit somewhat deeper waters than *C. zonatus*. However, our data indicate that at the Igaya Bay study site on Miyake-jima both species overlap completely in all aspects of their habitat including depth. *C. zebra* is a more gregarious species than *C. zonatus*, and the increase in numbers at >16 m (Table 1) may be more of an indication of social compatibility than of true population density at that depth, a possibility strengthened by the fact that *C. zonatus* was found to be very common at 22 m at Awabe, and occurred to at least 37 m at Tsubota. Both species were observed feeding in identical habitats, including bare sand, living and dead corals, algal covered boulders, small rocks, etc. Although not tallied on census dives, *C. zebra* was occasionally observed at depths less than 4 m. Juveniles of both species were found in tidal pools. *C. zonatus* and *C. zebra* are thus biotically sympatric at Miyake-jima.

The observations of Randall (1983) that the species of the subgenus *Goniistius* are nocturnal foragers and that specimens collected by day tend to have empty guts clearly do not fit the behavioral patterns and gut content analyses of *C. zonatus* and *C. zebra* at Miyake-jima. Both species feed almost continuously throughout the morning and early afternoon, decreasing feeding activities as social interactions increase in frequency near

Table 5. Percentage composition of food by taxonomic group in wet weight and frequency of occurrence for *Cheilodactylus zonatus* and *C. zebra* from the Igaya Bay study site. +, less than 0.1% weight; —, not consumed; N, number of fish examined.

Food items	*C. zonatus* (N=6)		*C. zebra* (N=8)	
	% Freq.	% Weight	% Freq.	% Weight
Gammaridean amphipods				
Aorid sp.	100	3.5	100	7.2
Lembos sp.	50	4.1	100	11.8
Elasmopus sp. 1	100	5.3	88	1.3
Elasmopus sp. 2	17	0.1	75	2.4
Pontogeneia sp.	67	2.0	75	0.8
Elasmopus sp. 3	17	1.0	—	—
Unidentified	100	26.2	100	46.5
Crabs				
Thalamita spp.	50	5.6	88	8.2
Xanthids	83	3.6	63	1.8
Unidentified	33	1.1	63	6.6
Shrimps				
Alpheus spp.	—	—	38	0.8
Rhynchocinetes uritai	—	—	13	0.2
Unidentified	33	0.8	63	0.6
Isopods				
Sphaeromatids	67	2.7	63	0.9
Idoteids	33	9.3	—	—
Gonodactylid stomatopods	17	0.2	50	0.6
Galatheid crabs	17	0.1	13	0.4
Hermit crabs	—	—	13	0.1
Ostracods	100	0.2	63	+
Tanaids	17	0.1	25	+
Mysids	—	—	13	+
Sponges	100	11.3	100	4.5
Errant polychaetes	100	11.9	75	1.7
Terebellid polychaetes	67	3.4	13	0.4
Gastropods				
Stomatella spp.	—	—	38	1.9
Olivids	50	0.9	—	—
Eratoids	33	0.3	—	—
Chitons	—	—	13	0.1
Ophiuroids	17	0.7	50	0.2
Echinoids	33	1.1	38	0.2
Algae	83	0.4	63	0.1
Fish scales	—	—	13	0.1
Sipunculids	50	0.7	—	—
Mytilid bivalves	17	0.1	—	—
Unidentified animal material	33	0.6	13	0.2
Sand	100	2.7	100	0.4

sunset. Both species are often observed at rest throughout the day, and their characteristic resting posture, perched on pelvic fins on corals or in basket sponges, etc., makes them conspicuous and not easily forgotten. After a short period (our longest recorded diurnal resting sequence was 82 sec), the fish will resume feeding. The conspicuous posture associated with periodic resting may suggest the possibility that most foraging takes place at night. Critical observations of the two Miyake-jima species, however, have shown that this is not the case. Other species of the subgenus *Goniistius* may prove to be diurnally active upon closer inspection. However, on the basis of a single observation of "sleeping" at night (M. Hayashi, pers. comm.), we are not yet prepared to say that these species are quiescent nocturnally. Our observations of feeding in almost total darkness more than 30 min after sunset indicate that foraging resumes after the crepuscular social interactions cease.

A slight food segregation between *C. zonatus* and *C. zebra* was seen. Although similar food items were consumed by both species and the dietary overlap value between the species was high, the proportions of the food items in the diets were somewhat different. This type of food segregation has been recognized among several other marine (McEachran *et al.*, 1976; Bell *et al.*, 1978; Targett, 1978) and freshwater fishes (Keast, 1978; Smart and Gee, 1979). Furthermore, the fact that *C. zonatus* had a much higher value of niche breadth than that of *C. zebra* indicates that the former is relatively more of a generalist than the latter for food resource utilization. *C. zebra* tends to feed on epifauna, especially gammaridean amphipods and decapods, and *C. zonatus* tends to take both epifauna, mainly gammaridean amphipods, isopods, sponges, and decapods, and infauna, polychaetes. Similar findings in the diet of *C. zonatus* have been obtained from Mito and Misaki, on the Pacific coast of central Japan (Suyehiro, 1942).

Many ecologists (e.g. Schoener, 1974) have suggested that resource partitioning in ecological communities usually occurs along the dimensions of habitat, food, or temporal activity patterns. However, considerable habitat and diet overlap and similar diel activity patterns were observed between *C. zonatus* and *C. zebra* at Igaya Bay during the study period, although a slight food segregation was found. Several studies have shown that diets among related coexisting fishes greatly overlap where food is relatively abundant, while lower food abundance results in greater trophic and/or habitat segregation (Zaret and Rand, 1971; Werner and Hall, 1976; Gascon and Leggett, 1977; Baker-Dittus, 1978; Matthews *et al.*, 1982; Greenfield, Rakocinski and Greenfield, 1983; Bengtson, 1984). Thus, the considerable niche overlap between the two *Cheilodactylus* species at Igaya Bay may be due to the relative abundance of food resources, although we did not examine food resource abundance at the study area.

Acknowledgments

We thank Mr. Makoto Sakurai, Kyushu University, for assisting in the collection of specimens. Dr. Robert K. Trench, University of California, Santa Barbara, and Dr. Osamu Baba, University of Tokyo, provided valuable discussion. We are grateful to Mr. Masayoshi Hayashi, Yokosuka City Museum, and Dr. Greg Stroud, Australian Museum, Sydney, for sharing valuable information with us. Our thanks are also extended to Dr. Takehiko Hiwatari, University of Tokyo, for identification of gammaridean amphipods in the gut content material and to Dr. Keiichi Matsuura, National Science Museum, Tokyo, and Ms. Martha J. Zaiser, Tatsuo Tanaka Memorial Biological Station, for helpful suggestions. This study was made possible by a Grant-in-Aid for Special Project Research on Biological Aspects of Optimal Strategy and Social Structure from the Ministry of Education, Science and Culture, Japan (No. 59115044), and is contribution number 56 of the Tatsuo Tanaka Memorial Biological Station.

Literature cited

Baker-Dittus, A. M. 1978. Foraging patterns of three sympatric killifish. Copeia, 1978(3): 383–389.

Bell, J. D., J. J. Burchmore and D. A. Pollard. 1978. Feeding ecology of three sympatric species of leatherjackets (Pisces: Monacanthidae) from a *Posidonia* seagrass habitat in New South Wales. Aust. J. Mar. Freshwater Res., 29(5): 631–643.

Bengtson, D. A. 1984. Resource partitioning by *Menidia menidia* and *Menidia beryllina* (Osteichthyes: Atherinidae). Mar. Ecol. Prog. Ser., 18(1/2): 21–30.

Bray, R. N. and A. W. Ebeling. 1975. Food, activity, and habitat of three "picker-type" microcarnivorous fishes in the kelp forests off Santa Barbara, California. Fish. Bull., U.S., 73(4): 815–829.

Gascon, D. and W. C. Leggett. 1977. Distribution, abundance, and resource utilization of littoral zone fishes in response to a nutrient/production gradient in Lake Memphremagog. J. Fish. Res. Bd. Can., 34(8): 1105–1117.

George, E. L. and W. F. Hadley. 1979. Food and habitat partitioning between rock bass (*Ambloplites rupestris*) and smallmouth bass (*Micropterus dolomieui*) young of the year. Trans. Amer. Fish. Soc.,

108(3): 253–261.
Greenfield, D. W., T. A. Greenfield and S. L. Brinton. 1983. Spatial and trophic interactions between *Gambusia sexradiata* and *Gambusia puncticulata yucatana* (Pisces: Poeciliidae) in Belize, Central America. Copeia, 1983(3): 598–607.
Greenfield, D. W., C. F. Rakocinski and T. A. Greenfield. 1983. Spatial and trophic interactions in wet and dry seasons between *Gambusia luma* and *Gambusia sexradiata* (Pisces: Poeciliidae) in Belize, Central America. Fieldiana Zool., New Ser., (14): 1–16.
Hixon, M. A. 1980. Competitive interactions between California reef fishes of the genus *Embiotoca*. Ecology, 61(4): 918–931.
Horn, H. S. 1966. Measurement of "overlap" in comparative ecological studies. Amer. Nat., 100 (914): 419–424.
Keast, A. 1978. Feeding interactions between age-groups of pumpkinseed (*Lepomis gibbosus*) and comparisons with bluegill (*L. macrochirus*). J. Fish. Res. Bd. Can., 35(1): 12–27.
Kimura, S. and K. Suzuki. 1980. Fish fauna of Ago Bay and its adjacent waters, Mie Prefecture, Japan. Rep. Fish. Res. Lab., Mie Univ., (2): 1–58.
Larson, R. J. 1980. Competition, habitat selection, and the bathymetric segregation of two rockfish (*Sebastes*) species. Ecol. Monogr., 50(2): 221–239.
Levins, R. 1968. Evolution in changing environments: some theoretical explorations. Princeton Univ. Press, Princeton, New Jersey, x+120 pp.
McEachran, J. D., D. F. Boesch and J. A. Musick. 1976. Food division within two sympatric species-pairs of skates (Pisces: Rajidae). Mar. Biol., 35(4): 301–317.
Macpherson, E. 1979. Ecological overlap between macrourids in the western Mediterranean Sea. Mar. Biol., 53(2): 149–159.
Macpherson, E. 1981. Resource partitioning in a Mediterranean demersal fish community. Mar. Ecol. Prog. Ser., 4(2): 183–193.
Masuda, H., C. Araga and T. Yoshino. 1980. Coastal fishes of southern Japan, revised ed. Tokai Univ. Press, Tokyo, 382 pp., 143 pls.
Matthews, W. J., J. R. Bek and E. Surat. 1982. Comparative ecology of the darters *Etheostoma podostemone*, *E. flabellare* and *Percina roanoka* in the upper Roanoke River drainage, Virginia. Copeia, 1982(4): 805–814.
Moyer, J. T. and A. Nakazono. 1978. Population structure, reproductive behavior and protogynous hermaphroditism in the angelfish *Centropyge interruptus* at Miyake-jima, Japan. Japan. J. Ichthyol., 25(1): 25–39.
Moyer, J. T. and Y. Yogo. 1982. The lek-like mating system of *Halichoeres melanochir* (Pisces: Labridae) at Miyake-jima, Japan. Z. Tierpsychol., 60: 209–226.
Moyer, J. T. and M. J. Zaiser. 1981. Social organization and spawning behavior of the pteroine fish *Dendrochirus zebra* at Miyake-jima, Japan. Japan. J. Ichthyol., 28(1): 52–69.
Randall, J. E. 1981. Examples of antitropical and antiequatorial distribution of Indo-West-Pacific fishes. Pacif. Sci., 35(3): 197–209.
Randall. J. E. 1983. A review of the fishes of the subgenus *Goniistius*, Genus *Cheilodactylus*, with description of a new species from Easter Island and Rapa. Occ. Pap. B. P. Bishop Mus., 25(7): 1–24.
Ross, S. T. 1977. Patterns of resource partitioning in searobins (Pisces: Triglidae). Copeia, 1977(3): 561–571.
Schoener, T. W. 1974. Resource partitioning in ecological communities. Science, 185(4145): 27–39.
Smart, H. J. and J. H. Gee. 1979. Coexistence and resource partitioning in two species of darters (Percidae), *Etheostoma nigrum* and *Percina maculata*. Can. J. Zool., 57(10): 2061–2071.
Suyehiro, Y. 1942. A study on the digestive system and feeding habits of fish. Japan. J. Zool., 10(1): 1–303, pls. 1–15.
Targett, T. E. 1978. Food resource partitioning by the pufferfishes *Sphoeroides spengleri* and *S. testudineus* from Biscayne Bay, Florida. Mar. Biol., 49(1): 83–91.
Tribble, G. W. 1982. Social organization, patterns of sexuality, and behavior of the wrasse *Coris dorsomaculata* at Miyake-jima, Japan. Env. Biol. Fish., 7(1): 29–38.
Werner, E. E. and D. J. Hall. 1976. Niche shifts in sunfishes: experimental evidence and significance. Science, 191(4225): 404–406.
Worgan, J. P. and G. J. FitzGerald. 1981. Diel activity and diet of three sympatric sticklebacks in tidal salt marsh pools. Can. J. Zool., 59(12): 2375–2379.
Zaret, T. M. and A. S. Rand. 1971. Competition in tropical stream fishes: support for the competitive exclusion principle. Ecology, 52(2): 336–342.

(MS: Department of Fisheries, Faculty of Agriculture, University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo 113, Japan; JTM: Tatsuo Tanaka Memorial Biological Station, Ako, Miyake-jima, Tokyo 100-12, Japan)

三宅島において共存するタカノハダイとミギマキの垂直分布と食性

佐野光彦・Jack T. Moyer

三宅島の伊ケ谷湾において タカノハダイとミギマキの

垂直分布，昼間の行動パターン，および食性を調査し，両種で比較した．両種の生息場はかなり重複しており，水深によるすみわけは見られなかった．また，昼間の行動パターンにおいても明瞭な差は見いだされなかった．

タカノハダイとミギマキはともにヨコエビ類や十脚類などの小型底生無脊椎動物を食べ，餌生物の種類においてはかなり重複していた．しかし，消化管内容物における各餌生物の量的割合においては種間で多少差が見られた．従来，*Goniistius* 亜属魚類は夜間に摂餌すると言われていたが (Randall, 1983)，タカノハダイとミギマキでは昼間に摂餌することが明らかとなった．

(佐野：113 東京都文京区弥生 1-1-1 東京大学農学部水産学科；Moyer：100-12 東京都三宅島阿古 田中達男記念生物実験所)

かと思います．

最後になりましたが，遠路はるばる参加された講演者と研究会議運営に当たられた諸氏に深く御礼申しあげます．　(Akinobu Nakazono 中園明信)

魚類の染色体と進化

国際魚類研究会議の最終日，8 月 3 日午前，第 2 会場において，"魚類染色体" に関するシンポジウムが行われた．

大平洋・インド洋魚類国際会議に，染色体部門が入ったのは最初のことで，当初参加者があるかどうか心配されたが，7 題の研究発表（印度 1 名，タイ 1 名，韓国 1 名，中国 2 名，日本 2 名）があった．発表は淡水魚関係が多かったのは，特に中国，印度などでは淡水魚の種類が多く，研究が淡水魚一辺倒の感をうける現状が反映されたためであろう．シンポジウムは，発表 1 人 20 分，討論 5 分で進められ，中間に 10 分の休憩をおいた．しかし最終日ということもあって，休憩のまま会場に戻らない人があって，後半は室内が多少閑散となったのは残念であった．英語による発表は，アメリカなどの英語国からの参加者がなかったこともあって，表現力や理解力が乏しく，国際会議としての機能が十分果たせなかった感じをうけた．

シンポジウム 7 題の内，注目されたのは中国 Liu Lingyun の魚類染色体 G-バンド分染法の研究である．女性特有の器用さもあって，美事な染色体像が提示された．腎細胞の短期培養法により，(1) BUdR 50～60 μg/ml, (2) Methotrexate 0.5 μg/ml, (3) Actinomycin D or Mitomycin D を作用させ，伸長した染色体上に G-バンドを検出する方法で，将来染色体研究にたいへん有用な方法になるだろう．

国際魚類会議の中の染色体部門は，今回がはじめての試みであったため出席者も少なかったが，今後はさらに研究者も増え，発表も多くなることが期待される．また国際魚類会議に染色体部門のあることを知らない人が，日本国内でも多数あった．今後，魚類学会や水産学会のみならず，動物学会，遺伝学会，染色体学会などにも予めアナウンスしておくことが必要であると考えている．

(Yoshio Ojima 小島吉雄)

昭和 60 年度第 3 回役員会

昭和 60 年 7 月 10 日（水）於東京水産大学．

出席者：上野・岩井・阿部・新井・石山・黒沼・高木・隆島・富永・藤田・中村・松浦・丸山．

議事：1．報告事項，2．前回記録の確認，3．「国際会議」について組織委員会より報告を受け，検討した．4．宍道湖・中海の淡水化中止を求める要望書の文案を検討した．5．その他．

編集後記・Editorial notes

国際魚類会議は成功裡に終了しました。本号の会記で述べられているように，外国の研究者も多数参加しました．参加者の多くが研究成果を国際会議の Proceedings に投稿し，論文数は約 100 に達しました．この編集作業が現在おこなわれています．このため，魚類学会の編集幹事も連日 Proceedings のすみやかな出版にむけて努力しています．もちろん，同時に魚類学雑誌の編集も円滑におこなわれねばなりませんので，本号の編集は多紀保彦編集幹事の全面的なご協力をお願いしました．

(KM)

訂　正・Errata

魚類学雑誌 32 巻 2 号に以下の誤りがありました．お詫びして訂正いたします．

図書紹介・New publications: Page 271，右最終部分に (Toru Taniuchi 谷内　透) を追加．

Japanese Journal of Ichthyology, 32 (2), Sano and Moyer: Page 240, left column, second paragraph, 4th line, delete "intraspecific".