

Diets of 45 Fish Species from 17 Families at Kuchierabu-jima Island

Naoko TAKEUCHI¹⁾, Toshifumi SAEKI²⁾, Yoichi SAKAI²⁾
and Hiroaki HASHIMOTO²⁾

¹⁾ *Department of Marine Biology, School of Marine Science and Technology,
Tokai University, Shimizu-orido 3-20-2, Shizuoka 424-8610, Japan*

²⁾ *Graduate School of Biosphere Science, Hiroshima University, Kagamiyama 1-4-4,
Higashi-hiroshima 739-8528, Japan*

Abstract Stomach contents of 45 fish species from 17 families (Apogonidae, Belonidae, Carangidae, Cheilodactylidae, Cirrhitidae, Haemulidae, Holocentridae, Lethrinidae, Lutjanidae, Ophidiidae, Pempheridae, Pinguipedidae, Priacanthidae, Scorpaenidae, Serranidae, Synodontidae, Tripterygiidae) sampled from the coastal zone around Kuchierabu-jima Island, southern Japan, were analyzed. Of all prey items, fish and crustaceans were preyed on by 59 % and 74 % of all predators, respectively. Of the crustaceans, brachyurans were preyed on by 52 %, suggesting that in addition to fish as prey items, brachyurans are commonly preyed on by predatory fish species.

Key words: coral reef fish, carnivores, piscivores, stomach contents

INTRODUCTION

Kuchierabu-jima Island, located in west of the Ohsumi Group, southern Japan, is a small volcanic island nearly 38 km² in area (30° 28'N, 130° 10'E). The island is strongly influenced by the warm Kuroshio Current. A large part of the ichthyofauna of the island consists of tropical species (Gushima and Murakami, 1976). Around the island, various species of marine fish have been researched since the early 1970s until present. For example, foraging behaviors and reproduction have been reported on blue sprat, clingfish, cornetfish, damselfish, goby, lizardfish, moray eel, parrotfish, sandperch, wrasse and so on (e.g. Shibuno *et al.*, 1996; Takeuchi *et al.*, 2005). Invertebrates such as coastal zooplankton and the turban shell have also been researched. The information from these studies provides useful data for understanding the interactions between these many forms of life and the trophic structure of the community.

This study was undertaken to provide additional information on the prey items of 45 fish species from 17 families sampled during mainly 1970-1985. Diets of eleven species with sample size ≥ 10 were compared with diets of other populations of the species.

MATERIALS AND METHODS

Almost all of the fish specimens were collected near the shore of Kuchierabu-jima Island during the periods of April-November from 1970 to 1998 (mainly 1970-1985). *Helcogramma obtusirostris* were sampled during October-November 1999. Specimens of *Parapercis millepunctata*,

Saurida gracilis, and *Trachinocephalus myops*, dealt with in Shibuno *et al.* (1996) were also utilized in the present study. A total of 676 specimens (45 species of 17 families; Table 1) were obtained using spears, spear guns or by fishing.

Table 1. Family, species, abbreviation, number of specimens, and range of body size of specimens with stomach contents collected around Kuchierabu-jima Island.

Family	Species	Japanese name	Abbreviating species code	No. of specimens with contents	Range of body size (cm)
Apogonidae	<i>Apogon doederleini</i>	Ōsuji-ishimochi	Ad	70	5.9-10.8
	<i>Apogon notatus</i>	Kurohoshi-ishimochi	An	1	7.8
	<i>Cheilodipterus macrodon</i>	Rhukyu-yarai-ishimochi	Cm	3	13.8-17.4
Belonidae	<i>Tylosurus crocodilus crocodilus</i>	Okī-zayori	Tc	3	46.0-61.0
Carangidae	<i>Carangichthys dinema</i>	Itohira-aji	Cd	1	31.8
	<i>Carangoides orthogrammus</i>	Nan'yo-kaiwari	Co	14	22.5-27.0
	<i>Caranx sexfasciatus</i>	Gingameaji	Cs	19	11.8-23.0
	<i>Decapterus maruadsi</i>	Maru-aji	Dm	1	23.5
	<i>Decapterus muroadsi</i>	Muro-aji	Du	3	21.7-24.5
	<i>Elagatis bipinnulata</i>	Tsumuburi	Eb	2	32.0, 40.0
	<i>Seriola dumerili</i>	Kanpachi	Sd	4	11.3-46.6
	<i>Trachinotus baillonii</i>	Koban-aji	Tb	4	7.0-30.0
	Cheilodactylidae	<i>Goniistius zonatus</i>	Takanohadai	Gz	12
Cirrhitidae	<i>Cirrhitus pinnulatus</i>	Iso-gonbe	Cp	69	8.9-22.0
Haemulidae	<i>Plectorhinchus flavomaculatus</i>	Oshare-koshōdai	Pf	3	15.7-18.8
	<i>Plectorhinchus orientalis</i>	Mushuji-koshōdai	Po	4	20.3-45.0
	<i>Plectorhinchus picus</i>	Ajia-koshōdai	Pp	4	25.0-35.8
Holocentridae	<i>Myripristis berndti</i>	Aka-matsukasa	Mb	4	10.6-16.3
	<i>Sargocentron diadema</i>	Niji-ebisu	Si	4	14.2-25.3
	<i>Sargocentron spinosissimum</i>	Ittoudai	Ss	7	14.6-17.1
Lethrinidae	<i>Lethrinus atkinsoni</i>	Iso-fuefuki	La	1	18.0
	<i>Lethrinus haematopterus</i>	Fuefukidai	Lh	1	25.5
	<i>Lethrinus nebulosus</i>	Hama-fuefuki	Ln	3	24.7-100.0
	<i>Monotaxis grandoculis</i>	Yokoshima-kurodai	Mg	1	19.5
Lutjanidae	<i>Lutjanus gibbus</i>	Hime-fuedai	Lg	21	5.0-19.9
	<i>Lutjanus kasmira</i>	Yosuji-fuedai	Lk	9	7.7-16.7
	<i>Lutjanus monostigma</i>	Itten-fuedai	Lm	6	20.0-24.9
	<i>Lutjanus quinquelineatus</i>	Rokusen-fuedai	Lq	4	10.0-16.1
Ophidiidae	<i>Brotula multibarata</i>	Itachiyo	Bm	2	27.8, 37.5
Pempheridae	<i>Pempheris sp.</i>	Ryūkyū-hatanpo	P	3	11.7-16.0
Pinguipedidae	<i>Parapercis millepunctata</i>	Wanuke-toragisu	Pm	75	7.7-19.4
Priacanthidae	<i>Heteropriacanthus cruentatus</i>	Gomahire-kintoki	Hc	3	19.0-27.0
Scorpaenidae	<i>Dendrochirus zebra</i>	Kirin-mino	Dz	2	14.7, 24.0
	<i>Scorpaenopsis neglecta</i>	Satsumakasago	Sn	1	13.5
Serranidae	<i>Cephalopholis argus</i>	Aonome-hata	Ca	2	37.0, 41.3
	<i>Cephalopholis boenak</i>	Yami-hata	Cb	1	12.5
	<i>Cephalopholis urodeta</i>	Niji-hata	Cu	1	17.8
	<i>Epinephelus chlorostigma</i>	Hōseki-hata	Ec	1	23.0
	<i>Epinephelus fasciatus</i>	Aka-hata	Ef	5	21.8-31.5
	<i>Epinephelus hexagonatus</i>	Ishigaki-hata	Eh	2	18.0, 23.0
	<i>Epinephelus merra</i>	Kanmon-hata	Em	10	16.8-32.0
	<i>Variola albimarginata</i>	Ojīro-bara-hata	Va	1	31.0
Synodontidae	<i>Saurida gracilis</i>	Madara-eso	Sg	33	11.1-35.0
	<i>Trachinocephalus myops</i>	Okī-eso	Tm	21	11.5-23.0
Tripterygiidae	<i>Helcogramma fuscipectoris</i>	Kuromasuku	Hf	79	1.2-2.6

Table 2. Continued.

Prey items	Tc	Cd	Co	Cs	Dm	Du	Eb	Sd	Tb	Bm	P	Hc	Dz	Sn
Teleostei	100	0	86	58	0	0	100	75	50	0	0	33	0	100
<i>Spratelloides gracilis</i>	67	—	71	11	—	—	100	75	—	—	—	33	—	—
<i>Atherinomorus lacunosus</i>	—	—	—	5	—	—	—	—	—	—	—	—	—	—
Crustacea	0	0	29	63	100	100	0	25	50	100	100	100	100	0
Copepoda	—	—	21	—	—	—	—	—	—	—	—	—	—	—
Decapoda	—	—	—	—	—	—	—	—	—	50	—	—	—	—
Macrura	—	—	—	11	—	33	—	—	—	—	—	—	—	—
Brachyura	—	—	—	—	100	—	—	—	—	50	33	33	50	—
<i>Grapsus albolineatus</i>	—	—	—	—	—	—	—	—	—	50	—	—	—	—
Mysidacea	—	—	14	47	—	33	—	25	—	50	67	33	50	—
Cumacea	—	—	14	—	—	—	—	—	—	—	—	—	—	—
Gammaridea	—	—	—	5	—	—	—	—	—	—	—	33	—	—
Gastropoda	0	100	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified	—	—	—	5	—	—	—	—	—	—	—	—	—	—

RESULTS AND DISCUSSION

Diet components of all survey species are listed in Table 2. Details of the characteristics of focal species ($n \geq 10$) are noted below.

Apogonidae

Apogon doederleini (Japanese name Ōsuji-ishimochi) ($n = 70$, Ad) fed mainly on invertebrates such as crustaceans (71 %), and polychaetes (11 %). Fish prey items such as gobioids also were fed on, 7 %. In Shikoku Island, Japan, and Australia, major food items were crustaceans (e.g. Macrura, Brachyura), and minor food items small fish and annelids (Okuda and Yanagisawa, 1996; Marnane and Bellwood, 2002). Males of this species are paternal mouthbrooders and may eat their own eggs according to their conditions (Okuda and Yanagisawa, 1996).

Carangidae

In *Carangoides orthogrammus* (Nan'yō-kaiwari) ($n = 14$, Co), fish prey items such as clupeoids were the dominant prey category, 86 %. Crustaceans such as copepods and mysids were also present (29 %). Previous studies have reported that this species feeds on fish and crustaceans (Takeuchi *et al.*, 2005; Kulbicki *et al.*, 2005). *Caranx sexfasciatus* (Gingameaji; $n = 19$, Cs) fed on fish in 58 % (Clupeidae, Atherinidae) and crustaceans (Mysidacea, Macrura) in 63 %. In other sites, this species feed mostly on fish (Ambassidae) and crustaceans (Macrura, Brachyura) (Blaber and Cyrus, 1983; Salini *et al.*, 1994; Baker and Sheaves, 2005).

Cheilodactylidae

Goniistius zonatus (Takanohadai) ($n = 12$, Gz) fed on crustaceans (Amphipoda, Brachyura, and Ostracoda) in all cases (100 %). Other invertebrates such as polychaetes were also fed on. In Shikoku Island, they are benthophagous suction-feeders and feed on epifaunal (small crustaceans as Amphipoda) and infaunal organisms (Annelida, Mollusca), depending on the conditions of algal mats or their body sizes (Matsumoto and Kohda, 2002).

Cirrhitidae

Cirrhitus pinnulatus (Iso-gonbe) (n = 69, Cp) fed on crustaceans (Brachyura, Isopoda) in 83 % and fish prey items in 22 %. A previous study has reported feeding on various kinds of invertebrates such as brachyurans and ophiuroids (Takeuchi *et al.*, 2005).

Lutjanidae

Lutjanus gibbus (Hime-fuedai) (n = 21, Lg) fed on crustaceans (Brachyura, Mysidacea, Macrura) in all cases (100 %). Fish prey items such as scorpaenids and gobioids were also found (33 %). Previous studies have reported that they feed on crustaceans (Brachyura, Stomatopoda, Mollusca) and fish (Clupeidae) (Hiatt and Strasburg, 1960; Randall and Brock, 1960; Blaber *et al.*, 1990; Kulbicki *et al.*, 2005).

Pinguipedidae

Parapercis millepunctata (Wanuke-toragisu) (n = 75, Pm) fed on crustaceans (Brachyura, Stomatopoda) in 89 % and fish in 36 %. Previous studies have also reported feeding on crustaceans and fish (shown as *P. cephalopunctata* in Shibuno *et al.* (1996) and Takeuchi *et al.* (2005)).

Serranidae

Epinephelus merra (Kanmon-hata) (n = 10, Em) fed on crustaceans (brachyurans) in 90 % and fish in 20 %. Previous studies have reported that they feed mainly on crustaceans (Brachyura, Macrura, Amphipoda) and fish (Gobiidae, Blenniidae), and secondarily molluscs (Takeuchi *et al.*, 2005; Kulbicki *et al.*, 2005; Nakamura *et al.*, 2006).

Synodontidae

In *Saurida gracilis* (Madara-eso) (n = 33, Sg), fish prey items (Clupeidae, Blenniidae) were fed on frequently (73 %). Crustaceans were also fed on, 6 %. Previous studies have also reported that they feed on crustaceans (Macrura, Stomatopoda) and fish (Baker and Sheaves, 2005; Kulbicki *et al.*, 2005; Takeuchi *et al.*, 2005). *Trachinocephalus myops* (Oki-eso) (n = 21, Tm) fed on crustaceans (Macrura, Mysidacea) in 71 % and fish (Clupeidae, Pomacentridae) in 48 %. Takeuchi *et al.* (2005) reported that this species fed on brachyurans.

Tripterygiidae

Helcogramma obtusirostris (Kuromasuku) (n = 79, Ho) fed on crustaceans (Harpacticoida, Tanaidacea) in all cases (100 %). Terrestrial prey items (Diptera) and other invertebrates (Acarina, Gastropoda) were also found. Eggs of fish were found in the stomachs of males, either those having territories or sneaking males, but not in females. Based on these results and field observations (Saeki unpub. data), the eggs seemed to be their own eggs. Little is known about the food habit of *H. obtusirostris*. In tidal regions, they feed mainly on demersal zooplankton and invertebrates on the substrata (Saeki unpub. data).

A total of 61 fish species from 21 families were analyzed in the present study and Takeuchi *et al.* (2005). Of 61 species, 59 % (36 species, 15 families) preyed on fish prey items. In particular, *S. gracilis* specimens were found to contain a total of 13 fish species (6 families) in their stomachs (Table 2).

Regarding the swimming patterns (degree of reef-association) of prey fish, two patterns could be roughly classified; a pelagic fish type and a reef fish type. The pelagic fish type including Clupeidae, Atherinidae and Carangidae was preyed on by 26 % of the 61 fish (16 species of 8 families) surveyed. The reef fish type, comprising the other prey, occurred in 23 % of all fish surveyed (14 species of 8 families). These ratios were not significantly different from one another (Fisher's exact probability, $P = 0.4$). On the other hand, crustaceans were preyed on by 74 % of the fish (45 species, 18 families) surveyed. Of the crustaceans, brachyurans (52 % by 32 species), macrurans (33 % by 20 species) and mysids (23 % by 14 species) were the major prey items. Thus, we consider that in addition to fish as prey items, crustaceans, especially brachyurans, are commonly preyed on by predatory fish species, although the percentage dependencies for different prey items may have been affected by the condition of sampled fish.

Gushima and Murakami (1976) reported that a total of 217 fish species from 54 families living in Kuchierabu-jima Island were recorded based on surveys during the period of 1970-1973. To clarify the trophic structure of this community, it is considered that all of this information should be synthesized in terms of the ecological characters of the organisms.

Acknowledgements

We are grateful to the people of Kuchierabu-jima Island for permission to conduct fieldwork in their waters. We thank K. Gushima for thoughtful and timely guidance and support, S. Tatekawa and Y. Okamura for analyzing stomach contents, and many colleagues at the Biology of Aquatic Resources of Hiroshima University for supporting this study.

REFERENCES

- Baker, R., Sheaves, M. 2005. Redefining the piscivore assemblage of shallow estuarine nursery habitats. *Mar Ecol Prog Ser.* **291**: 197-213.
- Blaber, S. J. M., Cyrus, D. P. 1983. The biology of Carangidae (Teleostei) in Natal estuaries. *J Fish Biol.* **22**: 173-188.
- Blaber, S. J. M., Milton, D. A., Rawlinson, N. J. F., Tiroba, G., Nichols, P. V. 1990. Diets of lagoon fishes of the Solomon Islands: predators of tuna baitfish and trophic effects of baitfishing on the subsistence fishery. *Fish Res.* **8**: 263-286.
- Gushima, K., Murakami, Y. 1976. The reef fish fauna of Kuchierabu, offshore Island of southern Japan. *J Fac Fish Anim Husb, Hiroshima Univ.* **15**: 47-56.
- Hiatt, R. W., Strasburg, D. W. 1960. Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. *Ecol Monogr.* **30**: 65-127.
- Kulbicki, M., Bozec, Y. M., Labrosse, P., Letourneur, Y., Mou-Tham, G., Wantiez, L. 2005. Diet composition of carnivorous fishes from coral reef lagoons of New Caledonia. *Aqua Living Resour.* **18**: 231-250.
- Marnane, M. J., Bellwood, D. R. 2002. Diet and nocturnal foraging in cardinalfishes (Apogonidae) at One Tree Reef, Great Barrier Reef, Australia. *Mar Ecol Prog Ser.* **231**: 261-268.
- Matsumoto, K., Kohda, M. 2002. The effect of feeding habitats on dietary shifts during the growth in a benthophagous suction-feeding fish. *Zool Sci.* **19**: 709-714.
- Nakabo, T. ed. 2002. Fishes of Japan with pictorial keys to the species. English edition. Tokai University Press, Tokyo, 1749 pp.

- Nakamura, Y., Terashima, H., Chettanand, S., Sato, N., Ida, H. 2006. Preliminary survey and diet analysis of seagrass bed fishes at Mauritius, western Indian Ocean. *Galaxea*. **8**: 61-69.
- Okuda, N., Yanagisawa, Y. 1996. Filial cannibalism by mouthbrooding males of the cardinal fish, *Apogon doederleini*, in relation to their physical condition. *Environ Biol Fish*. **45**: 397-404.
- Randall, J. E., Brock, V. E. 1960. Observations on the ecology of epinepheline and lutjanid fishes of the Society Islands, with emphasis on food habits. *Trans Am Fish Soc*. **89**: 9-16.
- Salini, J. P., Blaber, S. J. M., Brewer, D. T. 1994. Diets of trawled predatory fish of the Gulf of Carpentaria, Australia, with particular reference to predation on prawns. *Aust J Mar Freshwater Res*. **45**: 397-411.
- Shibuno, T., Shigeta, T., Abe, O., Fujita, H., Hashimoto, H., Gushima, K. 1996. Feeding habits of pinguipendic and synodontid fishes at Kuchierabu-jima. *J Fac Appl Biol Sci, Hiroshima Univ*. **35**: 105-111 (in Japanese with English summary).
- Takeuchi, N., Kai, H., Kadota, T., Himeno, N., Kobayashi, K., Shimizu, N., Gushima, K. 2005. Diets of 28 fish species from 12 families at Kuchierabu-jima Island. *J Grad Sch Biosp Sci, Hiroshima Univ*. **44**: 15-24.

口永良部島における17科45魚種の食餌

竹内 直子¹⁾・佐伯 智史²⁾・坂井 陽一²⁾・橋本 博明²⁾

¹⁾ 東海大学海洋学部, 静岡市 424-8610

²⁾ 広島大学大学院生物圏科学研究科, 東広島市 739-8528

要 旨 南日本にある口永良部島の沿岸域において採集した17科45種の魚類（テンジクダイ科, ダツ科, アジ科, タカノハダイ科, ゴンベ科, イサキ科, イットウダイ科, フェフキダイ科, フェダイ科, アシロ科, ハタンボ科, トラギス科, キントキダイ科, フサカサゴ科, ハタ科, エソ科, ヘビギンボ科）の胃内容物を分析した。すべての餌品目のうち, 魚類と甲殻類は各々全体の約59%と74%の魚類によって食べられていた。甲殻類のうちカニ類は52%によって食べられており, 魚類に加えて, カニ類も主に食べられていると考えられた。

キーワード：サンゴ礁魚類, 肉食性魚, 魚食性魚, 胃内容物

