Diets of 28 Fish Species from 12 Families at Kuchierabu - jima Island

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Abstract Stomach contents of 28 fish species from 12 families (Aulostomidae, Belonidae, Carangidae, Cirrhitidae, Fistulariidae, Lethrinidae, Mugiloididae, Scombridae, Scorpaenidae, Serranidae, Sphyraenidae, Synodontidae) sampled from the coastal zone around Kuchierabu-jima Island, southern Japan, were analyzed. Of the 28 fish species having stomach contents, 75 % (21 species from 11 families) fed on various kinds of fish prey. Invertebrate prey such as crustaceans, echinoderms, and cephalopods were fed on by 57 % (16 species from 9 families). There are many primarily or secondarily piscivorous fishes that can feed on fish, which bring about complex predatory fish-prey fish interactions in the coral reef community.

Key words: coral reef fishes, food habits, stomach contents, piscivore

INTRODUCTION

During the last decade, numerous papers have been published dealing with the food habits of coral reef fishes. Details of when, where, how and what kind of prey a fish feeds on are still unclear for many species.

Especially, piscivorous fish that feed on other fish effect the survival, growth, and maturity of prey fish (Milinski, 1993; Carr and Hixon, 1995), and so play a significant role in the structuring of coral reef communities (Hixon, 1991). Therefore, it is important to confirm the level and intensity of predation by piscivores in coral reefs. A step to understand the predatory role of coral reef piscivores is to detail information on the identity and size of consumed prey by dietary analysis. However, although there are many reports about fisheries resources such as grouper and jack, there are not enough to reveal the diets of other coral reef fishes.

A large part of the ichthyofauna of Kuchierabu-jima Island consists of tropical species (Gushima and Murakami, 1976). This study was undertaken to provide information on the prey items of 28 fish species from 12 families along the coast of Kuchierabu-jima Island. The results were compared with diets of other population of these species.

MATERIALS AND METHODS

The fish samplings were conducted from the shore of Kuchierabu-jima (30 28 N, 130 10 E), southern Japan, from 0600 to 2000 during the periods of June-October 1997, May-November 1998, August-November 1999, June-August 2000, November 2001, June 2003, September-December 2004, and June-July 2005. A total of 147 specimens (28 species from 12 families; Table 1) were obtained using spears, spear guns, or by fishing.

Family	Species	Japanese name	Abbreviation	No. of specimens	Range of	
				with contents	size (cm)	
Aulostomidae	Aulostomus chinensis	Herayagara	Ac	12	45.2-77.5	
Belonidae	Tylosurus crocodilus crocodilus	Okizayori	Тс	3	45.0-84.5	
Carangidae	Carangoides orthogrammus	Nanyoukaiwari	Со	1	38.0	
	Caranx melampygus	Kasumiaji	Cm	17	35.0-65.0	
	Seriola lalandi	Hiramasa	SI	1	37.5	
	Seriola rivoliana	Hirenagakanpachi	Sr	1	16.1	
Cirrhitidae	Cirrhitus pinnulatus	Isogonbe	Ср	3	13.0-18.3	
Fistulariidae	Fistularia petimba	Akayagara	Fp	1	80.0	
Lethrinidae	Lethrinus nebulosus	Hamafuefuki	Ln	1	45.0	
Mugiloididae	Parapercis cephalopunctata	Wanuketoragisu	Pc	8	16.1-18.4	
Scombridae	Gymnosarda unicolor	Isomaguro	Gu	3	41.4-115.7	
	Katsuwonus pelamis	Katsuo	Кр	8	27.0-55.0	
	Thunnus albacares	Kihada	Та	2	48.0, 49.0	
Scorpænidæ	Scorpaenopsis diabolus	Niraikasago	Sd	1	14.7	
Serranidae	Cephalopholisargus	Aonomehata	Ca	2	25.0, 33.0	
	Cephalopholis miniata	Yukatahata	Ci	1	22.0	
	Cephalopholis urodeta	Nijihata	Cu	1	16.5	
	Epinephelus caerul eopunctatus	Hakutenhata	Ec	1	29.0	
	Epinephelusmerra	Kanmonhata	Em	1	15.0	
	Epinephelus fasciatus	Akahata	Ef	2	24.0, 26.0	
	Epinephelus howlandi	Hiregurohata	Eh	2	24.0, 25.0	
	Epinephelus tauvina	Hitomihata	Et	1	34.0	
	Plectropomus leopardus	Sujiara	PI	5	28.0-50.0	
	Variola albimarginata	Ojirobarahata	Va	1	33.0	
Sphyraenidae	Sphyraena pinguis	Akakamasu	Sp	11	27.0-31.0	
Synodontidae	Saurida gracilis	Madaraeso	Sg	2	10.6, 20.5	
	Synodus ulae	Akaeso	Su	14	9.5-19.8	
	Trachinocephalus myops	Okieso	Tm	1	14.2	

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

After collection, the specimens or stomachs were immediately preserved in 10% buffered formalin. Most specimens were measured as standard length (cm), but Carangoides orthogrammus and Parapercis cephalopunctata were measured as total length (cm). The stomach contents were classified to order, family, and where possible to species under a binocular microscope. The percentage frequency of occurrence for each prey item was calculated in each species. Empty stomachs were not included in the analysis.

RESULTS AND DISCUSSION

Of 147 specimens, 107 specimens contained stomach contents. Details of diets are as follows and in Table 2.

Prey items		Ac	Тс	Со	Cm	SI	Sr	Ср	Fp	Ln	Pc	Gu	Кр	Та	Sd
Teleostei		100	67	100	100	100	100	33	100	0	25	100	75	100	100
Unknown		92	67	-	53	100	100	33	100	-	25	67	50	100	-
Apogonidae	Apogonidae sp.	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Blenniidae	Xiphasia setifer	-	-	-	-	-	-	-	-	-	-	-	13	-	-
Carangidae	Carangidae sp.	8	-	-	12	-	-	-	-	-	-	33	-	-	-
Clupeidae	Spratelloides gracilis	-	-	-	41	-	-	-	-	-	-	-	13	50	-
	Spratelloides delicatulus	-	-	-	6	-	-	-	-	-	-	-	-	-	-
Labridae	Labridae sp.	8	-	-	6	-	-	-	-	-	-	-	-	-	-
Monacanthidae	Monacanthidae sp.	-	-	-	-	-	-	-	-	-	-	-	-	50	-
Pempheridae	Pempheridae sp.	-	-	-	-	-	-	-	-	-	-	33	-	-	-
Pomacentridae	Pomacentridae sp.	-	-	-	24	-	-	-	-	-	-	-	-	-	-
Scorpaenidae	Scorpaenopsis cirrhosa	-	-	-	6	-	-	-	-	-	-	-	-	-	-
		8	-	-	-	-	-	-	-	-	-	-	-	-	-
									13	-	-				

Table 2. Percentage frequency of occurrence calculated for each prey items in each diet of 28 fish species shown abbreviation.

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	Decapoda sp.	-	-	-	6	-	-	-		-	-	13	-	-
Gastropoda		0	0	0	0	0	0	0	0 100	0	0	0	0	0
	Patellogastropoda sp.	-	-	-	-	-	-	-	- 100	-	-	-	-	-

Table 2. Continue	ed.														
Prey items		Ca	Ci	Cu	Ec	Em	Ef	Eh	Et	Ы	Va	Sp	Sg	Su	Tm
Teleostei		50	100	0	0	0	0	50	0	100	100	100	100	100	0
Unknown		50	100	-	-	-	-	50	-	80	100	45	100	43	-
Acanthuridae	Acanthurus pyroferus	-	-	-	-	-	-	-	-	-	-	-	-	7	-
Blenniidae	Blenniidae sp.	-	-	-	-	-	-	-	-	-	-	-	50	-	-
Chaetodontidae	Chaetodontidae sp.	-	-	-	-	-	-	-	-	-	-	-	-	7	-
Clupeidae	Spratelloides gracilis	-	-	-	-	-	-	-	-	-	-	55	-	50	-
Labridae	Labridae sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Thalassoma amblycephalum	-	-	-	-	-	-	-	-	20	-	-	-	-	-
Tripterygiidae	Helcogramma sp.	-	-	-	-	-	-	-	-	-	-	-	-	7	-
Crustacea		50	0	100	100	100	100	50	100	0	0	0	0	0	100
	Brachyura sp.	50	-	-	100	-	50	50	-	-	-	-	-	-	100
	Thalamita picta	-	-	-	-	100	-	-	-	-	-	-	-	-	-
	Tetralia nigrolineata	-	-	-	-	100	-	-	-	-	-	-	-	-	-
	Percnon planissimum	-	-	-	-	-	100	-	100	-	-	-	-	-	-
	Macrura sp.	-	-	100	-	-	-	-	-	-	-	-	-	-	-
	Stomatopoda sp.	-	-	-	-	-	-	50	-	-	-	-	-	-	-

Aulostomidae

In Aulostomus chinensis (n = 12, Ac), most of the prey items were fish, which accounted for 100 % by frequency of occurrence. The other prey items were several kinds of crustaceans such as decapods and macrurans (25 %). Maximum size of prey items was 14.5 cm BL of Carangidae sp. from one A. chinensis with 69.2 BL. Previous studies have been reported for this species (Indo-Pacific species) from Marshall Islands and Hawaii, and for congeneric species like A. maculatus (West Atlantic species) from the West Indies. In the previous study sites, this species mainly fed on two types of fishes as pelagic fish (e.g., Atherinidae, Carangidae) and reef fish (e.g., Acanthuridae, Tetraodontidae). Invertebrates were also present in the diet, but at a lower amount (Hiatt and Strasburg, 1960; Randall, 1967; Hobson, 1974; Parrish et al., 1986). The high incidence of fish prey probably indicates that this species with size of 30-80 cm BL is primarily a piscivore.

Belonidae

Tylosurus crocodilus crocodilus (n = 3, Tc) fed on fish mainly. One specimen contained an invertebrate of an echinoderm. In the West Indies, Australia, and Solomon Islands, this species also fed on mostly two types of fishes as pelagic fish (Spratelloides gracilis, Herklotsichthys spp., Stolephorus sp.) and reef fishes (e.g., Acanthuridae, Gobiidae) (Randall, 1967; Blaber et al., 1990; Salini et al., 1990). It is considered that this species may not only move in surface waters, but also search for prey reef fish near the sea bottom. This species with 40-90 cm BL probably is primarily a piscivore.

Carangidae

In Caranx melampygus (n = 17, Cm), fish prey were the dominant prey category in 100 % by frequency of occurrence. Both types of fish prey as pelagic fish (Carangidae, Spratelloides spp.) and reef fish (e.g., Labridae, Scorpaenidae) were identified in their stomach contents. Invertebrate prey

such as cephalopod were also present in the diet of C. melampygus, but with a lower frequency. In Hawaii and Solomon Islands, fish prey made up the principal dietary component of the C. melampygus (Blaber et al., 1990; Sudekum et al., 1991; Meyer et al., 2001). The single specimens of Carangoides orthogrammus (Co), Seriola Ialandi (SI), and Seriola rivoliana (Sr) also contained fish prey. Previous studies have shown that C. orthogrammus in Hawaii, S. Ialandi in New Zealand, and S. rivoliana in the Azores fed on fish prey frequently (Russell, 1983; Meyer et al., 2001; Barreiros et al., 2003). The high incidence of fish prey probably indicates that these species are primarily piscivores.

Cirrhitidae

Cirrhitus pinnulatus (n = 3, Cp) fed on crustaceans such as brachyurans (Xanthidae) and fish prey. Parrish et al. (1986) has reported that fish prey of this species accounted for about 21 % by volume and 19 % by frequency. In Marshall Islands and Hawaii, this species fed mainly on various kinds of invertebrates such as brachyurans (Xanthidae), ophiuroids, and octopus (Hiatt and Strasburg, 1960; Hobson, 1974). The high incidence of crustaceans and fish prey probably indicates that it is primarily a carnivore and secondarily a piscivore.

Fistulariidae

One specimen of Fistularia petimba (Fp) was collected in depth of about 40 m by lure fishing. The specimen contained an unknown fish. In another site in Japan, one specimen of F. petimba was found to contain one SIIago japonica (SiIIaginidae) (Takeuchi unpub. data). F. petimba is found throughout tropical Atlantic, Indo-West Pacific, and Hawaii along coastal areas with soft bottoms, usually at depths over 10 m (Fritzsche, 1976). This species perhaps is primarily a piscivore similar to congeneric species like F. commersonii (shallow reef species) (Takeuchi et al., 2002).

Lethrinidae

One specimen of Lethrinus nebulosus (Ln) contained only invertebrate prey such as echinoderm, ophiuroids, and gastropod. In Australia, this species also fed on various kinds of invertebrates (e. g., annelids, brachyurans, stomatopods). In addition, fish prey such as Pomadasidae and Carangidae were also present in the diet of the population (50 % by frequency of occurrence) (Salini et al., 1994). This species perhaps is primarily a carnivore and secondarily a piscivore.

Mugiloididae

In Parapercis cephalopunctata (n = 8, Pc), crustaceans as brachyurans and stomatopods were the dominant prey category in 100 % by frequency of occurrence. Fish prey were also present in the diets, but with a lower frequency (25 %). In Okinawa Island, the stomach contents of this species only contained invertebrate prey such as brachyurans and macrurans (Sano et al., 1984). In the study site, Shibuno et al.(1996) has reported that this species with about 15-19 cm TL fed mostly on crabs (Portunidae, Grapsidae, Xanthidae) and stomatopods (Gonadactylidae), which account for about 78 % and 40 % by frequency of occurrence (fish prey account for 30 %). The small fishes of 9-15 cm TL fed on many fish prey and crabs, which account for 53 % and 53 %. Therefore, this species with 16-18 cm TL perhaps is secondarily a piscivore.

Scombridae

In Gymnosarda unicolor (n = 3, Gu), Katsuwonus pelamis (n = 8, Kp), and Thunnus albacares (n = 2, Ta), fish prey were the dominant prey category in 75-100 % by frequency of occurrence. Invertebrate prey such as crustaceans and cephalopod were also present in diet. Among the prey items of one K. pelamis with 60 cm TL was a specimen of sharptail mola Masturus lanceolatus (The National Science Museum, Tokyo, NSMT-P 68568, 4.8 cm SL) and two specimens of hairtail blenny Xiphasia setifer (24 cm TL, not measured). This represents an addition of a new prey item to the already diverse feeding habits of skipjack tuna. G. unicolor in Marshall Islands, K. pelamis in Solomon Islands, and T. albacares in French Polynesia also fed on mainly fish prey (Randall, 1980; Blaber et al., 1990; Bertrand et al., 2002). The high incidence of fish prey probably indicates that these species are primarily piscivores.

Scorpaenidae

One specimen of Scorpaenopsis diabolus (Sd) contained fish prey, Tripterygiidae sp.. Parrish et al. (1986) has reported that in Hawaii, fish prey in diets of this species was the dominant prey item, which accounted for 94 % by frequency of occurrence. Generally, stonefish and scorpionfish perform ' sit-and-wait ' foraging and can catch mobile fish prey. The species perhaps is primarily a piscivore.

Serranidae

Of the 10 species, 5 species including Cephalopholis argus (n = 2, Ca), Cephalopholis miniata (n = 1, Ci), Epinephelus howlandi (n = 2, Eh), Plectropomus leopardus (n = 5, Pl), and Variola albimarginata (n = 1, Va) fed on fish prey such as Labridae. 6 species including C. argus, Cephalopholis urodeta (n = 1, Cu), Epinephelus caeruleopunctatus (n = 1, Ec), Epinephelus merra (n = 1, Em), Epinephelus fasciatus (n = 2, Ef), Epinephelus tauvina (n = 1, Et) fed on crustaceans such as brachyurans and macrurans. In Marshall Islands, Society Islands, Hawaii, Madagascar, Okinawa Islands, Red Sea, and Solomon Islands, three species of Cephalopholis, E. merra, E. fasciatus, E. tauvina, and P. leopardus fed on two types of fishes as pelagic fish (e. g., Clupeidae, Engraulidae) and reef fish (e. g., Bleniidae, Serranidae) (Hiatt and Strasburg, 1960; Randall and Brock, 1960; Hobson, 1974; Harmelin-Vivien and Bouchon, 1976; Randall, 1980; Sano et al., 1984; Shpigel and Fishelson, 1989; Blaber et al., 1990; Nakai et al, 2001). Invertebrate prey such as crustaceans and cephalopods were also present in diets of these species frequently. Many species perhaps are primarily or secondarily piscivores.

Sphyraenidae

All Sphyraena pinguis (n = 11, Sp) fed on only fish prey such as pelagic fish Spratelloides gracilis, occurring in 55 % of stomachs. Little is known about the food habit of the species. It has been reported that the larvae of S pinguis fed on Podon sp. and copepod nauplii (Kuwahara and Suzuki, 1982). In the study site, S pinguis with over 10 cm BL usually form loose shoal and attack S gracilis in the water column (Takeuchi unpub. data). The high incidence of fish prey perhaps indicates that it is primarily a piscivore.

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Synodontidae

Saurida gracilis (n = 2, Sg) and Synodus ulae (n = 14, Su) fed on only fish prey such as pelagic fish, Spratelloides gracilis and reef fish, Acanthuridae and Bleniidae. One specimen of Trachinocephalus myops (Tm) contained crustacean such as brachyuran. S. gracilis in Marshall Island, Hawaii, Okinawa, and Kuchierabu-jima also fed on primarily fish prey (e.g., Aulostomidae, Atherinidae, Spratelloides sp.), secondarily crustaceans such as stomatopods (Hiatt and Strasburg, 1960; Hobson, 1974; Sano et al., 1984; Parrish et al., 1986; Shibuno et al, 1996; Nakamura et al., 2003). S. ulae in Hawaii also fed on mostly fish prey (Parrish et al., 1986). Little is known about the food habit of T. myops. S. ulae and S. gracilis probably are primarily piscivores.

A total of 19 fish prey categories were identified. Of 28 species from 12 families having stomachs contents, 75 % (21 species from 11 families) contained fish prey. Of the 21 species, 7 species contained pelagic fish such as Carangidae and Clupeidae. Clupeidae Spratelloides gracilis and S delicatulus were predated on by 5 species and are common pelagic prey. Reef fish such as Labridae and Tripterygiidae were predated on by 10 species from 7 families. Invertebrate prey such as crustaceans, echinoderms, and cephalopods were fed on by 57 % (16 species from 9 families). Shibuno et al. (1998) has reported that of 31 species, 12 species of piscivorous fishes at the reefs fed on mainly pelagic fish, S gracilis. In the study site, carnivorous fishes such as Mullidae and Labridae can intentionally feed on pelagic fish by their skillful tactics (Takeuchi unpub. data). Therefore, their predation effects against fish may be underestimated. There are many primarily or secondarily piscivorous fishes that can feed on fish, which bring about complex predatory fish-prey fish interactions in the coral reef community.

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口永良部島における12科28魚種の食餌

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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12科28種の魚類(ヘラヤガラ科,ダツ科, アジ科,ゴンベ科,ヤガラ科,フエフキダイ科,トラギス科,サバ科,フサカサゴ科,ハタ科,カ マス科,エソ科)の胃内容物を分析した。胃内容物を含む28種のうち,75%(11科21種)は様々な 種類の魚類を食べていた。甲殻類,ウニ類や頭足類のような無脊椎動物は57%(9科16種)によっ て食べられていた。魚類を主としてもしくは二次的に食べる魚類は多く存在し,それらはサンゴ礁 群集において複雑な魚類捕食者・餌魚関係を生み出していると考えられる。

キーワード:サンゴ礁魚類,食性,胃内容物,魚食性