Population Structure and Feeding Behavior of the Stomatopod Crustacean *Kempina mikado* (Kemp & Chopra, 1921) in the East China Sea

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The population structure and feeding behavior of the edible stomatopod crustacean *Kempina mikado* (Kemp & Chopra, 1921) was studied from samples captured with bottom trawls in the East China Sea. The sex ratio (female: male) was 1.64:1. Four size-class groups were discriminated for each sex which may correspond to one to four year-old cohorts. Gut analysis showed that this animal is a typical carnivore and mainly ate the tentacular clubs of the squid *Loligo edulis* and fish, regardless of sex and body size. From the present data, the suspected heavy predation on commercially important penaeid prawns by *K. mikado* was not confirmed.

Key words: Stomatopoda, feeding habits, population

The stomatopod crustacean *Kempina mikado* (Kemp & Chopra, 1921) is distributed from Japan to Taiwan.^{1–3)} It is a tasty species which is occasionally captured in large quantities by bull trawls in the East China Sea; thus, we expect it may develop as a new commercial resource. Over its distribution, the present species has been suspected as heavily predating on commercial penaeid prawns, as suggested for a closely related species *Oratosquilla oratoria*.^{4–6)} For *K. mikado*, there are no data on its ecology. On the other hand, ecological information on *O. oratoria* includes growth,⁷⁾ burrows,⁸⁾ and food preferences.^{5,6)} Both species belong to the family Squillidae and are similar in morphology and size. Here, we report on a study of the growth and feeding habits of *K. mikado* in the East China Sea and compare the results with previous studies on *O. oratoria*.

Materials and Methods

Specimens of *K. mikado* were collected from 29 August to 13 September in 1993 by the research and training vessel, Ten-yo Maru (877 tons) of the National Fisheries University, with a bottom trawl net (mesh size of the cod end 9.7 mm) in waters (29°00'–31°07'N and 125°24'–127°16'E) known as the fisheries sections 258, 259, 260, 269, 270, 481, 482, 483, and 491, in the East China Sea (Fig. 1). The net with otter boards was towed 18 times during the daytime at depths of 84–116 m for 60–150 min at 2.7–3.7 knot.

The carapace length (CL), excluding the rostral plate, and total length (TL) from the apex of the rostral plate to the tip of the submedian teeth of the telson, were measured with a slide caliper, following the method of Hamano & Morrissy.⁷⁾

The developmental stage of the ovary was observed on dissected specimens by eye. The stomach contents were examined by binocular microscope and recorded using the frequency of occurrence method, which indicates the presence or absence of a particular food type as either 1 or 0, respectively, as used previously for *O. oratoria*.⁶⁾ To dis-

criminate age cohorts, the raw data were classified into size classes (width 1 mm, $\leq CL <$) with moving means over three size-class intervals. Then, Gaussian distributions were fitted to the frequency distributions using a computer analysis according to the method of Hamano & Morrissy.⁷⁾

Results and Discussion

Eighty-five male and 139 female *K. mikado* were collected during this investigation. The most numerous sample in a single haul (57 animals) was captured at 30°17'N 126°50'E at a depth of 93 m, with a bottom water temperature of 16.4°C and salinity of 34.58. Many individuals seemed to occur around this location (Fig. 1). The sex ratio expressed as number of female: number of male was 1.64:1. This is very close to the 1.63:1 of *O. oratoria* in Hakata Bay.⁹⁾

Population Structure

There was no significant difference for the regression of CL (mm) on TL (mm) between males and females (ANCOVA, $ps > 0.05$). Thus the equation was re-calculated using both data sets: $TL = 42.78CL^{1.022}$, ($n = 224$, $r = 0.98$, $p < 0.001$). We have adopted CL in preference to TL in the following text.

Four size-class groups were discriminated in each sex (Fig. 2), similar to the closely related species *O. oratoria*. These groups appear to correspond to year classes.⁷⁾ We could not capture adequate samples of small-sized individuals, apparently due to mesh selectivity.^{7,10)} The mean CLs of the Gaussian distributions applied to small-sized groups in Fig. 2 were, therefore, overestimated. Females with mature ovaries were not captured. Thus, we believe that *K. mikado* spawns around the period of high water temperature similarly to *O. oratoria*, which lays eggs between May to September around Japan.¹¹⁾ Females of *K. mikado* had finished their spawning prior to 29 August when this investigation started. If this population is similar to a population of *O. oratoria*,⁷⁾ the smallest-sized cohorts of both

Fig. 1. Relative density of *K. mikado* at 18 sampling stations in the East China Sea.

Fig. 2. Size distribution of male and female *K. mikado*.

Values and arrows indicate the means of the Gaussian distributions.

sexes in Fig. 2 are one-year-old cohorts after settlement and the largest cohorts are four years old. Four-year-old individuals were rare in two closely related stomatopods, *O. oratoria* in the Seto Inland Sea⁷⁾ and *Squilla mantis* in the Mediterranean Sea.¹²⁾ Fishing mortality may be lower on the present species.

Stomach Contents

The stomach contents of *K. mikado* showed that it is a typical carnivore (Table 1). Stomachs contained clubs of squids' tentacles, scales and rays of fishes, and fragments of appendages of prawns. Other organisms that we could identify were fragments of bivalves and hermit crabs. Gut analysis of two closely related squillid species, *Squilla mantoidea* and *S. tiburonensis*, in the northern Gulf of California showed that these animals prefer penaeid prawns.⁴⁾ The rate of prawn consumption by three stomatopods, *S. mantoidea*, *S. tiburonensis*, and *S. bigelowi*, is estimated as approximately 42.3 tons of prawns/year in the region.⁴⁾ *O. oratoria* occurring in Hakata Bay, Japan, shows a preference for penaeid and crangonid shrimps and this species may greatly influence the structure of the benthic community through predation on decapod shrimps including commercial penaeid prawns.^{5,6)} However, *K. mikado* mainly ate squid and fish regardless of its sex and body size, with relatively low predation rates on prawn species (Table 1).

Most fragments of squids in their stomachs were identified as tentacular clubs of *Loligo edulis*. Mantle fragments were rare. Stomach contents of *L. edulis* collected in these waters have been previously reported as mainly fragments of small fishes, squids, and decapod crustaceans.¹³⁾ Many crustaceans were also contained in the stomachs of small *L. edulis* distributed in the Sea of Japan, off Shimane Prefecture.¹⁴⁾ From these observations on diet, we hypothesize the following: the squid, using its long tentacles, attacks *K. mikado* as the stomatopod sits at the entrance of its burrow and the stomatopod takes the full brunt of the attack on its strong raptorial claws. Most stomatopods successfully cut the clubs off tentacles and then eat them.

Gut analysis also showed that the present species often captured fish (Table 1). Two species of *Oratosquilla*, *O.*

Table 1. Stomach contents of *Kempina mikado* in four size groups, collected in the East China Sea

Sex	Carapace length (mm)	No. collected inds.	No. inds. with stomach contents	Number (frequency, %)* of occurrence			
				Squid	Fish	Prawn	others
Male	<25	11	5	2(40.0)	4(80.0)	0 (0.0)	0 (0.0)
	25≤-<30	18	7	5(71.4)	3(42.9)	1(14.3)	1(14.3)
	30≤-<35	37	25	13(52.0)	10(40.0)	4(16.0)	1 (4.0)
	35≤	19	11	8(72.7)	5(45.5)	0 (0.0)	0 (0.0)
	Subtotal	85	48	28(58.3)	22(45.8)	5(10.4)	2 (4.2)
Female	<25	11	5	1(20.0)	3(60.0)	0 (0.0)	1(20.0)
	25≤-<30	22	14	7(50.0)	8(57.1)	2(14.3)	0 (0.0)
	30≤-<35	65	32	13(40.6)	17(53.1)	5(15.6)	0 (0.0)
	35≤	41	22	16(72.7)	10(45.5)	2 (9.1)	0 (0.0)
	Subtotal	139	73	37(50.7)	38(52.1)	9(12.3)	1 (1.4)
Total		224	121	65(53.7)	60(49.6)	14(11.6)	3 (2.5)

* 100 × number of specimens present with prey item in stomach/number of specimens with stomach contents.

nepa and *O. inornata*, have been shown to be unable to catch living, laterally compressed fish in an aquarium.¹⁵⁾ In Hakata Bay, however, *O. oratoria* eats a few fish and appears to be somewhat adapted to catching fish.⁶⁾ There is little morphological difference between the raptorial appendages of *K. mikado* and these *Oratosquilla* species; hence, *K. mikado* will be as quick and powerful in its foraging behavior as these latter species.

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