J. of Aquaculture
Vol. 16(2) : 84-87, 2003

한국양식학회지
Journal of Aquaculture
©Korean Aquaculture Society

Stomach Contents of Rockfish (*Sebastes schlegeli*) in Artificially Illuminated Sea Cage

Chul-Won Park, Min-Suk Kim, Cindy K. Cho[1], Yong-Joo Park, Saywa Kim*[1] and Jong-Man Kim
Marine Resources Laboratory, KORDI, Seoul 425-600, Korea
[1]*Division of Environmental Biology, Yong-In University, Yongin 449-714, Korea*

Effect of artificial illumination on feeding by the rockfish *Sebastes schlegeli* receiving no synthetic feed in the cage of the Tongyong Marine Ranch was investigated by analysing the stomach contents of 20 individuals every month from October 1998 to July 1999. The fish was found to have fed on naturally available zooplanktons, i.e. *Calanus sinicus*, zoeae, amphipods and copepodites in October, fish larvae in November-December, nematodes in January, amphipods in February and again fish larvae from May to July. Despite increase in the weight of stomach contents from 260 mg/fish during the initial period of study to 2,173 mg/fish, as many as 70% of the fish were found to have empty stomach during March-April. Weight of stomach contents did not increase with increasing age of the fish. Occurrence frequency was 83-90% for *C. sinicus* during October-November and >50% for fish larvae during March-April and June-July.

Keywords: Rockfish, Artificial illumination, Stomach contents, Crustacean zooplanters, Fish larvae

Introduction

Artificial feeding is a common practice of rockfish rearing, especially between the initial seedling production and eventual release into the natural habitat (Love et al., 1991). In recent times progressive farming of rockfish has involved illumination of the cage to make the natural food organism as an energy source to increase survival, growth and production of the planktivorous juvenile stage. *Artemia* larvae are commonly used as food for the planktivores like the flounder and rockfish (Watanabe et al., 1983; Kusakari, 1991). Due to appropriate nutritive value and easier hatchability of the planktons by the juvenile fish in the cage, attempts have been made to make more suitable planktons available to fish fry; for instance, studies on rockfish by Lee et al. (2000) and Kim et al. (2002), and on young flounders by Kim et al. (1996) support the idea that natural zooplankters are one of the best food organisms for the juvenile rockfish.

To attract planktonic food organisms into the fish cages, artificial illumination has been a useful strategy (Uryn, 1979; Rausin et al., 1991). Tacon et al. (1991) reported a positive growth response and survival in the aquaculture of the juvenile seabass with artificial illumination at night. With the natural food supply to small fry, nutritional deficiency should be no longer a problem in the initial stage of fish farming (Reitan et al., 1993; Watanabe and Kiron, 1994; Song et al., 2002). Although total quantity of food available may not be adequate, an attempt has been made to increase food availability of natural zooplankters and fish larvae to rockfish fry by attracting the zooplankters into the cage by artificial illumination.

The objectives of the study is to trace the changes in food items of the rockfish with the growth as a part of the development of marine ranching technologies established since 1998 at the model site in Tongyong area of KORDI, with the cooperation of Ministry of Maritime Affairs and Fisheries, in Korea.

Materials and Methods

For artificial illumination, an incandescent electric lamp (200W) was used. The lamp was positioned approximately 0.5 m above the water surface, and operated every night from 18:00 to 06:00 during the experimental period from October 1998 to July 1999.

At the beginning of the study, 1,000 rockfishes each with the mean body weight of 6.3 g were stocked in a 4×2×2 m (16 m^3 water volume) cage with 6 mm mesh aperture in

*Corresponding author: swkim@yongin.ac.kr

Tongyong Marine Ranch. Twenty specimens of the rockfish in the sea cage receiving no synthetic feed were captured every month at night. The specimens were fixed with 10% neutralized formalin on board, brought to the laboratory and subsequently the stomach contents were analysed. Wet weight of stomach was measured to mg accuracy with an electric balancer (Mettler Toledo), then the stomach was removed to separate its contents. Wet weight of the separated contents was measured, and the contents were examined under a dissecting microscope (Zeiss SV11) and a compound microscope (Zeiss Auxiolab) to identify the food organisms eaten by the rock fish fry.

Seasonal variations in the frequency of occurrence of food items were calculated with following formula.

Frequency of occurrence (%)=Ni/Nt ×100

Ni: number of stomachs with a specific food organisms

Nt: total number of stomachs with food

Results and Discussion

Stomach contents mainly consisted of crustacean zooplankters, *i.e. Calanus sinicus*, zoeae, amphipods and copepodites at the beginning of the study, October and November, then fish larvae from November (Table 1). The frequency of occurrence of *C. sinicus* exceeded 80% during the first two months. Copepodites were also one of the major food items (>60% during the same period). Then rockfish fry appear to shift to selective feeding by preferring the larger crustacean zooplankton, for Kim and Park (2002) reported that *C. sinicus* and copepodite were not dominant in the cage in October 1998 (cf. Fig. 1). The high occurrence frequency of 50% of amphipods was obviously due to their attraction to the artificial illumination in October. No such attraction of the amphipods into the cage was observed in natural conditions without illumination. Along with amphipods, fish larvae became the major food item from November. Subsequently, the fish larvae became an important food item again from February, for the frequency of occurrence of fish larvae was >50% during the period between February and July except April and May. Under natural or aquacultural conditions, approximately one year old rockfish mainly consumed fish larvae or artificial pellet (Kim and Kang, 1991).

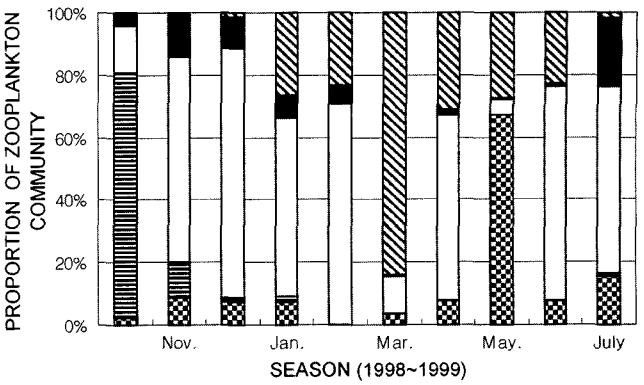

Fig. 1. Percentage composition of zooplankton community among total zooplankton abundance from October 1998 to July 1999 in Tongyong marine ranch. Hatched column: *Noctiluca scintillans*, solid: metazoans except copepods and amphipods, open: copepods, copepodite and copepod nauplius, stripe: amphipods, lattice: larval animals (after Kim and Park, 2002).

Interestingly, the presence of amphipod in the stomach of the rockfish fry suggested that the fry is also an opportunistic feeder. Likewise the presence of crustacean zooplankton in

Table 1. Seasonal change in the frequence of occurrence of food items of the rockfish (*Sebastes schlegeli*) from October 1998 to July 1999.

Season	Food items	Frequency of occurrence (%)	Season	Food items	Frequency of occurrence (%)
October	*Calanus sinicus*	83.3	February	Fish larvae	52.6
1998	Copepodite	61.1		Nematoda	21.1
	Decapoda larvae	61.1	March	Fish larvae	66.7
	Amphipoda	50.0	April	Fish larvae	20.0
November	*Calanus sinicus*	90.0	May	Fish larvae	36.4
	Copepodite	70.0		*Calanus sinicus*	9.1
	Amphipoda	25.0		Decapoda larvae	9.1
	Fish larvae	35.0	June	Fish larvae	50.0
December	Fish larvae	20.0	July	Fish larvae	83.3
	Copepodite	10.0		Decapoda larvae	66.7
	Zoeae	5.0		Zoeae	16.7
	Amphipoda	10.0		Amphipoda	16.7
January	Fish larvae	47.4			
1999	Nematoda	42.1			

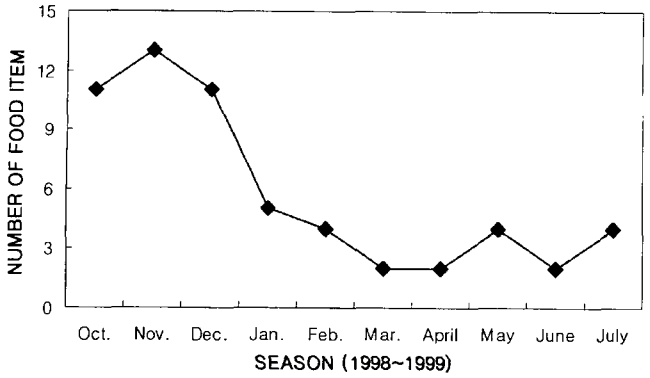

Fig. 2. Seasonal variation in the number of food item of rochfish (*Sebastes schlegeli*) from October 1998 to July 1999.

the 9-month old rockfish may also be due to opportunistic feeding. In January, a large number of nematods were found in the stomach. It is not clear whether these nematods were actually eaten or parasites. In July, residues of decapods and amphipods were found in the stomach, indicating that the crustacean zooplankters were important prey organisms even in a 9-month old rockfish reared in the experimental cage.

Number of food organisms of the rockfish decreased with the growth from 11-13 items at the beginning in October 1998 to 2-4 at the end of July 1999 (Fig. 2). Similar patterns in the change of favourite food items with the growth of fish were reproted for the Thai barb (*Puntius gonionotus*) (Dev and Rahmatullah, 1998) and *Acanthogobius flavimanus* (Huh and Kwak, 1999).

Mean wet weight of stomach increased more than eight times *i.e.* from 260 mg at the beginning of the study to 2,173 mg (Fig. 3). Mean wet weight of stomach contents, however, did not increase with the growth (Fig. 4). Despite rapid increase of stomach weight, the empty stomach in more than 70% of the specimens suggested the fast digestion and/or passage of food in March and April. Maximum of mean wet weight of stomach contents recorded was 2,330 mg.

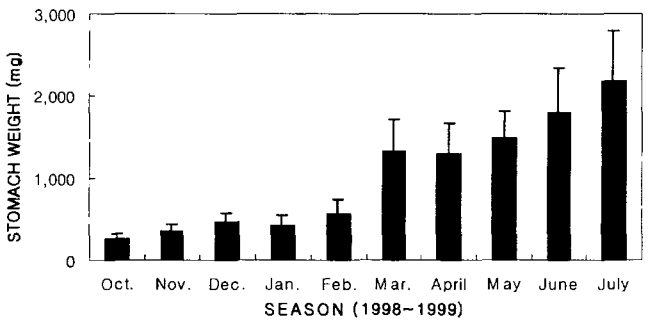

Fig. 3. The increase in mean stomach weight with the growth of rockfish (*Sebastes schlegeli*) from October 1998 to July 1999. Error bar=SD.

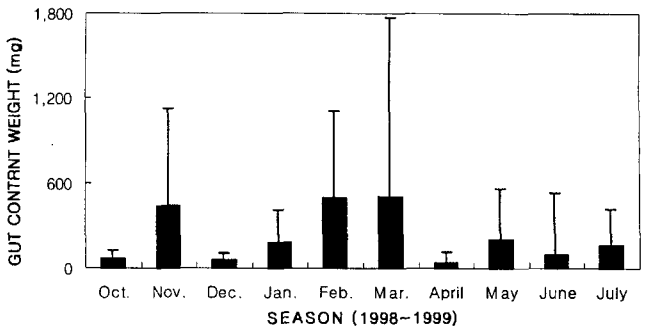

Fig. 4. Seasonal variation in mean stomach content weight of rockfish (*Sebastes schlegeli*) from October 1998 to July 1999. Error bar=SD.

Acknowledgement

We thank Jae-Sung Jeong, Yong-In University, for the assistance.

References

Dev, B. C. and S. M. Rahmatullah, 1998. Food selection indices of the Thai barb *Puntius* (=*Barbodes*) *gonionotus* in extensively managed, rain-fed ponds in Bangladesh. Asian Fish. Sci., **11**: 111–119.

Huh, S. H. and S. N. Kwak, 1999. Feeding habits of *Acanthogobius flavimanus* in the eelgrass (*Zostera marina*) bed in Kwangyang Bay. J. Korean Fish. Soc., **32**: 10–17 (in Korean).

Kim, D. S., J. H. Kim, C. H. Jeong, S. M. Lee and Y. B. Moon, 1996. Effects of dietary herbs on growth and body composition in oliver flounder, *Paralichthys olivaceus*. J. Aquacult., **9**: 461–465 (in Korean).

Kim, J. K. and Y. J. Kang, 1991. Mathematical approaches related to daily feeding activities of rock trout, *Agrammus agrammus*. Bull. Korean Fish. Soc., **24**: 315–326.

Kim, K. W., G. J. Park, I. H. Ok and S. C. Bai, 2002. Effects of dietary synthetic amino acid supplementation in Korean rockfish fry *Sebastes schlegeli*. J. Aquacult., **15**: 157–163 (in Korean).

Kim, S. and C. W. Park, 2002. Impact of artificial illumination on zooplankton dynamics. Korean J. Environ. Biol., **20**: 312–314.

Kusakari, M., 1991. Mariculture of kurosoi, *Sebastes schlegeli*. Environ. Biol. Fish., **30**: 245–251.

Lee, S. M., J. Y. Lee and I. G. Jeon, 2000. Dietary squid liver oil and soybean oil ratio on growth and body composition of Korean rockfish *Sebastes schlegeli*. J. Aquacult., **13**: 207–213 (in Korean).

Love, M. S., M. H. Carr and L. J. Haldorson, 1991. The ecology of substrate-associated juveniles of the genus *Sebastes*. Environ. Biol. Fish., **30**: 225–243.

Rausin, N., M. Kadari and P. Cornelis, 1991. Use of night-light to attack food organisms into tropical marine fish cages. Aquacult. Fish. Mgmt., **22**: 183–192.

Reitan, T. I., J. R. Rainuzzo, G. Oie and Y. Olsen, 1993. Nutri-

tional effects of algal addition in first-feeding of turbot (*Scophthalmus maximus* L) larvae. Aquaculture, **118**: 257–275.

Song, Y. B., S. W. Moon, S. J. Kim and Y. D. Lee, 2002. Effects of EM-fermented orange in commercial diet on growth of juvenile flounder, *Paralichthys olivaceus*. J. Aquacult., **15**: 103–110 (in Korean).

Tacon, A.G.J., N. Rausin, M. Kadari and P. Cornelis, 1991. Use of night-lights to attract food organisms into tropical marine fish cages. Aquacult. Fish. Mgmt., **22**: 183–192.

Uryn B.A., 1979. Farming of juvenile whitefish *Coregonus lavaretus* (L.) in submerged, illuminated cages. Sp. Publ. European Maricult. Soc., **4**: 289–297.

Watanabe, T. and V. Kiron, 1994. Prospects in larval fish dietary. Aquaculture, **124**: 223–251.

Watanabe, T., C. Kitajima and S. Fujita, 1983. Nutritional value of live organisms used in Japan for mass propagation of fish: a review. Aquaculture, **34**: 115–143.

Manuscript Received: January 3, 2003
Revision Accepted: March 12, 2003
Responsible Editorial Member: Kyung-Min Han