

Feeding Behavior in Scyphozoa, Crustacea and Cephalopoda

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Introduction

Aquatic invertebrates are excellent models for the study of animal feeding behavior and at the same time are very important fisheries resources that are frequently harvested using baited fishing gears. Studies on their chemical senses can bring a better understanding to the factors affecting feeding processes in simple organisms, as well as contribute to the development of better baiting techniques that can be applied to improve the efficiency of their capture methods. The authors present some model organisms for the study of feeding behavior in Scyphozoa, Crustacea and Cephalopoda.

Scyphozoa

Though jellyfish are most commonly associated with being a nuisance to swimmers and fishermen, they are very important members of the marine ecosystem where they have a high impact on plankton communities and can consume up to 20% of all fish larvae. They also provide shelter and food to a number of aquatic organisms and in some Asian countries they are exploited as a valuable fisheries resource for food. Lately, there has been interest in developing hatchery and rearing techniques for a number of species of edible jellyfish, but until now there are only conflicting reports on their chemosensory abilities and little is known about their senses of smell and taste. Past research on chemoreception in jellyfish has focused on observing feeding behavior of a few species towards their natural prey, on testing their responses to prey extracts and a few pure substances, mostly amino acids and peptides and electrophysiological recordings of their reactions towards fish mucus and other chemical substances.

The authors chose the 'moon' jellyfish *Aurelia aurita* as a model for the study of scyphozoan feeding behavior and developed a simple technique for testing behavioral responses towards a natural prey (frozen brine shrimp, *Artemia* spp.) and three types of agar pellets containing *Artemia* homogenate, the bitter substance quinine and seawater as control (Archdale *et al.*, 2002). Observations of the feeding responses towards the natural prey showed that the tentacles on the jellyfish's umbrella margin would stick to the prey and contract, bringing it close to the margin. By this time, the oral arms, which are four elongations resembling tongues that extend from the mouth, would begin to move and one would 'lick' the prey from the margin. Ciliary currents would transport the prey along the length of the oral arm, through the mouth and into the gastric pouch, where it would be digested. Both the frozen *Artemia* and the *Artemia* homogenate agar pellets were treated following this pattern of feeding behavior; but the quinine and seawater agar pellets were rejected shortly after being picked up by the oral arm and carried away by the swimming currents generated from the contraction of the umbrella. Our results showed that although all types of agar pellets were captured, not all were ingested; that *A. aurita* can discriminate a prey according to its taste; and that prey selection takes place after transfer to the oral arms, suggesting that it is there where taste selection occurs.

Crustacea

Crustaceans and in particular decapods, support some of the most profitable capture fisheries and aquacultures. Extensive research has been done on their feeding behavior and chemoreceptive qualities, but little attention has been paid to their attraction towards sweet substances. The authors chose the blue swimming crab *Portunus pelagicus* as a model for studying crustacean feeding behavior. First, crab feeding responses to natural preys (fish and clam) were observed and the behaviors followed this sequence: inactive, increase in antennule flicking, mouthpart movement, prodding of substrate, emergence from substrate and food search. Following this, individual crabs were presented with solutions of single amino acids or saccharides at increasing concentrations (10^{-8} – 10^{-4} M). Some individual amino acids and saccharides elicited the same sequence as natural foods and particularly strong responses were observed towards alanine, betaine, serine, galactose and glucose (Archdale and Nakamura, 1992). To confirm the detection of these substances by the antennules of the crabs, they were subjected to stimulation by single amino acids and saccharides at 10^{-3} M and their responses were recorded through a suction electrode placed on the nerve bundle of the antennule. It was confirmed that saccharides elicited similar responses as amino acids (Anraku *et al.*, 2001). To test possible fisheries applications of our findings, field trials with baited traps were carried out at four locations in the Philippines. The baits employed were fish meat, sugar cane (rich in saccharides) and a combination of the two. Crab catch during the trials was highest on traps with a combination of both baits, followed by fish meat and showing a lower catch with sugar cane alone. When the baits were combined, the catch increased due to the synergistic effect of the amino acids and saccharides present in them, both of which are attractive to the crabs.

Cephalopoda

Coleoid cephalopods, such as cuttlefish and octopus, are exploited commercially as an important fisheries resource. They have been described as visual animals that rely heavily on their sense of vision to locate, pursue and catch their prey. For this reason, little attention has been paid to their senses of smell and taste. The few studies on cephalopod chemoreception revealed chemoreceptor-like structures for distance chemoreception in the olfactory pit and contact chemoreceptors in the suckers, lips and mouth of several species. The authors chose the cuttlefish *Sepia esculenta* and the octopus *Octopus vulgaris* as a model of cephalopod feeding behavior. First, a brief review of chemoreceptors in both species was carried out. The olfactory organ revealed the presence of ciliated chemoreceptor cells. The suckers in the arms of both species showed ciliated tapered receptor cells in the columnar cell layer of both infundibulum and acetabulum of the sucker.

The feeding behaviors of the cuttlefish and octopus in relation to chemical stimulants present in baits were compared by using starch

or cellulose binders. Both animals discriminated test chemicals by touching with the arms, which indicates the presence of chemoreceptors in the suckers located on these appendages. The effects of chemical stimulants on the feeding behavior of the cuttlefish, *Sepia esculenta* were determined. Baits containing amino acids (L-Ser, L-Ala, L-Arg, Tau, L-Glu-Na, L-Pro, L-Glu and Gly) were ingested, but those with Bet or quinine-HCl were touched with the arms and not ingested (Anraku et al., 1998). The effects of chemical stimuli in the feeding behavior of the octopus using similar bait pellets showed that fish extract, some amino acids (Bet, Met, L-Gly, L-Pro, L-Ser) and quinine-HCl were transferred to the mouth, but those containing cephalopod inks (same genus or different order) were not transferred. Regarding ingestion and rejection of the baits, only those containing the fish extract had significantly higher ingestion rates; those containing Met, L-Gly, galactose and cephalopod inks of the same genus and different order had significantly lower ingestion rates (Anraku et al., 2005).

The octopus showed negative behavior responses to ink of other cephalopod species, while that of conspecifics had no effect, suggesting that the composition of inks could vary among cephalopods. Cuttlefish showed a more specific bait selection behavior for chemicals than octopus, despite the fact that the latter is known to

have a larger number of chemoreceptors. It was found that chemoreception in the arms and lip is responsible for the feeding behavior in terms of bait quality selection. It is also suggested that the properties of chemoreceptors on the arms and lip might be different, particularly in the octopus.

References

- Anraku, K., Ohta, M., Sasaki, T., Marui, T. and Kawamura, G. (1998) *The effect of amino acids on feeding behavior of cuttlefish Sepia esculenta*. Jpn. J. Taste Smell Res., 5, 519–522 [in Japanese].
- Anraku, K., Archdale, M.V., Mendez, B.C. and Espinosa, R.A. (2001) *Crab trap fisheries: capture process and an attempt on bait improvement*. UPV J. Nat. Sci., 6, 121–129.
- Anraku, K., Archdale, M.V., Hatanaka, K. and Marui, T. (2005) *Chemical stimuli and feeding behavior in octopus, Octopus vulgaris*. Phuket Mar. Biol. Center Bull. (in press).
- Archdale, M.V. and Nakamura, K. (1992) *Responses of the swimming crab, Portunus pelagicus to amino acids and mono- and disaccharides*. Nippon Suisan Gakkaishi, 58, 165.
- Archdale, M.V., Yamanouchi, T. and Anraku, K. (2002) *Feeding behavior of Aurelia aurita towards Artemia and artificial pellets*. Jpn. J. Taste Smell Res., 9, 747–750.