



Food and Feeding Habits of Wedge Clam (*Donax cuneatus*) Off Thoothukudi, Gulf of Mannar, India

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ABSTRACT

Background: Bivalves are benthic animals existing in coastal habitats, particularly mudflats and tidal. Because of their availability, rich protein content and cheaper cost, they contribute a major portion of the small-scale fishery resource worldwide. Limited information has been available on the food-feeding and habitat structures of bivalves along Indian waters. Therefore, the present investigation was carried out to know the food-feeding and habitat preferred by wedge clam, *Donax cuneatus* off Thoothukudi, Gulf of Mannar, India.

Methods: Soil, water and wedge clam samples were collected from the selected site from September 2019 to March 2021 and soil texture, water quality parameters and gut contents were analyzed at the laboratory.

Result: During the study period, salinity, water temperature, pH and dissolved oxygen (DO) were in the range from 31-37‰, 24-28°C, 7.7-8.7 and 4.1-5.8 mg/l, respectively. Wedge clams were mainly observed at sandy beaches up to 10 cm in depth. *Donax cuneatus* mainly feeds on detritus (65%), followed by phytoplankton (31%) and zooplankton (4%). Hence, the diverse fluctuation of food particles, season-specific food and feeding biology and local environmental conditions at the studied region might be the responsible features for the availability of *Donax cuneatus*.

Key words: Feeding ecology, Gulf of mannar, Habitat, Plankton, Wedge clam.

INTRODUCTION

Within the Phylum Mollusca, Bivalvia is the second-largest taxonomic class with about 10,000 existing species documented worldwide (Rahman *et al.*, 2015). The diversity of bivalves includes 101 families and 1,380 genera with 9,620 species (Huber, 2015). Globally, annual total marine bivalve production is more than 15 million tons, with Asia alone producing more than 85% (FAO, 2017; Wijsman *et al.*, 2019). Bivalves are mainly suspension and deposit-feeders in nature (Desai *et al.*, 2020; Maloy *et al.*, 2013), so they can modify, maintain and build complete habitats (Dame, 1996). Bivalve serves a critical role in benthic-pelagic coupling and nutrient recycling processes in the coastal ecosystem (Dame, 1996). These organisms are attached to the solid substratum or even bored in the rigid substrates (Gosling, 2003). They are discriminating particle feeders having well-built mechanisms for particle selection (Ward and Shumway, 2004). In, bivalve filtration and feeding processes mainly depend on the structure of gill and concentration of particles in the adjacent waters (Jorgensen, 1996); food-feeding depends on the surface and shape of the particles (Bougrier *et al.*, 1997).

Benthic communities might be experiencing different responses based on the food availability and competition presumably among the consumers for limited food resources (Campanya-Llovet *et al.*, 2017). They are important mediators to transfer energy from primary producers to the consumers or the next trophic level (Wang *et al.*, 2015). Bivalves are keystone species that monitor the phytoplankton by grazing, destroying bio-indicators for

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marine habitats as a top-down and bio-deposition of nutrients as a bottom-up mechanism in the aquatic ecosystem (Newell, 2004; Pandey *et al.*, 2018; Khudhur and Shekha, 2019). The bivalves family Donacidae, is widely distributed in the Indo-West Pacific, from East Africa, including Mauritius, Madagascar and Reunion Islands, to New Caledonia, South to New South Wales and North to Southern Japan and dominant in the tropical and temperate region where they are exposed to sandy beaches (Ansell, 1983; FAO, 1998). Donacids are filter feeders in nature (Singh, 2017) and they play a vital role in the benthic-pelagic food

web (Dame, 1996). They are also subject to predation by varied varieties of invertebrates, birds, fish and mammals (Loesch, 1957).

The global human population is continuously growing up and natural resources are limited; hence, bivalves can be an alternative source to provide a nutritional diet for humans. In Asia, millions of people using bivalves as inexpensive and affordable healthy food items rich in amino acids, essential fatty acids, essential minerals and vitamins (Joy and Chakraborty, 2017). At the same time, food is a major substance for any organism in the ecosystem; therefore, it is essential to know the feeding nature of particular species. From Indian waters, limited information is available on the food, feeding habits and habitat structures of *Donax cuneatus*. Therefore, the current study was conducted to know the food and feeding habits of wedge clam from the Thoothukudi, Gulf of Mannar, India.

MATERIALS AND METHODS

During the period of September 2019 to March 2021, the wedge clam samples were collected from Tuticorin, Harbour beach (Latitude- 8°44'34.53" N and Longitude- 78°10'2.96"E), situated in the southern part of Tamil Nadu. Monthly, around thirty individuals of wedge clams were handpicked during the high tide and collected specimens were brought to the fisheries biology laboratory of the institute for further gut content analysis (Ma and Mukai, 2009).

A total of 390 specimens of *D. cuneatus* in the length range of 11-23 mm and weight range of 0.6-2.12 g were examined for food and feeding study. Samples were incised through a knife and scalpel and the gut was removed from meat tissues using a sharp blade. The guts were emptied into a test tube mixed with one ml of distilled water. The same was poured onto Sedgwick-Rafter (S-R) cell and examined under a binocular photomicroscope. The food items were identified up to the genera level using the taxonomic keys given by Santhanam *et al.* (1987) and Mitra *et al.* (2004). Quantitative and qualitative analysis of gut contents were carried out using the numerical method (Biswas, 1993). The relative volume of each item was calculated as per the point method and points are allotted based on the size of the food item and relative dominance in the gut (Gurjar *et al.*, 2017). For habitat characteristics, sediment samples were collected from sampling locations and brought to the laboratory for further analysis. For determining the composition and texture of the soil, samples were analyzed as per the method given by Bragadeeswaran *et al.* (2007). The monthly salinity (hand-held refractometer ATAGO S/Mill-E), water temperature (calibrated mercury thermometer), pH (microprocessor pH meter) were measured and dissolved oxygen (DO) was estimated by standard methods of APHA (2012).

RESULTS AND DISCUSSION

The present study indicated that primarily wedge clam preferred to inhabiting sandy beaches where more than 80

per cent of soil texture was sand and the remaining were muddy and silty textures. Samples of wedge clam were found up to 10 cm depth, but more than 65% of specimens were observed from 2-5 cm during the spring tide. Salinity, water temperature, pH and dissolved oxygen (DO) were recorded in the range from 31-37‰, 24-28°C, 7.7-8.7 and 4.1-5.8 mg/l, respectively. In the present study it has been observed that wedge clam is a quick burrower in the sandy beaches and lives under the surface of wave-swept parts of intertidal areas along Harbour beach of Thoothukudi coast. Earlier authors also reported that wedge clams were mainly present in sandy beaches along intertidal zone (Ansell, 1983; Tan and Low, 2013). Some bivalve species live under the buried condition in soft or sandy bottoms, whereas others are attached on or even bored in the hard substratum (Gosling, 2003). In the present study, *D. cuneatus* was mainly observed during high tide, which might be due to favourable conditions to get their food items. During high tide, they become more active and move towards the surface for feeding. McLusky and Stirling (1975) also observed that the feeding of *Donax* species depends on wave action and water movement. Salas and Hergueta (1990) also reported that *Donax* species lived in wave-beaten areas and high-energy environments. The abundance of *D. cuneatus* was affected by the result of various factors such as effluent and industrial discharge into coastal areas of the southeast coast of India (Hussain *et al.*, 2010).

Food composition

In the present study, different food items such as phytoplankton (*Amphora* spp. *Bacillaria paxillifera*, *Coscinodiscus* spp. *Hemidiscus cuneiformis*, *Navicula* spp. *Pinnularia* spp. *Pleurosigma* spp. *Rhizosolenia* spp. *Skeletonema* spp. *Schroederella* spp. *Thlassionema* spp. *Thalassiosira* spp. and *Trichodesmium* spp), zooplankton (copepods, eggs, foraminifera, tintinnids) and detritus were recorded from the gut content of wedge clam (Table 1). Xu and Yang (2007) stated that phytoplankton is the main food source for the various organisms present in the intertidal areas. Several studies revealed that other than phytoplankton, supplementary food sources such as detritus, bacteria and zooplankton are also important for their growth and survival (Lehane and Davenport, 2002; Prato *et al.*, 2010). Wang *et al.* (2015) stated that bivalves feeding could vary on the availability of food items in the surrounding environment and species-specific feeding strategies.

Group-wise contribution of food items has been dominated by detritus (65%), followed by phytoplankton (31%) and zooplankton (4%) (Fig 1). Bacillariophyceae was dominantly observed among phytoplankton, while copepods were recorded as the main food items among zooplankton. The contribution of detritus in the bivalve diet is more important when the availability of the phytoplankton was very less to satisfy the energy needs of bivalves (Langdon and Newell, 1990).

Monthly variation in food items

Phytoplankton

In the present study, among phytoplankton, diatoms were abundantly recorded from the gut contents of wedge clams during the entire study period (Table 1). Malviya *et al.* (2016) reported that diatoms are the most important ecologically phytoplankton groups, contributing about 20% of primary productivity worldwide. From January to March (post-monsoon), a higher abundance of phytoplankton such as *Bacillaria* spp., *Coscinodiscus* spp. and *Navicula* spp. were observed in the gut of wedge clam, which might be due to higher diversity and abundance of phytoplankton in the post-monsoon season Thoothukudi, Southeast Coast of India (Velmurgan *et al.*, 2014).

According to earlier studies, phytoplankton was known as a primary and important food item for bivalves (Gosling, 2003; Xu and Yang, 2007). In the present study, less number

of phytoplankton was observed during October to December as monsoon season (Fig 2) might be due to the low intensity of light and some other abiotic factors responsible for affecting plankton production (Bragadeeswaran *et al.*, 2007). Subsequently, a higher percentage of detritus was observed due to a lower abundance of plankton in surrounding waters and heavy rain during this period which leads to more influx of sediments through surface runoff waters. Bragadeeswaran *et al.* (2007) reported that the composition of sand in sediment was higher during the monsoon season. Wang *et al.* (2015) have been observed that phytoplankton abundance decline as a consequence of bivalve grazing. Arapov *et al.* (2010) observed that the concentration of phytoplankton communities depends on the surrounding water. The accumulation of food items in filter-feeders would presumably reflect their concentrations in water (Zuykov *et al.*, 2013).

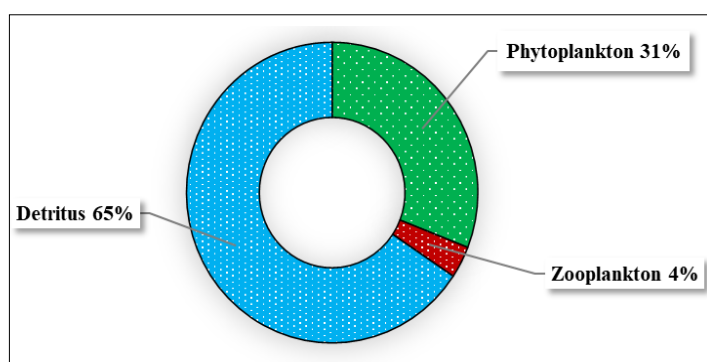


Fig 1: The overall contribution of food items in the gut of wedge clam, *Donax cuneatus*.

Table 1: Percentage-wise food items recorded in the guts of wedge clam, *Donax cuneatus*.

Food items	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21
Phytoplakton													
<i>Amphora</i> spp.	0	4.5	0	0	0	3.5	0	0	2.5	0	0	3.2	2.5
<i>Bacillaria paxillifera</i>	3.1	0	0	6.2	3	6.5	5.4	2.5	0	0	5.4	2.6	0
<i>Coscinodiscus</i> spp.	4.8	0	0	0	5.2	2.3	4.8	5.5	0	0	0	1.2	3.5
<i>Hemidiscus cuneiformis</i>	0	4	0	0	5	0	3.2	0	4.5	0	2.8	5.4	0
<i>Navicula</i> spp.	2.2	0	4.5	0	4.1	6.2	4.5	0	5.7	4.5	0	7.5	4.3
<i>Pinnularia</i> spp.	0	0	5.5	5.1	0	0	0	0	0	0	0	0	2.7
<i>Pleurosigma</i> spp.	3.5	0	0	0	3	5.5	5.8	6.8	0	0	4.3	0	2.6
<i>Rhizosolenia</i> spp.	0	5.4	6.8	0	0	1	0	6.5	0	0	1.4	0	3.5
<i>Skeletonema</i> spp.	0	0	0	3.7	4	2.5	5.3	0	0	0	8.4	0	3.8
<i>Schroederella</i> spp.	0	0	0	0	0	1.5	0	0	1.8	0	0	0	0
<i>Thlassionema</i> spp.	10.5	0	4.5	0	0	2.5	3.5	0	3.6	7.5	0	7.8	0
<i>Thalassiosira</i> spp.	0	6.8	2.5	3	0	0	0	0	1.5	0	0	0	0
<i>Oscillatoria</i> spp.	5.3	5.5	6.5	8.5	11.3	7.5	10.5	7.9	6.8	13.5	2.4	5.4	10.5
Zooplankton													
Foraminifera	0	3.5	1	0	0	0	0.6	1.5	0	0	0	1.3	1.1
Tintinnids	0	0	0	0	0	0	0.2	0	0	0	0	0.2	0.1
Copepods	2.1	2.5	2.2	2	1.4	2.5	4.5	3.8	3.5	3.5	3.6	0	2.9
Eggs	0	0.3	0	0	0.2	0	0	0	0	0	0.2	0	0
Detritus	68.5	67.5	66.5	71.5	62.8	58.5	51.7	65.5	70.1	71	71.5	65.4	62.5

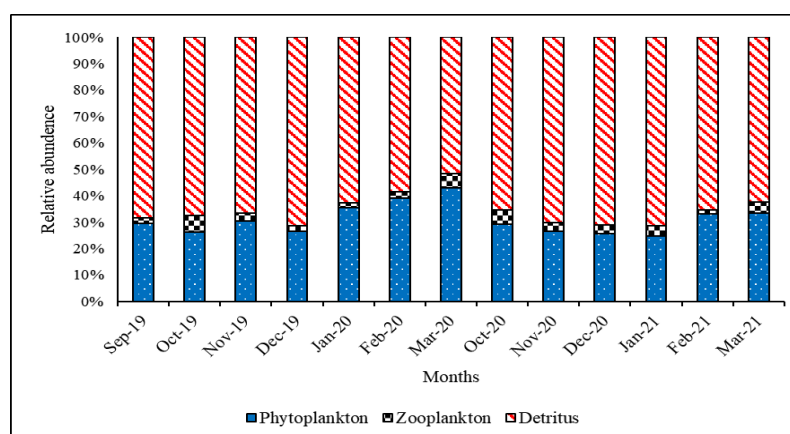


Fig 2: Bar diagram showing the monthly composition of different food groups in the gut of wedge clam, *Donax cuneatus*.

Zooplankton

In the present study, the gut matrix of wedge clam has shown monthly variations among different zooplanktons such as copepods, foraminifera, eggs and tintinnids (Table 1). Lehan and Davenport (2002) recorded that bivalves could ingest various zooplankton as copepods, barnacle cyprids, ostracods, bivalve larvae, crustacean nauplii, amphipods, unidentified eggs, cladocerans, euphausiacea, hydromedusae and foraminifera. In the current study, zooplankton was contributed only 4% of total food items in the gut of studied samples, revealing that wedge clam has less preferred zooplankton than phytoplankton. Bivalve could ingest zooplankton but selectively consumed smaller categories (Lehane and Davenport, 2002).

Detritus

The detritus as organic matter were dominantly observed throughout the study period. In contrast, a higher contribution (more than 70%) was observed in the monsoon season from October to December (Fig 2), which could be due to the influx of sediments resulted from heavy rains. Davenport *et al.* (2011) studied the food-feeding of *Pinna nobilis* and observed that volume-wise detritus contributed more than 95% of total food items. Langdon and Newell (1990) revealed that the contribution of detritus in the bivalve diet is much important when the phytoplankton abundance is very low to fulfill the required energy for the bivalve. In the present investigations, it has been reported that detritus contributed more than other food items in wedge clam, which could be due to the species which preferred sandy areas for their growth and development. Along sandy beach, food webs are primarily consisted by dissolved organic matter, carrion, wrack (stranded algae, partially fragmented leaves and sea grasses), fungi and bacteria living in the spaces between sand particles or attached to the surface of the grains, (McLachlan and Brown, 2006). The sediment texture plays a vital role in the feeding ecology and biology for suspension feeders because they collect their organic food particles (deposit faces and pseudo-faces) from the water column and sediment surface (Graf and Rosenberg, 1997; Chowdhury *et al.*, 2019).

CONCLUSION

Wedge clams were mainly observed at sandy beaches up to 10 cm in depth in the present study and feeds on detritus, followed by phytoplankton and zooplankton. Thus, the diverse change in food particles, season-specific feeding biology and environmental conditions at the studied region might be the responsible factors for the availability of *Donax cuneatus*. This species is also having a lot of potential for culture which can not only provide low cost protein for nutritional security but can also provide livelihood to small and marginal farmers. However, the success of bivalve culture is dependent on water quality parameters and the availability of foods in surrounding environments. More systematic studies may be attempted for stage wise preference of feed, seed availability, habitat suitability, water quality preference *etc.*

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