



Research Article

FOOD PREFERENCE AND FEEDING BEHAVIOUR OF THE LAND SNAIL *CRYPTOZONA BISTRIALIS* IN NAGAPATTINAM, TAMIL NADU INDIA

V. Valarmathi*

¹PG and Research Department of Zoology, A.D.M. College (Autonomous), Nagapattinam - 611 001, Tamil Nadu, IndiaArticle History: Received 22nd March 2017; Accepted 2nd April 2017; Published 10th April 2017

Abstract

Food preference and feeding behavior of the land snail *Cryptozona bistrialis* were investigated under laboratory condition and natural habitat. Feeding behavior of snail showed that the snail was herbivorous/omnivorous and occasionally exhibits cannibalism. They are abundant in the domestic area and preferred plants with more water content were observed. The snails were very active both in the early morning and late evening which extend up to mid night. They were voraciously eating the food mostly in group. Feeding could be detected by the opening of mouth, movement of jaws on the food materials and lowering of either all four tentacles or only anterior two tentacles. They used the radula for scraping and engulfing the food. Food preference of the snail revealed that out of the 12 food material offered, carrots, cabbage, cucumber and chow chow were highly accepted. The radish and papaya were moderately accepted while snake guard and cauliflower were rarely accepted. The beat root and spinach very rarely accepted and amaranthus and onion were completely rejected. Hence, snails preferred more succulent vegetable and fruits under laboratory condition.

Keywords: Food preference, Feeding behavior, *Cryptozona bistrialis*, Herbivorous, Omnivorous, Cannibalism.

INTRODUCTION

Land snails constitute an important component of terrestrial ecosystem and play a significant role in the functioning of terrestrial ecosystem. They along with other soil animals (Annelids, Arthropods, etc.) have been implicated as regulators of microbial decomposition of various plant litters (Mc Brayer, 1977; Jennings and Barkham, 1979 and Selfert and Shutov, 1981). They are endemic with the greatest diversity of land snail fauna in Sri Lanka (Dinarzarde Raheem and Fred Naggs, 2005). Thus the diversity of land snails increases the complexity of biological interaction which contributes stability to the community (Margalef, 1968). Land snails and slugs represent one of the largest invasions of the land, comprising some 30,000 - 35000 species (Solem, 1984). They form an integral constituent of the soil/ leaf litter ecosystem (Emberton, 1996) and playing an important role in nutrient recycling.

The pulmonates are generally regarded as highly specialized herbivores and they are remarkable for the wide variety of foods (Purchon, 1968). A few terrestrial snails and slugs are serious agricultural pests (Barnes, 1980). The land snails commonly eat the vegetation available in their habitat and are not very selective. In pulmonates, radula is a highly developed feeding organ found in buccal cavity.

Hyman (1967) and Kohn (1983) have described the feeding mechanisms of pulmonate snails. Morton (1979) has reported that terrestrial snails feed actively in the early morning and evening hours. A noon hours they rest on shady trees. Kohn (1983) has stated that pulmonates are adapted to feed on all kinds of vegetation. They are not restricted to particular species or particular part of plants.

Food and feeding behavior of different species land mollusks have been studied by Mason (1970), Chatfield (1976), Jennings and Barkham (1979), Seifert and shutov (1979), Raut and Ghose (1983), Chang (1991), Oli (1996), Gupta and Oli (1997). These studies have shown that the Food and feeding habits also determine choice of a particular habitat (Crawley, 1983). External factors that influence food behaviour include abundance and distribution of food material, presence of competitors, risk of predators, season and time of day (Gillette *et al.*, 2000; Scott *et al.*, 2005). The present study was therefore aimed at evaluating the food preferences and feeding behavior of the snail *Cryptozona bistrialis* using commonly available feed stuffs.

MATERIALS AND METHODS

Collection and maintenance of the snail under laboratory condition

*Corresponding Author: Dr. V. Valarmathi, Head and Associate Professor, PG and Research Department of Zoology, A.D.M. College (Autonomous), Nagapattinam-611 001, Tamil Nadu, India, Email: mathivalar.k@gmail.com.

Mature individuals of *C. bistrialis* were collected by hand picking from Kadambadi area of Nagapattinam. Specimens were brought and maintained in the laboratory. The snails were reared in the wooden cage. Wooden cage measuring 80 cm X 75 cm X 40 cm was partitioned into four compartments. The sides of the cage were fabricated with wire mesh to facilitate free ventilation. A door on the roof of the cage was used for handling of snails. The cage was placed in a cool and shady place protected from direct sunlight. The cage was filled with gravel and garden soil about 6 – 8 cm height. About 15 – 20 snails were introduced in each compartment of the cage to avoid overcrowding. Cold water was sprinkled to moisten the soil from time to time and to keep the snails in active condition. The snails were fed every morning with carrot, chowchow, cucumber, cabbage, radish and leafy green matters. Special care was taken to clean the cage by removing fecal pellets, leftover food material daily. The snails thrived well when provided with the temperature of $28^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and optimum relative humidity by periodical spray of cold water. Food preference, Feeding behavior of *C. bistrialis* was observed and recorded under laboratory condition.

Feeding behavior under natural condition

Field observations were made in order to obtain information on the feeding behavior and food preference of the snails *C. bistrialis* for one month under natural habitat in the selected domestic area / home garden located in Kadambadi area during the study period (November 2015). The feeding behavior was observed from morning 6 o'clock to evening 6 o'clock on a dry day as well as 1 or 2 days after rain.

Food preference under laboratory condition

About 10 snails of same size were selected among the collected snail to ascertain the food preferences of *C. bistrialis* under laboratory condition. Snails were housed in a aquarium tank measuring 30 x 20 x 24 cm. The snails were provided 12 feed stuffs like cabbage, cauliflower, cucumber, carrots, beat root, radish, chow chow, snake guard, papaya, onion, amaranthus and spinach. The snails were starved for one day before and then the food was given. Each food item was weighed (50 gm) were fed to the snails in the early morning. The leftover food materials again were weighed in the next morning and subtracted from the initial weight. The consumption of food and dietary preference activity on individual feedstuff was measured, hourly from 06:00 to 00:30 hr daily for 15 days. The main items of food in the order of preference were noted. The following sign have been used to represent the relative food preference of snail: ++++ Sign high acceptance of food, +++ sign moderate acceptance of food, ++ Sign indicates rarely acceptance of the snail to feed, + Sign indicated the poor liking of the snail to feed (very rarely acceptable) and - Sign indicates the negative response for feeding on the material and rejection of food.

Gut content analysis

In order to study the food preference of *C. bistrialis* under natural habitat, snails were collected and brought to the

laboratory. The specimen was weighed separately and then dissected for the collection of gut contents. The collected guts contents were emptied in to the watch glass. The composition of the gut contents were identified under the microscope and the same were analyzed qualitatively by eye estimation and quantitatively by weighing the contents.

OBSERVATIONS AND RESULTS

Food preference of *C. bistrialis*

The dietary preference of *C. bistrialis* under laboratory conditions was presented in the table 1. The present study indicated that this snail was strictly herbivorous and feeding mainly on fresh vegetables with higher water content. The snail showed stronger preference and intense liking with high acceptance of food towards carrots, cabbage, cucumber and chow chow. It was also observed that they were actively feeding on radish and papaya showed moderate acceptance of food. The Snake guard and Cauliflower were rarely accepted. Beat root and Spinach very rarely accepted by the snail, indicated the poor liking of the snail to feed. The snails showed negative response for feeding on the *Amaranthus* and Onion and completely rejected. Hence snails preferred more succulent vegetable and fruits under laboratory condition. Further, the snails were invariably gather around the food material and fed on them voraciously. However, snails kept under forcible longer period of starvation were found to feed on other available materials.

Food preference of *C. bistrialis* observed in natural habitat showed that feeding mainly on fresh leaves of cultivated and wild garden plants. During winter, when the vegetation is available in plenty in all the habitats of the study area, they eat whatever the vegetation that is available and are not very selective. At times, they feed on fruits and vegetables.

The findings of the gut content analysis of *C. bistrialis* (table 2) inferred that the land snail is majorly consuming mud (30.21%) and sand (26.39%) and small amount of green matters (15.10%).

Feeding behavior of *C. bistrialis*

The feeding behavior of the *Cryptozona bistrialis* was studied under laboratory condition during the feeding biology of the snail. It remains active and feeding in early morning and late evening. Snails were fed mostly during the nocturnal period and they fed on the most preferred feed stuffs and within the periods of peak feeding behavior for optimal performance and to minimize wastage. Peak activity for the species occurred after nightfall whereas peak feeding occurred when temperatures were between 18 and 23°C and relative humidity was between 70% and 85%. During hot, dry summer months they may become motionless or are compelled to aestivate.

During field observation the consumption of food by the snail could be detected by the opening of mouth and the movement of jaws on the food materials. Crawling snails while feeding will lower either all four tentacles or only

anterior two tentacles, when not feeding, usually have their tentacles extended upwards. Also the movements of feeding snails are slower than that of the crawling ones.

Table 1. Food preference of *C. bistrialis* under laboratory condition.

S. No.	Name of food item	Botanical name	Feeding response
1	Carrots	<i>Daucus carota</i>	++++
2	Cabbage	<i>Brassica oleracea</i>	++++
3	cucumber	<i>Cucumis sativus</i>	++++
4	Chow chow	<i>Sechium edule</i>	++++
5	Radish	<i>Raphanus raphanistrum</i>	+++
6	Papaya	<i>Carica papaya</i>	+++
7	Snake guard	<i>Trichosanthes cucumerina</i>	++
8	Cauliflower	<i>Brassica oleracea</i>	++
9	Beat root	<i>Beta vulgaris</i>	+
10	Spinach	<i>Spinacia oleracea</i>	+
10	Spinach	<i>Spinacia oleracea</i>	+
8	Amaranthus	<i>Amaranthus polygonoides</i>	-
9	Onion	<i>Allium cepa</i>	-

++++ Sign indicates the intense liking of the snail to feed (highly acceptable).

+++ Sign indicates the high liking of the snail to feed (moderately acceptable).

++ Sign indicates the liking of the snail to feed (rarely acceptable).

+ Sign indicates the poor liking of the snail to feed (very rarely acceptable)

- Sign indicates the negative response for feeding on the material (unacceptable).

Table 2. Gut content analysis of land snail *C. bistrialis*.

S. No.	Gut content	Food groups (%)
1.	Mud	30.21
2.	Soil	26.39
3.	Others	15.10

DISCUSSION

Feeding behavior

Pulmonates are in general herbivorous but they also accept animal corpses. The terrestrial pulmonates commonly eat the vegetation available in their habitat and are not very selective (Hyman, 1967). It is well known that the density of any animal population in an ecosystem is mainly influenced by food availability. Therefore the terrestrial snails tend to inhabit gardens, green lawns, open wood lands and other similar habitats (Purchon, 1968). Snails use plants as refuges and are thus protected from enemies, evaporation from extremes of temperature and other unfavorable environmental conditions (Runham and Hunter, 1970). External factors that influence food behaviour include abundance and distribution of food material, presence of competitors, risk of predators, season

and time of day (Gillete *et al.*, 2000; Scott *et al.*, 2005). The snails are mostly active at night and hide during the day (Ademolu *et al.*, 2011). Snails are polyphagous (Chevalier *et al.*, 2000). They feed on a variety of plant materials (leaves and fruits) as well as on decaying organic matter (Albuquerque *et al.*, 2008; Ademolu *et al.*, 2011).

Cryptozonia bistrialis is an omnivorous snail, feeding mainly on fresh leaves of cultivated and wild garden plants. At times, it feeds on fruits, fresh leaves, and fleshy vegetables. In addition to that in the natural condition, it feeds on dead animals, decaying matter, kitchen wastes, excreta of human, dog and cow dung and occasionally exhibiting cannibalism. Sand is consumed normally by the snail and is necessary for the proper functioning of the gizzard in the crushing of the food particles. Under forced conditions, it feeds on humus, fungus, lichens and decaying wood pieces that are available in the vicinity but has no particular food preference.

Observation in the present study have revealed that *Cryptozonia bistrialis* is a herbivorous snail feeding on the fresh leaves of cultivated plants mainly feed on fruits and vegetables. At noon, it takes rest in trees or small vegetation to avoid the warmth of the day.

C. bistrialis was not feeding continuously but after about 10 to 20 minutes break it repositioned and consumed the remaining matter in laboratory condition. Some land snail groups, such as the Streptaxidae, are almost entirely carnivorous, often attacking and feeding on other land snails. While most land snails are essentially detritivores, feeding on dead plant matter, many supplement their diet with animal material (Runham, 1978) and will opportunistically feed on dead snails. This is likely to be the case reported here. Cannibalism is also noticed in *C. bistrialis* as found in *M. indica* though they never try to kill other members of the community. The snails often feed on the dead individuals of their own species (Jahan *et al.*, 2001).

Generally *Cryptozonia bistrialis* were active during the rainy season (October-December). It exhibits "roaming behaviour" and seemed to move on the soil in the early morning and late evening according to the availability in the study area. Most of the snails were trampled on pathways and road sides during the rainy season. The snails were aggregated and formed into groups soon after the rain especially in front of light source during the night hours.

During the study periods it was observed in summer months, when the snails are exposed to dry environmental conditions, the snails aestivate by the aperture is temporarily closed by a calcified material known as epiphragm which is a whitish, fragile material. The snails bury themselves in the soil or hide beneath the stones or adhere to any substratum like the stem or lower surface of the leaves or the surface of the walls of buildings or trees in order to avoid direct solar radiation. The epiphragm helps to minimize the rate of evaporation from the soft part of the snails enclosed within the shell and prevent desiccation of the snail during aestivation. Often they are found buried under the wet humus layer of the soil. The snails were aggregated into large groups of similar size and exhibited 'huddling behaviour' during aestivation.

Food preference

Cryptozona bistrialis is a generalist consuming a large number of plants. Morton (1979) has reported that the terrestrial pulmonates commonly eat the vegetation available in their habitat and are not very selective. Kohn (1983) has stated that pulmonates are adapted to eat herbage of nearly any kind. They are not restricted to particular species or particular part of plants. They are non-selective feeders. Most of them are only moderately specialized. *Arion empiricorum* ate 158 out of 197 plants offered (Froming, 1954). Froming (1956) has also reported that *Rumina decollata* 73 out of 90 wild plants in its natural habitat. *Limax aroestis* and *Amalia carinata* feed almost entirely on green food and are most destructive in gardens (Cooke, 1959). Ramasubramaniam (1979) has stated that *Achatina fulica* feeds on all kinds of vegetation without food preference. Senthilkumar and Thirunavukkarasu (1989) have reported that *C. bistrialis* feeds on the garden plants which contain high amount of water and lime. The present investigation on the food preference of *C. bistrialis* observed in the Coconut plantation, Groves, Plantain plantation and domestic area showed that the snails were more abundant in domestic area. In gardens it prefers certain plants due to their abundant availability and palatability. The similar finding was reported by Takeda and Hiroshi (1988) on *A. fulica* which is most abundant in sites with high human density. It may be also inferred that *C. bistrialis* has no particular food preference and eats almost everything available.

Analyzing the gut contents in the gut of an animal is indicative of the food materials consumed by it. The food may also determine choice of a particular habitat where the preferred food is available in adequate amounts. Thus, a study of diet in analyzing the gut contents is useful in examining habitat preference. In a study of animal population biology, food is one of the important factors affecting the distribution and abundance of a species. Food may influence a population's chance to survive or multiply by modifying the fecundity, longevity or development of individual members in that population.

The snails are mainly nocturnal when they feed most readily. The results of the gut content analysis of *C. bistrialis* showed that the snail gut contained predominantly mud and sand as well as considerable amount of green matters. Hence the present investigation proved that this land snail having a broad diet and feeding preferences range widely (plant and animal detritus, green algae, bacteria on decaying plant material in addition to mud and sand. Hence *C. bistrialis* is largely herbivorous but equally opts for dead snails. These observations provide the basis for a better understanding of the food preference of the land snail.

CONCLUSION

C. bistrialis is a nocturnal land snail forming an integral constituent of the soil/ leaf litter ecosystem, playing vital role in nutrient recycling. It is a herbivorous/ omnivorous and mainly preferred to eat more succulent vegetable and fruits. But the feeding is not very selective. It

is not restricted to particular species or particular part of plants. It has the ability to choose and to recognize its preferred feed stuffs subsequently. More research is needed in future to get more information on its feeding.

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