

FOOD AND FEEDING BEHAVIOUR OF THE LAND SNAIL, *MACROCHLAMYS NUDA* (PFEIFFER) (STYLOMMATOPHORA: ARIOPHANTIDAE) FROM KUMAON HIMALAYAN FORESTS

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Abstract

The food and feeding behaviour of the land snail, *Macrochlamys nuda* were investigated under laboratory and field conditions during 1995. Of the 39 species of plants including trees, weeds, pteridophytes, bryophytes, ornamental flowering plants and vegetable plants, were offered for feeding in laboratory, 28% were rejected by the snail. Twelve species of plants viz - *Urtica parviflora*, *Rubia cordifolia*, *Sonchus asper*, *Poa annua*, *Galinsoga ciliata* (weeds), *Iris germanica* (flowering plant), *Raphanus sativus*, *Brassica oleracea* var. *botrytis*, *Brassica oleracea* var. *gemmifera*, *Cucurbita pepo*, *Cucumis melo*, *Coriandrum sativum* (vegetable plants) were highly acceptable. Ornamental and vegetable plants were preferred to wild plants. This species was not found to be carnivorous and is selective in choosing its food plants. All 5 species of trees and 3 species of bryophytes offered were completely rejected by the snail.

Key words

Macrochlamys nuda, Kumaon Himalayan forests, feeding, laboratory food palatability experiment, acceptability index, faecal analysis.

Introduction

Terrestrial snails play a significant role in the functioning of forest ecosystem. Mason (1970), Seifert and Shutov (1979) have demonstrated that these animals are important transformers of leaf litter in forests, as most of the particulate leaf litter are broken down first by these organisms, thereby increasing the surface/volume ratio for colonization of microbes which bring further degradation and mineralization of the litter.

Various attempts have been made to breed molluscs on artificial diets and it has been shown that different diets result in considerably different growth rates in molluscs (Williamson & Cameron, 1976). Food and feeding behaviour of different species of land molluscs have been studied by Pangga (1949), Wittich (1953), Fromming (1954, 1956), Getz (1959), Mead (1961), Ghose (1968), Ghose and Halder (1969), Ghose *et al.* (1969), Grime *et al.* (1968), Mason (1970), Jennings and Barkham (1975, 1976, 1979), Chatfield (1976), Seifert and Shutov (1979), Raut and Ghose (1983), Chang (1991), Oli (1996) and Gupta and Oli (1997). These studies have shown that food and feeding habits also determine

choice of a particular habitat (Drichamer & Vessey, 1982; Crawley, 1983).

In the present study food and feeding habit of the land snail, *Macrochlamys nuda* was studied and the findings are presented here.

Materials and Methods

Mature individuals of *M. nuda* were collected from Gethiya, situated at an altitude of 1800 m above sea level and is bounded by 29°22' N lat. and 79°29' E long. Temperature and humidity at the collecting site ranged between 22-23°C and 67-72% while mean values of pH, moisture content and organic matter were 6.6, 25% and 8% respectively. The rocks in the area are chiefly crystalline, metamorphic granites, gneisses and schists (Wadia, 1975). The climate of the study area is temperate. The year is divisible into four seasons: winter (mid Nov. to mid March), summer (mid March to mid June), rainy (mid June to mid Sept.) and autumn (mid Sept. to mid Nov.). The rainfall is rather seasonal, most of the precipitation (80-90%) occurs during monsoon months. The average annual rainfall is 2153mm.

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At the site, temperature of surface soil was recorded by a mercury thermometer and relative humidity by a hygrometer. For recording soil pH, moisture content, total organic matter etc. a sample of 500g soil from the site was collected in plastic bags and brought to the laboratory. pH was measured by digital pH meter while soil moisture was determined by weighing before and after drying (at 105°C) the soil samples. Moisture was expressed as percentage of the dry weight of the soil. Organic matter content was determined by ignition loss method (Jackson, 1973) and expressed as a percentage of the dry weight of the soil.

The food and feeding behaviour of the snails was investigated by food palatability experiments, faecal analysis and field observations as detailed below:

Laboratory food palatability experiments: Mature individuals of *M. nuda* were collected from the natural habitat. They were maintained in the laboratory and provided with an excess quantity of discs of carrot root (*Daucus carota*). To ascertain food preference, 39 plant species were selected from a wide range including trees, weeds, bryophytes, pteridophytes, ornamental flowering plants and vegetable plants. The fresh leaves of 39 plant species used in the experimental tests were collected either from plants naturally established in the field (tree, bryophytes, pteridophytes and weed species) or from cultivated areas (ornamental and vegetable plants). Only fully expanded non senescent leaves were collected. During the short period before they were used, the leaves were stored in polyethylene bags. The tree litters (twig, stem, bark, leaf, fruits) collected, however, were senescent. The flowers and the roots were also freshly collected. All feeding experiments were carried out during July and September, 1995 at Ecology Laboratory, D.S.B. Campus, Kumaon University, Nainital.

Various fresh parts of plants were weighed and supplied in excess immediately after the sunset. The left over plant materials were again weighed the next morning and subtracted from the initial weight. The quantity of food consumed was noted in terms of percent. The extent of feeding of different parts of plants was estimated on a 3 points scale: 0% indicated that none of the food was eaten, 1-50% indicated that food was moderately accepted and 51-100% indicated that food was highly accepted. In the observation tables, the following signs have been used to denote the relative food preference: '+' high acceptance of food, '+/-' for moderate acceptance and '-' is for rejection of the food. On the basis of quantity of leaves consumed by molluscs (i.e. Acceptability Index, A.I.) the plant species are rated as 'highly acceptable' or 'moderately acceptable'. This is standard method as described by Raut and Ghose, (1983) and Chang, (1991).

All the experiments were carried out in glass troughs with filter paper carpets kept saturated with distilled water at room

temperature (20 - 22°C). This maintained 100% humidity in most of the troughs.

The animals were starved for 24 hours and then given test food. Two mature individuals of *M. nuda* were used in the experiments.

Faecal analysis: Animals were collected from the natural habitat by random sampling and returned to the laboratory where they were wiped clean and transferred individually to clean petridishes. Faeces were collected from the dishes. Each faecal smear was examined under a compound microscope and the presence or absence of chlorophyll bearing plant material, mosses or unicellular algae or any other material was noted.

Field Observation: Field observations were also made in order to obtain information on the feeding behaviour and qualitative food selection of snails. Throughout the field study, casual observations on the feeding of the species was made.

Results and Discussion

The results of the laboratory food palatability experiment indicated that of the 39 species of plants offered, 28 were accepted while five species of trees and three species of bryophytes were completely rejected (Table 1). Among the 28 accepted species, 12 were most preferred while others were moderately accepted. The most preferred plant species were: *Urtica parviflora*, *Poa annua*, *Rubia cordifolia*, *Sonchus asper*, *Galinsoga ciliata* (weeds), *Iris germanica* (ornamental flowering plant), *Raphanus sativus*, *Brassica oleracea* var. *botrytis*, *Brassica oleracea* var. *gemmifera*, *Cucurbita pepo*, *Cucumis melo* and *Coriandrum sativum*. All these plants have soft epidermis and are succulent in nature which make them most preferable to the snail.

A number of wild plants have been reported to be consumed by molluscan species. Fromming (1954, 1956) reported that *Rumina decollato* (snail) ate 73 of 90 plant species, *Arion empiricorum* (slug) ate 158 of 197 plant species and *A. circumscriptus* (slug) ate 33 of 193 wild plants offered. Grime *et al.* (1968) reported that 49% of a total of 52 plant species tested were rejected by *Cepaea nemoralis* (snail). In Britain, majority of the land molluscs feed on wild plants (Chatfield, 1976). Chang (1991) has reported that 50% of the plant species offered to the snail, *Cepaea nemoralis*, were completely rejected. In India also, Raut and Ghose (1983) have demonstrated that a large number of wild plants are eaten by snails. In the present study *M. nuda* rejected 28% of the 39 plant species offered, while in another study Gupta and Oli (1997) found that *Macrochlamys glauca* (snail) rejected 30%, *Euaustenia monticola* (snail) rejected 34%, *Anadenus altivagus* (slug) rejected 25% and *Anadenus* sp. (slug) rejected 41% of the 56 plant species offered. This lack of acceptability could possibly be related to some chemical compounds or to low nutritional contents of the plants. High acceptability of certain plants could well be related to the high nutritional content in the leaves of these plants. These data demonstrated that the

Table 1. List of food plants and the portion of plants consumed by *Macrochlamys nuda*.

		Portion of Plants							
Plant Species		Twig	Leaf	Stem	Flower	Fruit	Bark	Root	Acceptability Index of leaf (%)
(A) Trees									
1.	<i>Quercus leucotrichophora</i>	-	-	-	No	-	-	-	0
2.	<i>Quercus floribunda</i>	-	-	-	No	-	-	-	0
3.	<i>Populus ciliata</i>	-	-	-	No	No	-	-	0
4.	<i>Pinus roxburghii</i>	No	-	-	No	No	-	-	0
5.	<i>Cedrus deodara</i>	No	-	-	No	No	-	-	0
(B) Weeds									
6.	<i>Urtica parviflora</i>	-	+	+/-	No	No	No	-	86
7.	<i>Rumex nepalensis</i>	-	+/-	+/-	No	No	No	-	42
8.	<i>Cirsium argyracanthus</i>	No	+/-	+/-	No	No	No	-	50
9.	<i>Rubia cordifolia</i>	No	+	-	No	No	No	-	55
10.	<i>Sonchus asper</i>	-	+	-	No	No	No	-	67
11.	<i>Oplismenus compositus</i>	No	-	-	No	No	No	-	0
12.	<i>Ipomoea</i> sp.	+/-	+/-	-	+/-	No	No	-	33
13.	<i>Trifolium repens</i>	No	+/-	-	No	No	No	-	39
14.	<i>Poa annua</i>	No	+	-	No	No	No	-	100
15.	<i>Impatiens scabra</i>	+/-	+/-	-	+	+/-	No	-	34
16.	<i>Impatiens amphorata</i>	+/-	+/-	-	+	+/-	No	-	27
17.	<i>Rumex hastatus</i>	No	+/-	-	No	No	No	No	5
18.	<i>Cynoglossum lanceolatum</i>	-	+/-	-	-	No	No	-	50
19.	<i>Galinsoga ciliata</i>	+/-	+	+/-	+	No	No	-	100
20.	<i>Achyranthes bidentata</i>	No	+/-	-	No	No	No	-	5
(C) Ornamental flowering plants									
21.	<i>Iris germanica</i>	No	+	+/-	+	No	No	+/-	100
22.	<i>Hemerocaulis flava</i>	No	-	-	+	No	No	-	0
23.	<i>Dahlia rosea</i>	+/-	+/-	-	+/-	No	No	-	38
(D) Pteridophytes									
24.	<i>Lepisorus sequipedalis</i>	No	+/-	-	No	No	No	No	15
25.	<i>Hypodematium crenatum</i>	No	+/-	-	No	No	No	No	10
26.	<i>Asplenium dalhousiae</i>	No	-	-	No	No	No	No	0
27.	<i>Selaginella chrysocaulos</i>	No	-	-	No	No	No	No	0
(E) Bryophytes									
28.	<i>Hyophila involuta</i>	No	-	-	No	No	No	No	0
29.	<i>Entodon plicatus</i>	No	-	-	No	No	No	No	0
30.	<i>Plagiochasma appendiculatum</i>	No	-	-	No	No	No	No	0
(F) Vegetable Plants									
31.	<i>Brassica napus</i>	No	+/-	No	No	No	No	No	20
32.	<i>Raphanus sativus</i>	No	+	No	No	No	No	+/-	80
33.	<i>Brassica oleracea</i> var. <i>botrytis</i>	No	+	No	No	No	No	No	70
34.	<i>Brassica oleracea</i> var. <i>gemmifera</i>	No	+	No	No	No	No	No	60
35.	<i>Cucurbita pepo</i>	+/-	+	+/-	+	+	No	No	75
36.	<i>Cucumis melo</i>	+/-	+	+/-	+	+	No	No	51
37.	<i>Phaseolus vulgare</i>	+/-	+/-	-	+	No	No	No	50
38.	<i>Zea mays</i>	No	+/-	No	No	+	No	-	0
39.	<i>Coriandrum sativum</i>	No	+	+/-	No	No	No	No	66

'+' = Most preferred, '+/-' = Preferred, '-' = Rejected, 'No' = Not offered.

acceptability indices of the plant species were not correlated with the availability of plant species in the field. Similar observations were also made by Grime *et al.* (1968) and Chang (1991).

The results of the experiment also indicated that ornamental and vegetable plants are preferred to wild plants by the snails studied. This result is in agreement with those of Pangga (1949), Mead (1961) and Raut and Ghose (1983) who reported that ornamental and vegetable plants are preferred presumably due to their succulent nature.

In the case of fresh plant leaves there was some indication that the choice of food was influenced by the presence of soft epidermis (for instance leaves of *Iris germanica*, *Dahlia rosea*, *Rumex nepalensis*, *Cucurbita pepo*, etc.). Leaves with hard surface seemed to be largely unpalatable (for example leaves of *Quercus* sp., *Pinus roxburghii*, *Cedrus deodara*, etc). Wittich (1953) has shown that leaves of several species of plants (for example, *Urtica* sp.) have a high protein content and this could increase their palatability.

In the present work also *Urtica parviflora* was vigorously eaten by this species of snail probably due to presence of high protein content.

Analysis of faecal matter indicated that this species consumed a high proportion of green plants. The excreta also contained a large proportion of unidentifiable materials. Small sized living nematodes were also seen in the faeces but there was no indication of animal material eaten in the faeces.

During field observation 179 snails were seen feeding on a variety of fresh, senescent and decomposing plant material (Table 2). The senescent leaves and fresh leaves of *U. parviflora*, which has AI. of 86% for its leaves were seen eaten by 37 snails.

It was not difficult to observe feeding since the animals were large. The consumption of food could be detected by the opening of mouth and movement of jaws. Crawling snails when not feeding, usually have their tentacles extended upwards, while feeding animals will lower either all four tentacles or only the anterior two. Also, the movements of feeding animals are slower than that of the crawling ones (Chang, 1991).

The field observations revealed that *M. nuda* tested in the present work fed on a variety of senescent and partially decomposed plant parts which probably could be due to the growth of fungal hyphae and bacteria on them. It is well known that microbes secrete strong cellulolytic enzymes which degrade the cell membrane (Ghose, 1968; Ghose & Halder, 1969; Ghose *et al.*, 1969) and that a considerable amount of nutrients stored in plant cells become available to animals feeding on such materials. Feeding on senescent and decomposing materials is thus related

Table 2. Food of *Macrochlamys nuda* from the field observation.

Plant species	No. of snails observed feeding	Plant parts
1. <i>Cynodon dactylon</i>	38	Leaves
2. <i>Urtica parviflora</i>	23	Leaves
	14	Decomposing leaves
3. <i>Rumex hastatus</i>	7	Leaves
4. <i>Achyranthes bidentata</i>	15	Leaves
5. <i>Ipomoea</i> sp.	5	Flowers
	3	Leaves
	4	Stem
6. <i>Rumex nepalensis</i>	5	Leaves
	8	Stem
7. <i>Oxalis latifolia</i>	4	Stem
	3	Leaves
	4	Senescent leaves
8. <i>Poa annua</i>	22	Leaves
9. <i>Galinsoga ciliata</i>	7	Leaves
10. <i>Vitex negundo</i>	2	Leaves
11. <i>Lantana camara</i>	15	Leaves

to some extent with the animals' nutrition. It has been found that feeding on decomposing materials enables consumption of more amount of food in shorter time and at the same time digestion is also facilitated (Raut & Ghose, 1983). This type of feeding in land molluscs may play an important role in the ecosystem by changing a considerable amount of resistant plant material to a state in which those could be easily degraded biologically by microorganisms in the soil.

The results presented in the Table 2 suggest that *M. nuda* feeds on dead plant materials including decomposing ones. The results of the food palatability experiments (Table 1) might appear to conflict with this view, since the molluscs readily ate a large number of green plant leaves. However, it must be emphasised here that in the food palatability experiments, the animals were being offered no alternative source of food and what they were offered might not necessarily be accessible to them under natural conditions.

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