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# FOOD PREFERENCE AND FEEDING BEHAVIOUR OF TWO PESTIFEROUS SNAILS, *ACHATINA FULICA* BOWDICH AND *MACROCHLAMYS INDICA* GODWIN-AUSTEN

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## Introduction

The giant African land snail *Achatina fulica* is a serious agrihorticultural pest in Indo-Pacific islands for more than a century. Since its introduction in Calcutta in 1847 it has spread to a number of Indian States viz. Assam, Nagaland, Manipur, Tripura, Bihar, Orissa, Uttar Pradesh, Tamil Nadu, Karnatak, Kerala and Andaman group of islands, as well as to some neighbouring countries viz. Nepal, Bhutan and Bangladesh.

Information from the Indian subcontinent on the economic status of *Macrochlamys indica*, an endemic species, is totally lacking, while some preliminary reports on *A. fulica* (Annandale, 1907; Behura, 1955; Ghose, 1962; Srivastava, 1966; Subba Rao, 1975; Raut, 1978) are on record. Contrast to this some what exhaustive studies have been made on the extent and nature of damage to different plants caused by *A. fulica* in Ceylon (Green, 1910a, b, c, d ; Mead, 1961), Malaya (Jarrett, 1923, 1931), Micronesia (Townes, 1946 ; Mead, 1961), Java (Riel, 1933 ; van Alphen, 1954), Sumatra (Esaki and Takahashi, cited in Mead, 1961 ; Lange, 1950), Philippines (Pangga, 1949), Palau Islands (Hatai and Kato, 1943), Hawaiian islands (Weel, 1948-49 ; Mead, 1961), Chichi Jima (Mead, 1961), Tinian (Chamberlin, 1952) and Koror (Kondo, 1950a, b). To fill the lacuna in our knowledge on the economic status of *A. fulica* the infested areas of West Bengal were surveyed during the period 1974 to 1978.

## Materials and Methods

Breeding of *Achatina* and *Macrochlamys* is monsoon dependent. It starts in both the species from the end of July in West Bengal, and the highest number of broods are obtained by the middle of July. By early November, the usual period of commencement of aestivation the young snails are found 100 to 120 days old. Aestivation, though interrupted by occasional showers continues till the advent

of next rainy season. On the average, in West Bengal, the life span of *A. fulica* and *M. indica* is 5 anb 3 years respectively. Young snails constitute a high per cent in a population, and as the damage is directly proportional to the number and size of the pest, snails of five different age groups viz. newly hatched, 60, 120, 365 and 730 days old of both the species were considered for the study.

*Field observations* :

The feeding habits and food preference of *A. fulica* and *M. indica* of different age groups were recorded from their natural habitat in the infested areas of West Bengal for a period of 5 years, 1974 to 1978. Feeding mechanism was studied in the evening—the peak period of feeding. The food preference was assayed from the extent of damage to food-plants.

*Open-air cage observations* :

With the initiation of consumption of plants food since hatching 200 young healthy snails of each species obtained from broods of cage reared specimens were transferred to a cage. The number was reduced to 100 for 30 days old snails. For older snails the number was 100 for each age group.

Snails of one age group were housed in a cage measuring 200 × 200 × 240 cm. the roof and the walls being made of fine polythene netting. The floor was covered with 8 cm deep loose, moist soil. The dead snails were replaced by individuals of the same age from reserve stock.

To ascertain food preference, plants were selected from a wide range including vegetables, fruit plants, fibre plants, oil producing plants, flower plants, ornamental plants and wild plants. Flowers and fruits were not removed from the twigs. Fresh plants were weighed, and supplied in excess immediately after the sun set.

In the next morning the left over plants were weighed and subtracting it from the initial weight the amount consumed was expressed in terms of per cent. The food consumption was maximum in June to October period, the period of highest activity, and this was considered as 100%.

The investigation started on July 16, 1974 and continued till July 15, 1975. The snails were kept active by occasional spraying of water.

The following plants were supplied :

*Vegetable plants*

1. Amaranth (*Amarantus* spp.)
2. Black bean (*Dolichos lablab*)

3. Cabbage (*Brassica oleracea*)
4. Drum stick (*Moringa indica*)
5. Garden spinach (*Spinacea oleracea*)
6. Gourd (*Cucurbita maxima*)
7. Lady's finger (*Hibiscus esculentus*)
8. Lettuce (*Lettuca sativa*)
9. Redish (*Raphanus sativus*)
10. Soybean (*Glycine max*)
11. Tomato (*Lycopersicum esculentum*)

***Fruit plant***

12. Papaya (*Carica papaya*)

***Fibre plants***

13. Cotton (*Gossypium herbaceum*)
14. Jute (*Corchorus* spp.)

***Oil producing plant***

15. Castor (*Ricinus communis*)

***Flower plants***

16. Marigold (*Tagetes patula*)
17. Zinnia (*Zinnia linearis*)

***Ornamental plant***

18. Vernonia (*Vernonia scandens*)

***Wild plants***

19. American life plant (*Bryophyllum pinnetum*)
20. Berakalmi (*Ipomea* sp.)
21. Kalkasunda (*Cassia sophera*)
22. Synedrella (*Synedrella nordiflora*)

## OBSERVATIONS

### Field

*Achatina fulica* :

The favourite haunts of *A. fulica* are in and around human habitation. Occasionally, they are found in areas far from human habitations. In wild areas, lacking cultivated plants they thrive equally well on wild plant species. In spite of differences in the amount of rainfall, temperature and humidity in different zones of West Bengal, preference is always for the same plant species, cultivated or wild, if it is available.

TABLE 1. List of food-plants and the portion of plants consumed by *A. fulica* and *M. indica* ('+' most preferred ; '±' preferred ; '—' not consumed)

| PLANT SPECIES | PORTION OF PLANTS | | | | | | |
|---|---|---|---|---|---|---|---|
| | Twig | Stem | Bark | Leaf | Floral bud | Flower | Fruit |
| VEGETABLE PLANTS : | | | | | | | |
| Amaranth (*Amarantus gangeticus, A. viridis*)* | + | + | + | + | + | — | — |
| Bean (*Dolichos* spp. ; *Glycine max*)* | + | + | — | + | + | + | + |
| Bitter gourd (*Momordica charantia*) | + | — | — | + | — | — | — |
| Cabbage (*Brassica oleracea*)* | + | + | + | + | — | — | — |
| Carum carui (*Momordica cochinchinensis*) | + | + | + | + | — | — | — |
| Chilly (*Capsium* spp.) | + | — | + | + | — | — | — |
| Drum stick (*Moringa olefera*)* | — | — | — | + | — | — | — |
| Fig (*Ficus hispida*) | — | — | + | + | — | — | — |
| Garden spinach (*Spinacea oleracea*) | + | — | — | + | — | — | — |
| Gourd (*Cucurbita maxima*)* | + | + | + | + | + | + | ± |
| Khamalu (*Dioscorea alata*)* | + | + | — | + | — | — | — |
| Lady's finger (*Hibiscus esculentus*) | + | + | + | + | + | + | + |
| Lettuce (*Lettuca sativa, L. indica*)* | + | + | + | + | — | — | — |
| Mankachu (*Amorphophallus campanulatus*) | — | — | — | ± | — | — | — |
| Puni (*Basella rubra*) | + | + | + | + | — | + | — |
| Radish (*Raphanus sativus*)* | — | + | + | + | — | — | — |
| Tomato (*Lycopersicum esculentum*) | + | — | — | + | — | — | ± |
| Sponge gourd (*Luffa* spp)* | + | + | + | + | + | + | ± |
| FLOWER PLANTS : | | | | | | | |
| Balsam (*Impatiens balsamina*)* | ± | — | — | + | — | + | — |
| Bauhinia (*Bauhinia accuminata*) | — | — | — | ± | — | + | — |
| Bougainvillea (*Bougainvillea spectabilis*) | — | — | — | + | — | — | — |
| Canna (*Canna indica*) | — | — | — | ± | — | + | — |
| China rose (*Hibiscus rosasinensis*) | + | ± | ± | + | + | + | — |
| Chrysanthemum (*Chrysanthemum* spp.)* | + | + | + | + | + | + | — |
| Clitoria (*Clitoria ternatea*)* | + | — | — | + | — | + | — |
| Cosmos (*Cosmos* sp.)* | + | + | + | + | + | + | — |
| Dhalia (*Dhalia* sp.) | — | — | — | + | — | ± | — |
| Gardenia (*Gardenia florida*) | — | — | — | + | — | — | — |
| Jasmin (*Jasmin sambac*) | — | — | — | ± | + | ± | — |
| Kathchampa (*Plumeria acutifolia*) | — | — | — | ± | — | — | — |
| Land lily (*Hibiscus mutabilis*) | — | — | — | ± | — | ± | — |
| Madhabilata (*Hiptage* sp.)* | — | — | — | ± | — | — | — |
| Marigold (*Tagetes patula*)* | + | + | + | + | + | + | — |
| Nine O'clock (*Portulaca* sp.) | + | + | + | + | + | + | — |
| Oleander (*Nerium odorum*) | — | — | — | + | — | ± | — |

| PLANT SPECIES | PORTION OF PLANTS | | | | | | |
|---|---|---|---|---|---|---|---|
| | Twig | Stem | Bark | Leaf | Floral bud | Flower | Fruit |
| Rose (*Rosa* spp.) | — | — | — | + | — | + | — |
| Sunflower (*Helianthus annus*) | + | + | ± | + | + | + | — |
| Vernonia (*Vernonia scandens*) | — | — | — | + | — | — | — |
| Vinca (*Vinca rosea*) | — | — | — | ± | — | — | — |
| Zinnia (*Zinnia linearis*) | — | — | — | + | — | — | — |
| FRUIT PLANTS : | | | | | | | |
| Banana (*Musa sapientum*) | — | — | — | ± | — | — | — |
| Cucumber (*Cucummis sativus*) | + | + | + | + | + | + | + |
| Guava (*Psidium guava*) | + | — | — | ± | — | — | — |
| Papaya (*Carica papaya*) | + | + | + | + | + | + | + |
| Star-apple (*Eugenia* sp,) | — | — | — | + | — | — | — |
| FIBRE PLANTS : | | | | | | | |
| Cotton (*Gossypium herbaceum*) | + | — | + | + | + | + | — |
| Jute (*Corchorus* spp.) | — | — | ± | + | — | — | — |
| BEVERAGES : | | | | | | | |
| Tea (*Thea sinensis*) | — | — | — | + | — | — | — |
| Coffee (*Coffea* spp.) | — | — | — | — | — | — | — |
| CEREALS : | | | | | | | |
| Maize (*Zea mays*) | — | — | — | + | — | — | — |
| Rice (*Oriza sativa*) | — | — | — | — | — | — | — |
| WILD PLANTS : | | | | | | | |
| Fig (*Ficus hispida*) | — | — | — | + | — | — | — |
| Pluchea (*Pluchea indica*)* | — | — | — | + | — | — | — |
| *Synedrella nordiflora* | + | + | + | + | — | — | — |
| *Allangana lamarcana* | + | — | — | + | — | — | — |
| ORNAMENTAL PLANTS : | | | | | | | |
| *Rheo discolor* | — | — | — | + | — | — | — |
| *Trichosanthus anguina* | — | — | — | + | — | — | — |
| *Bryophyllum pinnetum* | + | + | + | + | — | — | — |
| *Bryophyllum calynecium* | + | + | + | + | — | — | — |
| *Aloe indica* | — | — | — | ∓ | — | — | — |
| *Setcraesea* sp. | — | — | — | + | — | — | — |
| *Codaeum varaigata* | — | — | — | + | — | — | — |
| *Thuja orientalis* | — | — | — | + | — | — | — |
| *Poths scandens** | — | — | — | + | — | — | — |
| *Dieffenbachia picta** | — | — | — | + | — | — | — |

* The leaf or leaflets of the plant preferred by *M. indica*.

1

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**Photographs showing the nature and extent of damage of different food-plants caused by *A. fulica*. Fig. 1, Castor, Fig. 2, Cosmos, Fig. 3. Drumstick.**

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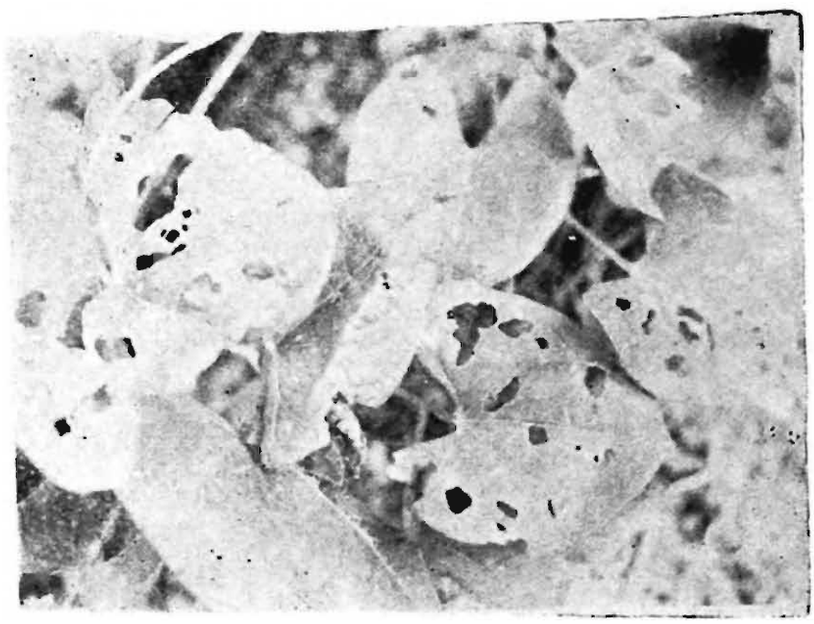

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Photographs showing the nature and extent of damage of different food-plants caused by *A. fulica*. Fig. 1. Lettuce (damaged one in the right hand). Fig. 2. Gourd, Fig. 3. *Dioscorea*.

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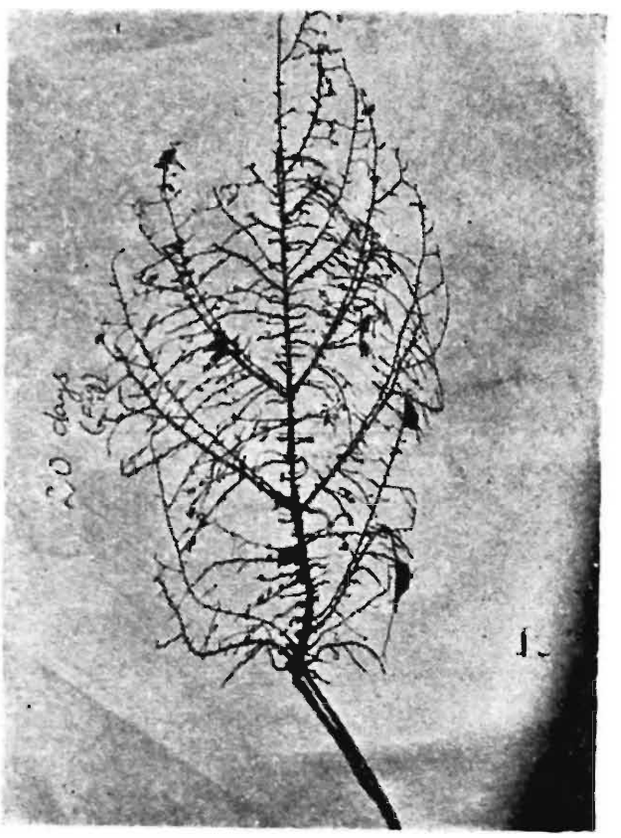


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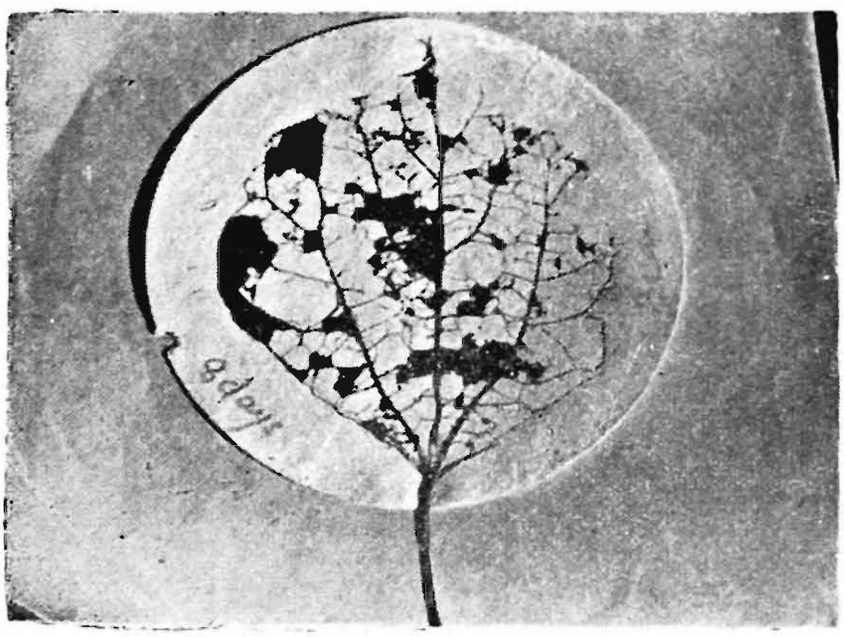
Photographs showing the nature and extent of damage of different food-plants caused by *A. fulica*. Fig. 1. *Rheo*. Fig. 2 *Pothos*. Fig. 3. Leaf of fig.



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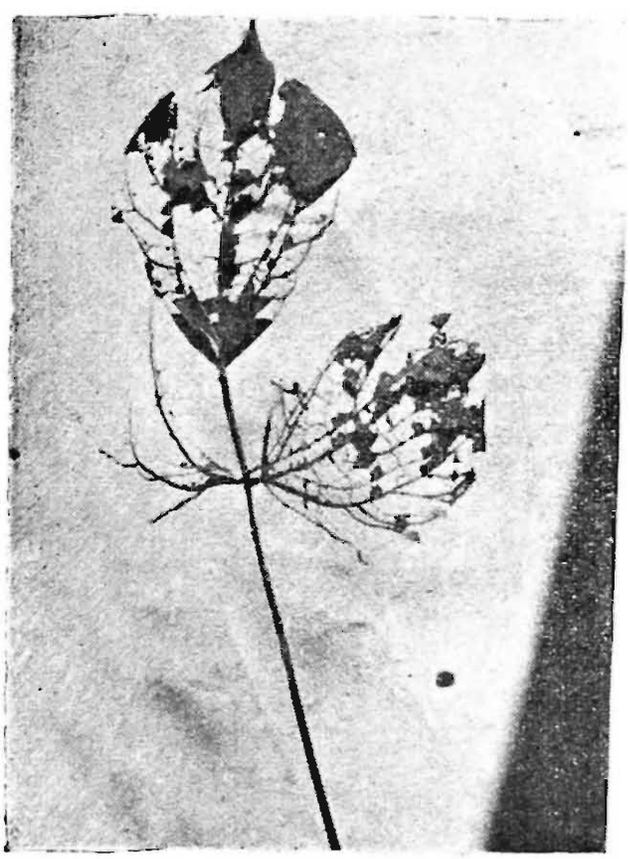

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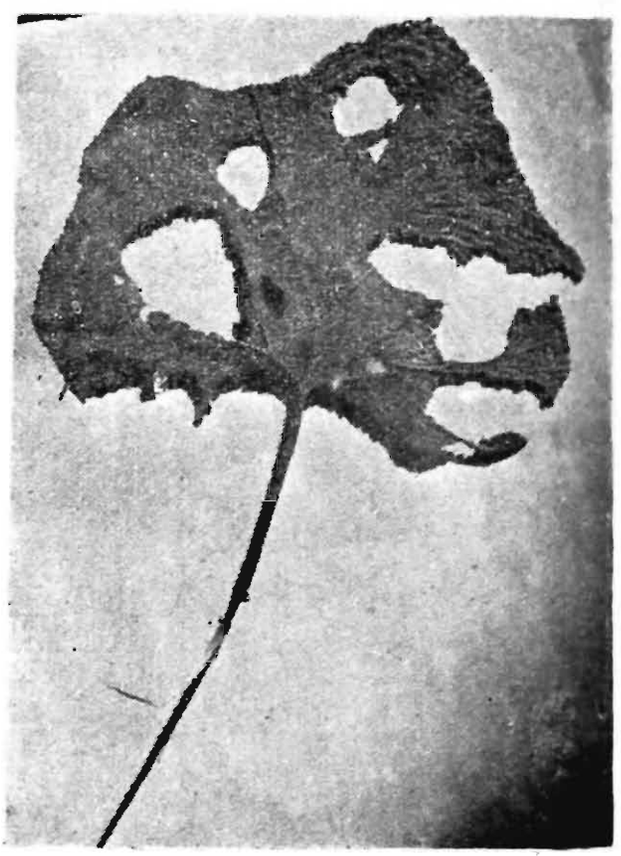

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Photographs showing the nature and extent of damage of different food-plants caused by *A. fulica*. Fig. 1. Leaflet of bean damaged by *A. fulica* of 6 to 8 days old. Fig. 2. Leaf of bean damaged by *A. fulica* of 14 days old. Fig. 3. Gourd leaf.

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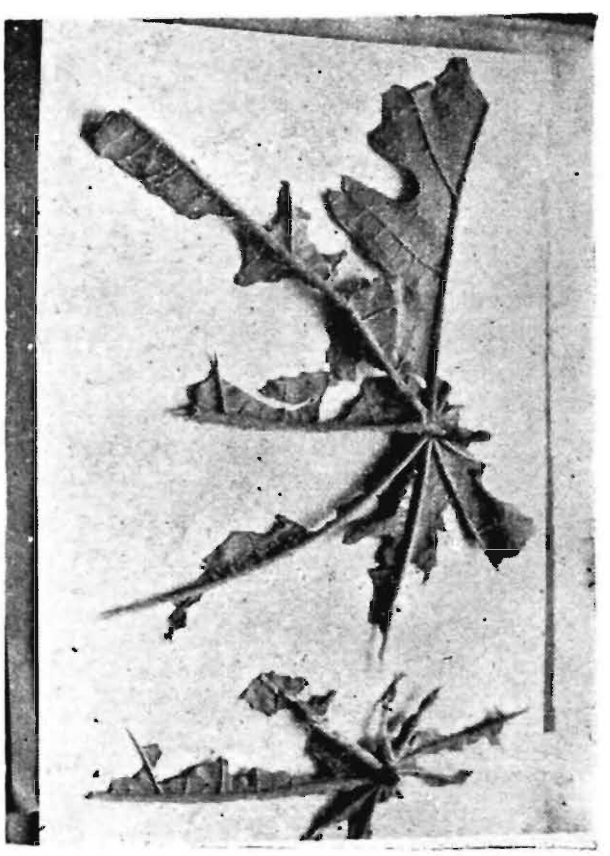

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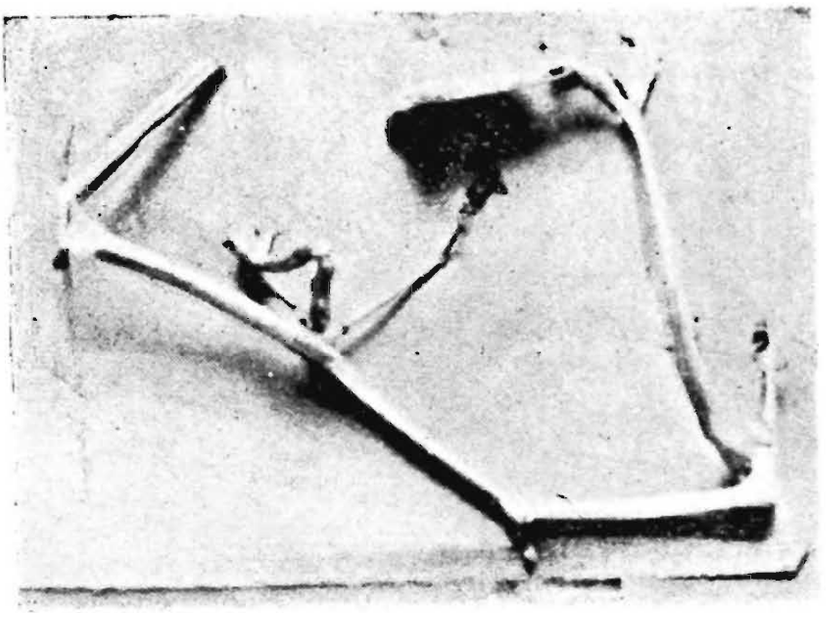
Photographs showing the nature and extent of damage of different food-plants caused by *A. fulica*. Fig. 1. Papaya leaf damaged by *A. fulica* of 25 days old. Fig. 2. Cotton leaf damaged by *A. fulica* of 27 days old. Fig. 3. Papaya leaf damaged by *A. fulica* of 28 days old.



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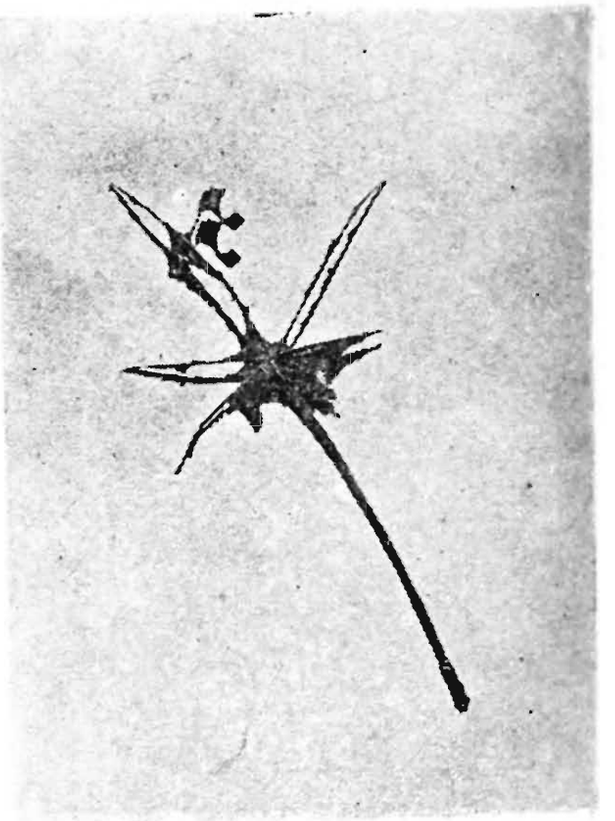

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Photographs showing the nature and extent of the leaves of different food-plants caused by *A. fulica*. Fig. 1. Gourd, Fig. 2. Castor, Fig. 3. Papaya.

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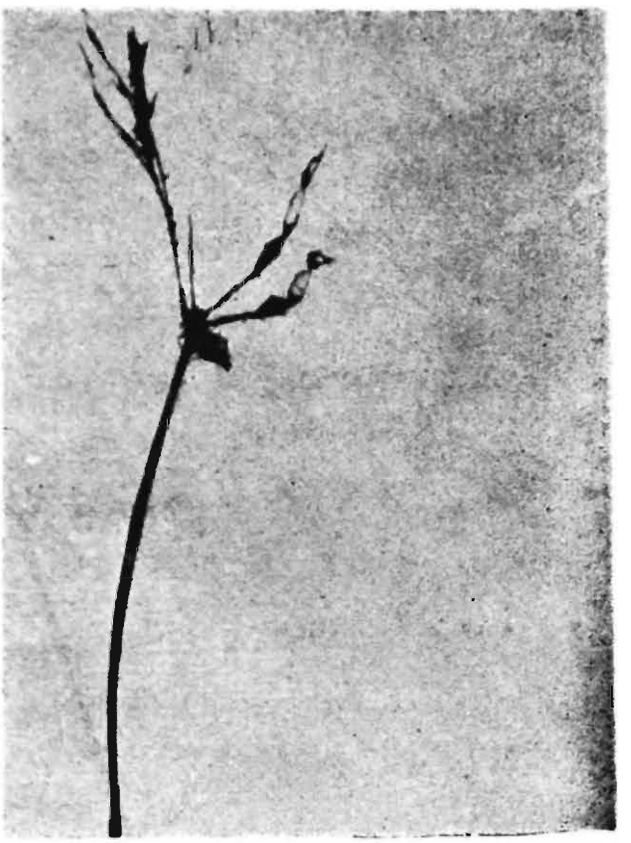

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Photographs showing the nature and extent of damage of plants or portion of the plants caused by *A. fulica*. Fig. 1. Radish, Fig. 2. Cotton leaf, Fig. 3. Leaf of papaya.

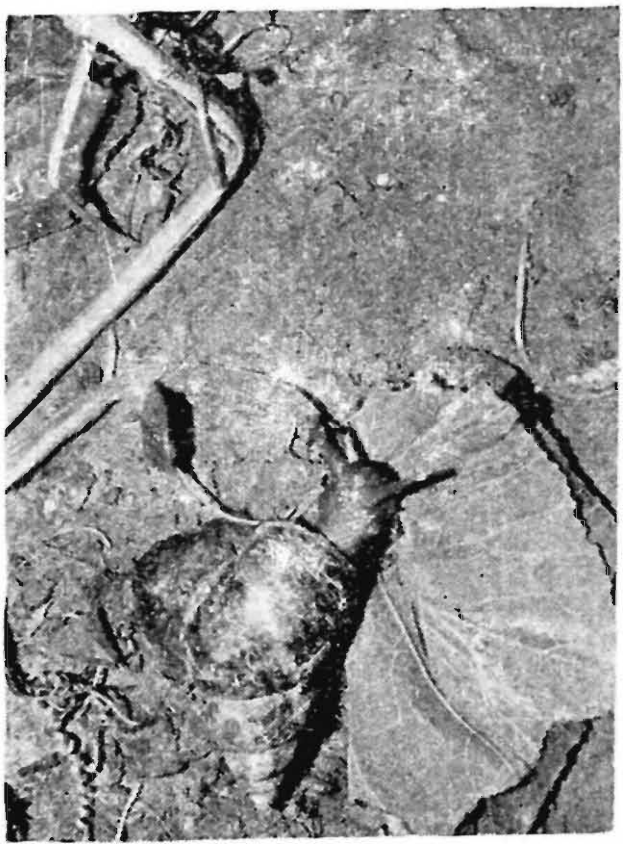

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**Fig. 1.** *A. fulica* eating the petiole of gourd leaf. **Fig. 2.** Bean leaf damaged by *M. indica*. **Fig. 3.** A group of *A. fulica* struggling for food.

Such a selection is not pronounced in snails depending entirely on wild plants. Observations on the food-plant preference have been shown in Table 1. The nature and extent of damage are very serious in some cases. The seedlings and young plants of castor (Plate V, fig. 1), leaves, twigs and bark of cosmos (Plate V, fig. 2), leaflets of drum stick (Plate V, fig. 3), the whole of lettuce (Plate VI, fig. 1) and gourd (Plate VI, fig. 2), leaves and twigs of *Dioscorea* (Plate VI, fig. 3), the whole of *Rheo* (Plate VII, fig. 1), leaves of *Pothos* (Plate VII, fig. 2) and lamina without ribs of fig (Plate VII, fig. 3) are preferred. Leaves of bottle gourd Lagenaria spp.) are also among the food item. Occasionally young *A. fulica* were observed to feed on the moss, *Semibarbula orientalis*.

*Macrochlamys indica* :

A good number of plants constitute the food of *M. indica* though the number is much less than that for *A. fulica*. Leaves of soft texture are liked most. The range of choice food-plants and the preferred zones are recorded in Table 1. However, a special preference to fallen and decomposed leaves and flowers of papaya, balsam, marigold, rose, china rose, castor, citrus and many other plants has been repeatedly observed.

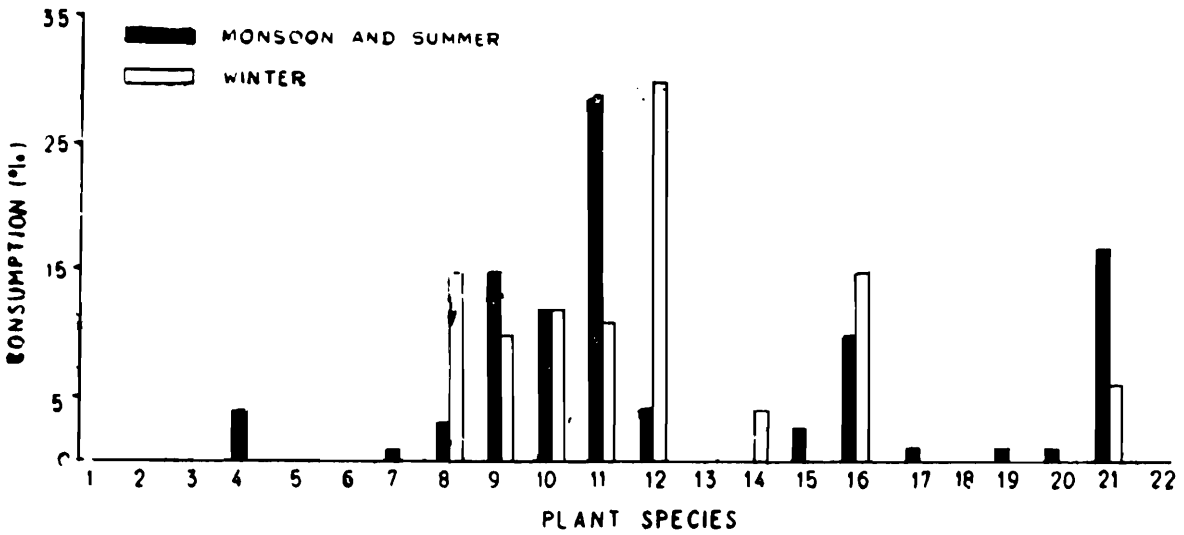
In some localities the snails have been observed to feed exclusively on the moss, *S. orientalis*. This moss species grow on old and damp brick walls and the snails live in the spaces between the bricks.

**Open-air cage**

Selection of food varied with age groups, seasons viz. monsoon, winter and summer in both the species *A. fulica* and *M. indica*. Selection of food in the snails kept active by artificial means was similar to that in monsoon.

The snails up to the age of 5 days ate only the broken and abandoned egg shells of the same brood. Feeding on plants started from the 6th day with the tender leaves of lettuce, beans (Plate VIII, fig. 1) and marigold. The veinules, and the petiole were not attacked till they were 14 days old. At this age they consumed whole of the leaf (Plate VIII, fig. 2) and by the 25th day started feeding on coarser leaves like those of gourd (Plate VIII, fig. 3), synedrella and amaranth. At this age they consumed whole of the leaves of lettuce, marigold, beans, synedrella and kalkasunda but the petiole was only slightly rasped. Coarser leaves like those of amaranth, papaya (Plate IX, fig. 1), jute, cotton (Plate IX, fig. 2) and cabbage were not attacked seriously. Selection and preference for food-plant and the nature of damage were almost similar in the snails 60 to 730 days old, while the younger ones restricted themselves mostly to soft plants.

Of the 22 species the most favoured plants were gourd, beans and marigold. However, in spite of adequate supply of the favoured plants, less favouted plants like synedrella, lettuce, papaya (Plate IX, fig. 3), tomato and zinnia were also consumed. In monsoon, the preferred food-plants in order of priority were gourd, marigold, lettuce beans, synedrella and American life plant (Text-fig. 1). The portions favoured



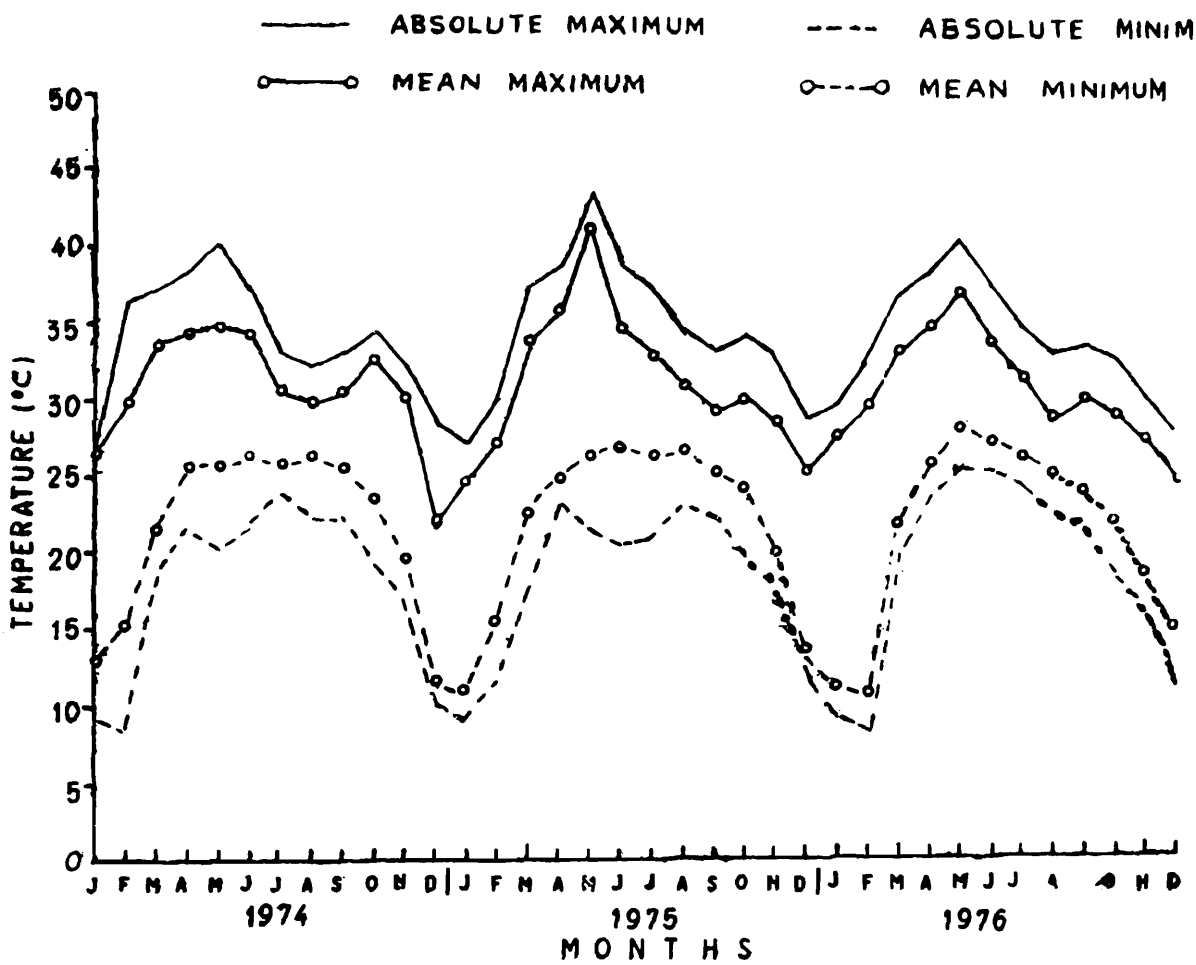

Text-fig. 1. Seasonal variation in food preference in *A. fulica*. 1 American life plant, 2 Kalkasunda, 3 Berakalmi, 4 Synedrella, 5 Vernonia, 6 Lady's finger, 7 Amaranth, 8 Cabbage, 9 Black bean, 10 Soybean, 11 Gourd, 12 Lettuce, 13 Drumstick, 14 Radish, 15 Garden, spinach, 16 Papaya, 17 Cotton, 18 Jute, 19, Tomato, 20 Castor, 21 Marigold, 22 Zinnia.

were the leaves, flowers, twigs and stem of gourd ; leaves, bark and growing region of marigold ; whole of the bean plant ; leaves, bark and growing regions of American life plant and tips of synedrella.

A favourable humidity range, 80 to 95 was maintained to keep the snails active. In winter this was maintained by spraying water with a low volume sprayer. In spite of all precautions the humidity often came down as low as 70 to 75 at noon in most of the days. The temperature range during the period was 8.6 to 26°C (Text-fig. 2), but in most of the days the temperature range during feeding was 8.6 to 10.4°C. The amount of food consumed in a 24-hour period was about 65% of that in monsoon (Text-fig. 3).

The cabbage was not a preferred food in monsoon but from November onwards the amount of cabbage consumed (Text-fig.1) was greater than that of gourd, though the snails severely damaged gourd (Plate X, fig. 2), castor (Plate X, fig. 2), papaya (Plate X, fig. 3), radish (Plate XI, fig. 1) and cotton (Plate XI, fig. 2) leaves. From about the beginning of the second week of December the snails started feeding on

succulent plants like cabbage, lettuce and American life plant and succulent parts of gourd and papaya. With the advent of winter and fall of humidity the snails preferred the ribs of the cabbage (Plate XI, fig. 3) and growing regions, petiole (Plate XII, fig. 1), floral



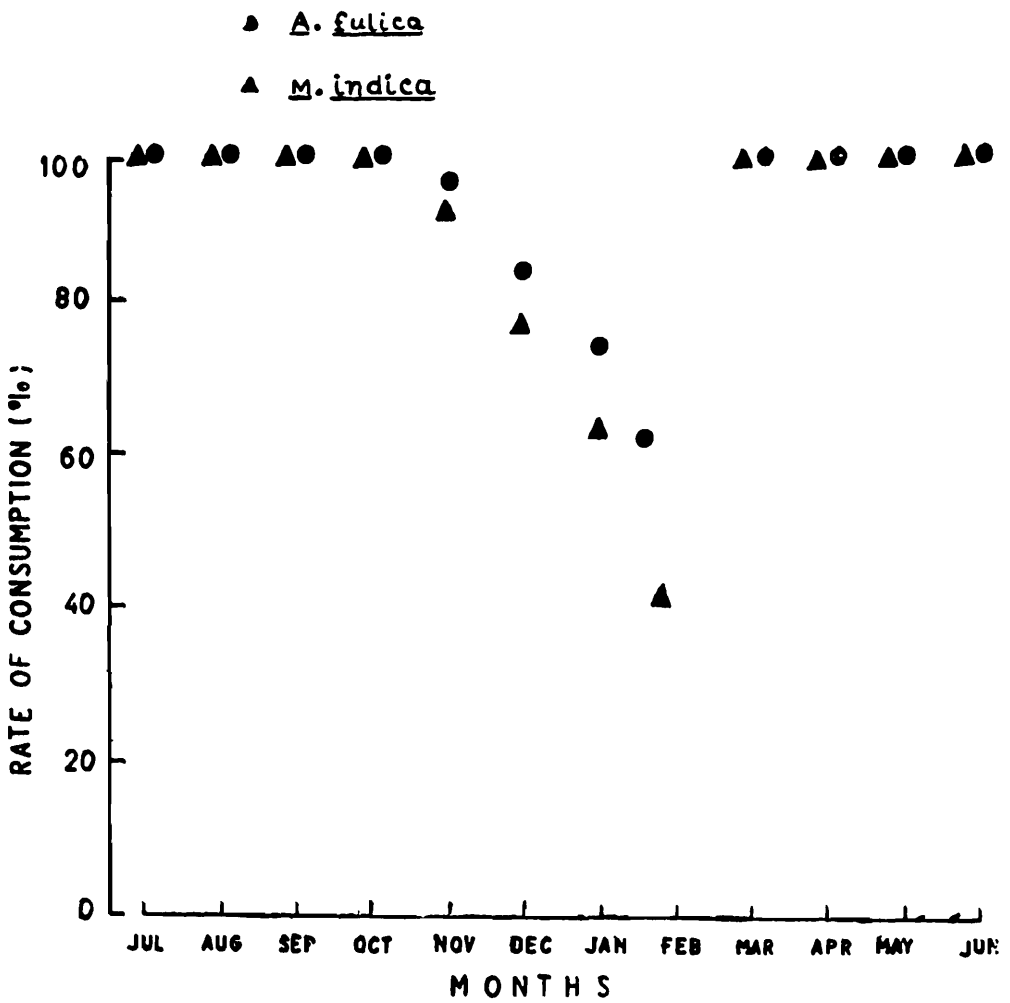

Text-fig. 2. The mean monthly temperature, the absolute maximum and absolute minimum temperature in the cage environment for the three years 1974 to 1976.

buds and chiefly the thalamus of flowers of gourd. By the third week of February, with the rise of temperature a change in food selection was recorded, and it gradually became to that similar in the monsoon. Specimens living on a very restricted number of plant species in nature and those maintained on a few selected plants since hatching showed food preference similar to those living on a wide food range when provided with other plants indicating that the feeding habit is probably genetically fixed.

*Macrochlamys indica* :

Contrast to *A. fulica* the newly hatched *M. indica* abstained from feeding for the first three days and swallowed only soil on the fourth day. Feeding on plants started on the fifth day and the plant food first consumed were young bean leaves (Plate XII, fig. 2.) Marigold

was eaten from the nineth day and consumption rate of bean leaves minus the ribs increased considerably. Synedrella and amaranth were eaten by the snails three weeks old. By this time they started feeding

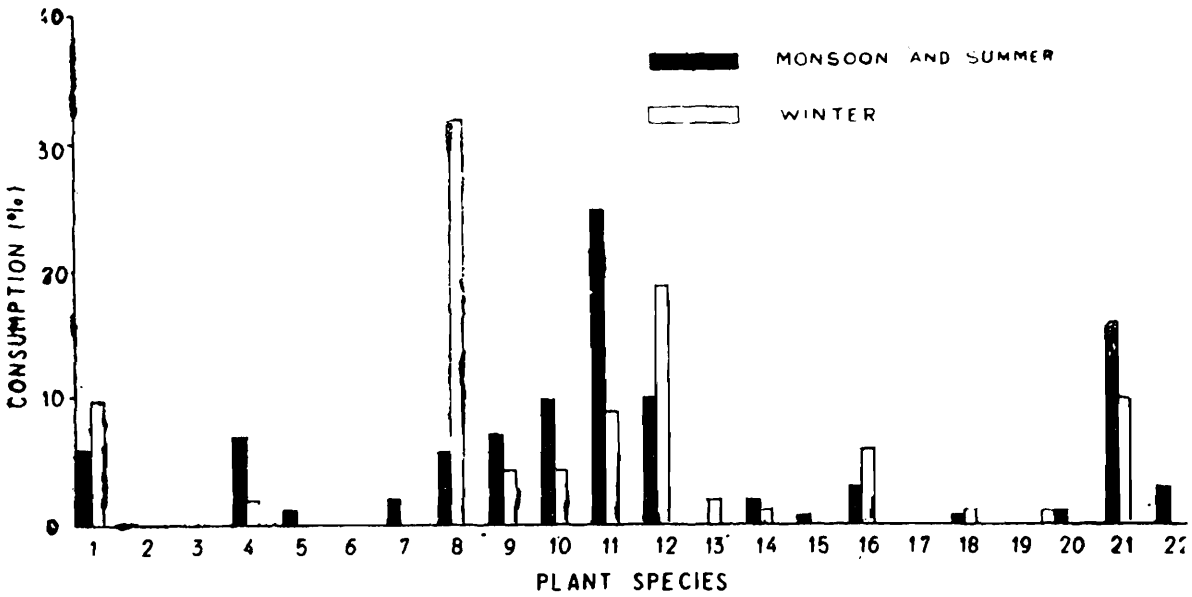



Text-fig. 3. Seasonal variation in the rate of food consumption by *A. fulica*, between 60 to 80 mm shell length and *M. indica* between 10.5 to 15.0 mm shell diameter.

upon coarser leaves like those of gourd, castor and papaya. In snails 30 days old, plant species in order of preference were beans, marigold and gourd (Text-fig. 4).


Text-fig. 4. Food preference in *M. indica*, 30 to 57 days old. (For explanations of plant species please see Text-fig. 1).

The number of plant species consumed by *M. indica* of about 60 days age group was more than that on which *A. fulica* of the same age group fed. The favoured food-plants in order of preference were gourd, beans, marigold, papaya and synedrella (Text-fig. 5). Even the fairly old snails, above 120 days age did not take principal veins of the leaves. The snails of all the higher age groups have similar food preference,




Text-fig. 5. Seasonal variation in food preference in *M. indica*. (For explanations of plants please see Text-fig. 1).

and the amount of food consumed was maximum during the period—middle of June to the middle of November (Text-fig. 3).

Food selection in winter was similar to that in *A. fulica* and preferred zones were veins of succulent plants. The stem of lettuce was avidly eaten by snails of all ages. The rate of food consumption was much less, 45% on the average in cooler months. Feeding and food preference in all age groups during summer were similar to that in monsoon.

*Feeding hours and duration* :

In sunny days, in monsoon, *A. fulica* in their natural habit start feeding from dusk. The period of feeding depends on the abundance of food, and may extend up to 03 hours next day. Aestivating snails activated by a heavy shower start feeding which continues for a few hours even if the day turns sunny after the rain.

*M. indica* emerge out of their shelter in search of food at least after one to one and half hour later than *A. fulica*. They feed for a shorter period of time, 19 to 01 hours. Similar to *A. fulica*, *M. indica* became active, after shower but feeding movement was restricted within a radius of about 100 cm from their shelter.

In cage environment feeding starts much earlier than that in the field. During day hours spraying of water induced feeding for a few hours in some of the snails.

*Feeding mechanism and behaviour* :

As a rule the snails of all ages start feeding from the margins of the leaves. In case the mouth can not reach the margin, a hole is first made on the lamina. The food is drawn towards the mouth with the help of extended labial palps. Occasionally the foot helps in the operation.

The labial palps, jaws and the radula, all work together in coordinated way during feeding and land snails consume food at a faster rate. The structure and functions of organs involved in feeding of land snails have been described in a number of species—*Helix pomatia* (Trappmann, 1916), *A. fulica* (Ghose, 1963), *Cryptozona semirugata* (Mantle, 1973), *Monacha cantiana* and *M. cartusiana* (Chatfield, 1976) and *Macrochlamys indica* (Das, 1977).

Feeding movement is rather fast, probably only second to breeding movement. The ocular tentacles extend to their maximum limit at a 45° angle with the substratum (ground). Momentary retroversion of the tip of the tentacles in contact with food is spontaneous. In the next moment the tentacles extend and feel the nature of food. By this time the labial palps are pressed against the food and feeding starts immediately.

A competition for food is pronounced in both the species. Fighting in the sense is absent owing to lack of offensive organs. This has been largely compensated by consuming a large amount of food in a shorter time. A new arrival often tries to dissuade others from feeding by crawling over the snails busy in feeding or by pushing the snout against it (Plate XII, Fig. 3). In the struggle stronger snails always win. A soft chuckling sound is often audible from a few feet distance when several snails eat on the same food-plant, but no such sound is audible if the same number of snails feed upon separate plants even in the same area, indicating fast eating rate in a competitive situation.

## DISCUSSION

The feeding habits and food-plants of land snails have drawn the attention of workers in many countries. Members of the family Cucurbitaceae probably top the menu of *A. fulica* in Ceylon (Green 1910c), Chichi Jima (Mead, 1961), New Britain (Dun, cited in Mead, 1961), Saipan (Lange, 1950), Tinian (Chamberlin, 1953), Philippines

(Pangga, 1949) and central parts of India (Srivastava, 1966). Our observations on both *A. fulica* and *M. indica* in West Bengal are in agreement with those of others. *Lagenaria* sp. is a choice of lower order, which has not been reported by previous workers. The highly valued economic plant bean, does not occupy the same status for *Achatina* in West Bengal as in Philippine (Pangga, 1949) and Saipan (Lange, 1950) but it is true for *M. indica* here.

The plant papaya is damaged by *A. fulica* in Ceylon (Green, 1910c), Sumatra (Heubel, 1938), Saipan (Esaki and Takahashi, cited in Mead, 1961 ; Lange, 1950), Palaus (Hatai and Kato, 1943), Micronesia (Townes, 1946), Philippines (Pangga, 1949), Koror (Kondo, 1950a, b) and Tinian (Chamberlin, 1952). *A. albopicta* is a known pest of papaya in East Africa (Williams, 1951). The high latex content of the floral buds, flowers and fruits of papaya make them vulnerable to severe damage from *Achatina*. In banana the skin is rasped by *A. fulica*. The fruit inside is not damaged but the market value is greatly reduced. Loss to banana cultivation is serious in all *Achatina* infested areas of the globe except Tinian (Chamberlin, 1952). In West Bengal *Achatina* is a serious threat to banana cultivation since the plantations offer an ideal habitat for the snails. Even in most unfavourable weather the snails were abundant in banana plantations.

Reports on the damage of beverages viz. tea and coffee by land snails are scanty and scattered. *Achatina* is not a serious pest of tea. Benthem-Jutting (1934, 1938) recorded eating up of shoots and flowers in Netherlands, but Heubel (1937, 1938) holds that in Sumatra the snails feed upon young leaves of tea when nothing else is available. On the other hand, tea is a major industry in Ceylon and no damage by *Achatina* has been reported from there (Hutson, 1920 ; Mead, 1961). In West Bengal only seedlings are attacked in nursery. Coffee is attacked by *A. cravini* Tanganyika (Salaam, 1938) and by *Ariophanta solata* and *Mariaella dussumieri* in India (Bhat and Viswanathan, 1972 ; Bhat and Shamanna, 1972 ; Bhat *et. al.*, 1973). Till now *A. fulica* has not reached the coffee growing areas of India.

The most favoured flower plants of *A. fulica* and *M. indica* are marigold, portulaca, cosmos and zinnia. Of the ornamental plants *Bryophyllum, Rheo, Trichanthus, Aloe, Setcreasea and Crinum* are preferred. Pangga (1949) holds that in Philippines ornamental plants are preferred to flower plants by *A. fulica*. Barring marigold, the situation in West Bengal is similar to that of Pangga (1949) in Philippines.

The ornamental plants are consumed presumably due to their succulent nature. Preference of *Bryophyllum calynacium* by *Achatina* to

*B. pinnetum* supports the idea. Interestingly, in widely separated countries *viz.* Malaya (South, 1923a, b, 1926), Sumatra (Feij, 1940), Ceylon (Macmillon, 1943), Hawaii (Weel, 1948-49), Philippines (Pangga, 1949) and Seychelles (Milsum, 1950) with different biogeographical conditions *A. fulica* feed on the same kind of ornamental plants.

Attack on vegetable plants *viz.* amaranth in Saipan (Lange, 1950) and Hawaii (Weel, 1948-49), cabbage in Philippines (Pangga, 1949) and Saipan (Lange, 1950), bitter gourd in Philippines (Pangga, 1946), chilly in Sumatra (Heubel, 1937, 1938), Rota (Kondo, 1952) and Saipan (Lange, 1950) ; lettuce in Saipan (Lange, 1950) and Hawaii (Weel, 1948-49) ; radish in Sumatra (Heubel, 1937, 1938) and Saipan (Lange, 1950) ; lady's finger (okra) in Ceylon (Green, 1910c) and Saipan (Lange, 1950), and tomato in Guam (Mead, 1961) by *A. fulica* are on record. Similar observations have been made in West Bengal but sponge gourd (*Luffa* spp.) and carum carui (*Momordica cochinensis*) not reported by previous workers are readily consumed by *A. fulica.* Selection of only a few vegetables—amaranth, cabbage, lettuce and sponge gourd by *M. indica* is presumably due to abundance of these plants in the infested areas.

A number of wild plants are also consumed by *A. fulica, Arion empiricorum, A. circumscriptus* and *Rumina decollata* but nothing is known on the same point in other molluscan pests. *R. decollata* ate 73 of 90, *A. empiricorum* 158 of 197 and *A. circumscriptus* 33 of 193 wild plants offered (Frömming, 1954. 1956). In Britain, majority of the land molluscs feed on wild plants (Chatfield, 1976). In West Bengal both *A. fulica* and *M. indica* feed upon a large number of wild plants, some of them viz. fig. synedrella and *Allangana* are preferred to the cultivated ones. This minimises the damage to crop plants to some extent, but the gain is elusive, since wild plants offer shelter to the snails, render the control measures ineffective and help the snails to survive in the absence of cultivated plants, the cumulative result of which is a rapid rise in population density.

Majority of the members of the Gramineae family are immune to pestiferous snails (Green, 1910c ; Hutson, 1920 ; South, 1926 ; Heubel, 1937, 1938; Herklots, 1948 ; Weel, 1948-49; Mead, 1961) probably except *Commelina* (Owen, 1965). Damage to corn (*Zea mays*) by *A. fulica* has been reported from Indo-Pacific regions. The situation is similar in West Bengal.

Eating of algae and moss by pestiferous snail is rather important from the point of crop protection and production. Feeding on algae by *Discus rotundatus* (Chatfield, 1973), fungi by *A. fulica* (Kondo, 1964) and *Rumina decollata, Arion circumscriptus* and *A. empericorum*

Frömming, 1954, 1956) is on record. Our observations on *M. indica* and *A. fulica* are not in complete agreement with those of others. The moss. *S. orientalis* constitutes only occasionally a very small per cent of food for adult *M. indica*, and young *A. fulica*. All land snails prefer decomposed plant matter, possibly due to the growth of fungal hyphae on them. A number of fungi and bacteria secrete strong cellulolytic enzymes which degrade the cell membrane (Ghose et. al., 1968 ; Ghose and Halder, 1969 ; Ghose, 1968) and a considerable amount of nutrients locked in plant cells are readily available to animals feeding on decomposing plant matters. Chatfield (1977) suggested that feeding on microorganisms is associated to some extent with the snail's nutrition. Feeding upon decomposing materials enables consumption of more amount of food in shorter time and at the same time digestion is also somewhat easier. Presumably this had led *M. indica* and young *A. fulica* with a delicate odontophore to depend more on decomposing plant matters. It is argued that this type of feeding in land snails plays an important role in the ecosystem by transfering a considerable amount of resistant plant matters to a state in which those could be easily degraded biologically by microorganisms in the soil (Mason, 1970; Chatfield, 1976).

Information on food preference in land snails under captivity is very limited (Mohr, 1949; Kondo, 1964; Rees, 1950 ; Owen, 1965). The present observations on *A. fulica* and *M. indica* supplied with 22 plant species clearly indicate that a high degree of food selection exists in them. *Achatina* and *Macrochlamys* live chiefly on cultivated plants but preference to *Bryophyllum* and marigold may be successfully utilised in crop protection by planting those in guard rows or in between crop plants.

The solitary report of Jaski (1953) on the selection of food-plants in respect to snalis age states that young *A. fulica* feed almost exclusively upon young shoots and succulent leaves up to the age of about 4 months. Our observations on the feeding of young *A. fulica* and *M. indica* are somewhat similar to those of Jaski (1953) up to the age of 60 days in the former and 45 days in the latter. It is noteworthy that during this period both the species of snail changed their preference for plant species—beans—lettuce—gourd—marigold with age. Switching over to coarser type of food-plants in snails older than the above age indicates the development of stronger feeding apparatus.

The activity of land snails usually depends on two factors—humidity and temperature. Eating of succulent plants during dry weather has been reported by Dowdeswell (1961). Feeding upon succulent plants

with the fall in humidity per cent as recorded by us in *A. fulica* and *M. indica* may be viewed upon as an adaptation to water getting. Less food consumption during winter in both the species suggests that temperature plays an important role in digestion as has been reported by Hodasi (1979) in *Achatina* (*Achatina*) *achatina*.

We are in dark on the biological clock for feeding in land snails. Active feeding during night in their natural habit and in day time when kept in dark in the laboratory indicate that they prefer to feed under darkness. This is presumably due to their habit of avoiding strong light and sunrays, which is supported by their active feeding during day hours in heavily clouded rainy days.

## SUMMARY

Studies on the food preference, feeding behaviour and duration of feeding in two species of land snail, *Achatina fulica* and *Macrochlamys indica* both in captivity and field in West Bengal, revealed that more than 80% plant species grown in this area are acceptable to them. A good number of wild species were their choice food-plants and the preference was at par with the cultivated ones. Snails living in places far away from human habitation and devoid of cultivated plants thrived equally well on wild species like those individuals occurring in and around human habitation and feeding upon crop plants. A marked preference for food-plants was recorded both in the field and in the laboratory when different species of food-plants were available or supplied at a time. The first food of *A. fulica* after 5 days of hatching were soft leaves of bean and lettuce while *M. indica* selected only the bean leaves. Older snails could rasp all the different regions of the food-plants. The number of preferred food-plants increased with the age of the snails of both the species. Seasonal influence on the selection of food-plants in both the species was well marked. In summer and monsoon months choice of food-plants was almost similar while in winter months the snails consumed only succulent varieties or succulent portions of other food-plants probably to compensate the loss of greater amount of body water due to low atmospheric humidity. The amount of food consumption was less in winter. A downward consumption rate in relation to body weight was related to the lowering of atmospheric temperature. Feeding hours extend from dusk to mid night depending on the amount of food available.

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