CHAPTER 4:
ECOLOGY AND CONTROL

4.1 INTRODUCTION:

The land snails and slugs are of importance to man as pests because of damage caused in agriculture, horticulture and forestry, so that in moist regions or during rainy season the control measures are necessary. Furthermore, snails and slugs are intermediate hosts for certain parasitic worms of man and some domestic animals. Dundee et.al., (1965) and Gillmore (1982) made detailed survey on the distribution of land snails as pests in United States. For the control purpose of these pest snails it is essential to understand in detail ecobiology of these snails. A number of workers have studied the ecology of the molluscs from marine as well as freshwater environment( Pelseneer, 1935: Ankel, 1936; Fisher, 1950 and Morton, 1958). Early work on land molluscs was concerned with slugs whereas the snails were practically neglected. Miles et.al., (1931) studied the ecology and the control of slugs in East Lancashire, England and reported that copper sulphate was the best suitable substance for the prevention of slug pest. Numerous reports on the dormant state (aestivation
and hibernation) of land snails are available both from the temperate and cold countries (Williams, 1951).

Land snails which are generally moisture loving is active in monsoon and spent the dry seasons in dormant state. The dormancy extends from November to June (Raut and Ghose, 1977). Monsoon influences the breeding and egg laying behaviour of the snails.

The distribution and population of snail depends on type of soil, temperature, rainfall, humidity and natural enemies. The variation in population density of snails from one place to other is probably due to a number of biotic as well as abiotic factors, was reported by Raut (1979) while studying the distribution and population of two pestiferous land snails, *Achatina fulica* and *Macrochlamys indica*. Barnes and Weil (1944 and 1945) studied the distribution and activities of slugs from North America. The discontinuous distribution of *Biomphalaria pfeifferi* in the lake Sibaya area of the Zululand coastal plain corresponds to an ecological succession amongst water bodies associated with the lakes fluctuating water level (Appleton, 1977). Nduku (1976) while working on *B. pfeifferi* found that calcium is a limiting factor in the biology of the snail. Burch (1955) in a study of land snails of Eastern Virginia, U.S.A., found an increase in the number of snail with the increase in Calcium, Magnesium,
Potassium and organic content of the soil. Fromming (1957) noted no effect by addition of trace metals to the soil on population density of Helix aspersa.

The brown garden snail, *H. aspersa* is well known agricultural pest on one hand and an edible snail on the other. The potential of this species as a pest was tested, mainly under laboratory conditions, by investigating oviposition, development, feeding, over wintering and starvation. This species select the soft and damp soil covered with leaves as oviposition site where the soil humidity was suitable and stable for developing embryos was reported by Kaneda *et al.* (1988).

The snails and slugs feeds on green, leafy vegetables, stems, bulbs and tubers. They were also observed consuming fungi, lichens, algae and animal materials present over the surface of the soil and within the soil also. The feeding habits and food plants of various land snails have drawn the attention of researchers. Members of family Cucurbitaceae probably the favourite food of the giant African snail, *A. fulica* (Green, 1910). Information regarding the natural diet of the more common species of land snail is less. Macan (1950) while working on the basommatophoran snails gave information regarding vegetation and other water bodies of water in the Windermere and in the English Lake district. Van Der Steen *et al.*
(1973) reported the influence of food quality on feeding, reproduction and growth in the land snails, *Macrochlamys gudei*. Deshpande et al. (1979) while working on the marine pulmonate slug, *Onchidium verruculatum* have observed aggregation behaviour of the large number of adult slugs when there is an ample of food.

As far as the food and feeding habits of the slug *Laevicaulis alte* is concerned, Kulkarni (1970) showed that feeding habits varied according to the environmental factors. These slugs were found to feed throughout the night, early morning and at sunset. Raut and Ghose (1983) offered about 65 different plants to the snails, *A. fulica* and *M. indica* and observed their feeding habits. Manna and Raut (1986) also studied feeding adaptations of the *A. fulica*. Hazari (1983) studied the biology of the land snail *Cerastus mosssonianus*. Recently, survival and food choice of the grey field slug *Deroceros reticulatum* on the different seed types under laboratory conditions was studied by Gebauer, (2002). A field study in Calcareous grassland in reference to terrestrial gastropods and experimental climatic change was done by Marcelo (2000).

Since snails and slugs are found as pest throughout the World, it has become necessary to solve this problem by artificial control. Various researchers studied this problem (Getzin, 1965; Newell, 1968; Runham
and Hunter, 1970 and Vyawahare, 1986). Molluscan pest can be destroyed in several ways, by chemical means (molluscicides), through the biotechnical measures and by mechanical methods. Copper sulphate is the classical molluscicide which has been used against terrestrial pulmonates and is regarded as favourite compound for the control of giant African snail, *A. fulica* (Strufe, 1968 and Christie et al 1978).

Crowell (1977) published a detailed report on chemical control of terrestrial snails and slugs. He tested as many as different types of organic and inorganic chemical agents for their molluscicidal properties, against several species of slugs and snails. Olivier and Haskins (1960) showed that sub-lethal concentration of pentachlorophenate could reduce the fecundity and egg production and egg viability of *Biomphalaria glabrata*. The effect of several herbicides such as aminotrizol, chloroprophan, dalapon, lenacil, linuron and simazon on the slugs, *Arion rufus, D. reticulatum, Limax maximus, L. flavus* were tested (Godan, 1963).

In view of the limited work reported on the ecology of the snail, *Macrochlamys petrosa*, the present investigation was undertaken. This chapter deals with distribution of snails, nature of habitat substratum preference, food preference and feeding habits. This chapter also deals with
chemical control of the snail while using some molluscicides and other chemical agents.

4.2 MATERIAL AND METHODS:

The snails *M. petrosa* were collected from different localities in and around the city, Aurangabad. They were brought to the laboratory and were kept in glass troughs containing sufficient moist soil. They were fed once in a day on various types of leafy vegetables. To provide adequate moisture, every day the soil in the trough was sprinkled with water.

The observations on the ecology were made in the natural as well as under laboratory conditions by performing the experiments. The animals were cleaned and their external features were studied. During the period of July 1999 to March 2000 frequent visits were made to the collection areas so as to study the several ecological aspects of *Macrochlamys petrosa*.

4.2.1 Food and feeding Habits:

To study food preference and feeding habits of the snail *M. petrosa* under laboratory conditions following set of experiment was run. The green leafy vegetables, various types of nuts and green leaves of various types of climbers; specially of cucurbitaceous family that were grown in natural habitat of snails, to be tested were placed in bunches in troughs. Fifty snails
were placed in troughs and left for a period of 24 hrs. The amount of food eaten in 24 hrs was also measured.

4.2.2 Substratum preference:

To test the experimentally the behaviour of the snails towards substratum preference, round glass troughs were used as the experimental containers. Moist soil sand and stones were collected from the natural habitat of the snail and were washed with tap water before their use in experiment. This material was divided into four parts i.e. i) moist soil ii) moist soil and sand iii) sand with stones and iv) only sand. In the centre of troughs 50 snails were placed and left for 24 Hrs. After 24 hrs location of the snails was noted down. Average percentage distribution and substratum preference of the snail was calculated for each type of substratum.

4.2.3 Control of the snail M. petrosa:

Control of the snail, M. petrosa was checked in the laboratory by conducting experiments under laboratory conditions. Laboratory experiments on artificial control were carried out by using chemical agents, like sodium pentachloroplenate, copper sulphate, Mercuric chloride, zinc sulphate and cadmium nitrates for assessing the toxicity of above molluscicides following experiments were carried out (1) dusting the
powder of chemical on snails (2) mixing the chemicals with soil and (3) sprinkling the liquid concentrations of these chemicals on food of snail.

4.3 OBSERVATIONS AND RESULTS:

*Macrochlamys* is a terrestrial snail which remains hidden under soil, stones; plant leaves etc. throughout the day except early morning and at night. The snails were abundantly found in gardens during peak rainy season.

**Food and feeding habits:**

Laboratory experiments were conducted to obtain information regarding the feeding habits of *Macrochlamys* various types of vegetables, fruits, corals to be tested were placed in bunches, in glass troughs. Fifty snails were placed in the center of trough and left for 24 hours. The amount of food eaten in 24 hours was measured quantitatively. Ten species of common plants occurring in the near by area of Aurangabad city were tested. It includes certain common leafy and fruit vegetables, and fruits ( see table No.5 ) It is observed that, Macrochlamys feeds on a wider variety of plants and round to prefer, soft and green vegetables as compared to other plants. These are, *Brassica oleracea var. capitata, Luffia*
acutangulata, solanum tuberosum, Momordica charantia, cucurbita moschuta, Lycopersian esculentum, spinacia oleracea Musa paradisiacal cucumis satinus and Trigonella foenum graecum. The leaves of these vegetables are readily accepted by the snail, Macrochlamys. However, the Leaves of capsicum annum, coriandrum sativum, Allium cepa, Raphanus sativum and Pisum sativum were strictly refused by Macrochlamys. In field observations, during December to May these snails are under aestivation. So in this period snails are not taking any type of food. What so ever food and water consumed by Macrochlamys before entering aestivation, is utilized through out aestivation condition. On the revival of favourable conditions which were followed by a rainfall, in the month of June-July, snails were comes out from aestivation period. It is found that snails were abundantly moving in the early morning on soil surface. The presence of high snail population also resulted in the differences of their feeding habits. The development of population is directly influenced by temperature, moisture, PH of soil etc.

Substratum preference:

Macrochlamys is a land snail which remains hidden under soil, stones, plants and leaves etc. throughout the day except early morning and at night. It was observed that during the night period these snails were
move active as compared to their day time activities. However, during the periods of dark cloudy moist weather; it was observed that the snails remained active throughout the day. The snails were abundantly found in the fields after the showers of rain in the rainy season, but in the winter and harsh summer these snail undergoes aestivation. For aestivation they preferred places having sufficient amount of humidity and less temperature.

Laboratory experiments were conducted in order to have a more information regarding substratum or habitat preference. For this purpose a model of ecosystem as mentioned in material and method was used. Various types of substratum prepared in round glass troughs viz. Moist soil, moist soil and sand, sand with stones and only sand, were offered to the snails for substratum preference. In the centre of trough 50 snails were placed and left for 24 hours. The number of animals preferring the particular type of substratum was noted. It is observed that moist soil was preferred by 80% of snails, 10% snails preferred moist soil and sand substratum, 8% snails preferred sand with stones and only 2% snails found in only sand substratum. No mortality of snail was observed during this experiment.

**Artificial control by using some common mollucicides and chemicals:**

Different chemicals viz. sodium pentachloroplenate, copper sulphate,
Mercuric chloride, zinc sulphate, and cadmium nitrate were lightly dusted on the snail, mixed with soil and sprinkled the liquid concentrations of these chemicals on food of snail and their effects were noted. It was found that, these chemical compounds were highly toxic to the snails and immediate secretion of slime was there and within 10 to 20 minutes death of animal observed.

It is observed that direct dusting of powder of chemicals on snail and sprinkling the liquid concentration of these chemicals on food of snail is most effective as compared to mixing the chemical with soil. Because snails avoids substratum of soil mixed with chemical and they escape from that site. (See Table 6).

It is also observed that, no death was occurred in some snails since the dusted material was cast off with slime, but 100% mortality observed in chemical sprinkled food consumed snails.

4.4 DISCUSSION:

Ecology of snail population is dependent upon soil, climate and availability of food. These factors play an important role in the life history and development of snails. A characteristic feature of mollusks is high water content in the various body parts. As a result there is a close relationship between population density and the moisture of the soil in a
particular area. Due to evaporation of water from the mantle and other parts and also due to the secretion of mucus; body water is lost and must be replaced rapidly by water uptake from the environment. This occurs not only by drinking, but also by absorption of water through the skin itself, which is non-keratinized and consists of a single cell layer (Howess and well, 1934; Pusswald, 1948). *Macrochlamys* also maintains water percentage of body throughout year (see Table 1). In the dry summer months, these snails enter in an aestivation period; they prepared calcareous membrane at aperture (see plate 1 fig. b). Throughout aestivation period it prevents the excess loss of water.

Many investigators shoved that the activity of snails is depends up on weather conditions like temperature and humidity, this applies both to land and freshwater pulmonates (Partsvaniya, 1972). The migratory behaviour of slugs and snails is greatly affected by the microclimatic conditions in their habitat (Newell, 1968 and Crawford-Sidebotham, 1972).

Snails feed on leaves, stems, bulbs and tubers but they also consume fungi, lichens, algae and animal matter. Many observations have been made on what snails will eat both in wild and in the laboratory. Very little systematic information is available on the make up of the diet of population in the wild, even less, on what nutrients are necessary and in what
quantities for normal growth (Runham and Hunter, 1970). Miles et al. (1931) found that feeding habits appears to be broadly characteristic of a particular snail and slug species. Getz (1959) performed experiments feeding of leaves to slugs Derocerus leave, D. reticulatum and Arion circumscriptus. He tried about 45 species of plant leaves but could not definitely suggest as to the feeding habits of a special species under natural conditions. Bodhankar (1984) offered 40 different plant species to the slug, Laevicaulis alte and studied the food preference of that slug species. He found that the slug prefers leafy green soft vegetation and shows seasonal variations in feeding activity. Raut and Ghose (1983) also studied food-preference and feeding behaviour of two pestiferous snails, Achatina fulica and Macrochlamys indica offering them 65 types food of different plant species. They divided these plants species. They divided these plants viz., vegetable plants, flower plants, a fruit plants, fiber plants, beverages, cereals, wild plants and ornamental plants. They also mentioned that which part of a particular plant is taken in by these snails. Similar type of work was done by Bhatlwande (1989) on Cerastus moussonianus, he offered 30 plants as food. He found that Cerastus prefers sweat gourd, bitter gourd, bottle gourd more as compared to other food plants and shows seasonal variation in feeding activity. Same types of results obtained on
Macrochlamys petrosa during this investigation. Macrochlamys prefers more food from member of the family cucurbitaceous. Food preferred by this snail is mainly *Brassica oleracea Var. capitata* (cabbage), *Luffa acutangulata* (Ribbed gourd), *solanum tuberosum* (potato) *Momordica charantia* (Bitter gourd), *Cucurbita moschuta* (sweat gourd), *Lycopersian esulentum* (Tomato), *Spincia oleracea* (spinach), *Musca paradisiacal* (Banana), *Cucumis sativus* (cucumber) and *Trigonella foenumgraecum* (metha). Food refused by Macrochlamys was *Capsicum annum* (chili), *Coriandrum sativum* (coriander), *Allium cepa* (onion) *Raphanus salivus* (Raddish), and *Pisum sativum* (Pea).

Food and feeding behavior of land snail was studied by many investigators. The influence of food quality on feeding, reproduction and growth in the land snail *Macrochlamys gudci* was studied by Van Der et al. (1973), and reported some methodological comments regarding food and feeding behavior of *Macrochlamys*. Food is essential for physiological activities. Food choice is also important factor observed in land snails and slugs. Recently, Gebauer (2002) studied on survival and food choice on three different seed types under laboratory conditions in slug *Deroceros reticulatum*. 
A considerable work has been done on the control of snails and slugs and numerous substances have been recommended as these substances proved good results. Many chemical molluscicides are repellent at high concentration but are effective at very low concentration; between these two extremes the response to them is indifferent (Godan, 1958). The most commonly used chemical substance as molluscicide is the copper sulphate. Borg (1953) tried it for control of giant African land snail, Achatina fulica Van Dinter (1956) used it in rice fields in Surinam to control the snail, Pomacea lineate and P. glauca. Holz (1962) has observed that the efficiency of copper sulphate is very greatly reduced by the mud of the fields. Muller (1962) found that molluscicidal action of copper sulphate is very greatly reduced by alkaline or hard water and by vegetation and organic matter of the area under treatment.

Kulkarni and Nagabhushanam (1973) found that the chemical substances such as potassium cyanide, copper sulphate, Ammonium sulphate, Ammonium chloride, potassium permanganate were highly toxic to slug Laevicaulis alte. Similar studies on the land snail, Cryptozona semirugata by Mantale, (1970) Nagabhushanam and Mantale 1973, revealed that copper sulphate, potassium cyanide, potassium permanganate were deadly toxic to the snail and caused 100% mortality within short
time. Bodhankar (1984) and Vyawahave (1986) have used various chemical substances for testing their toxicity to the slug, *Laevicaulis alte*. They showed that certain compounds like Arsenious trioxide, cadmium nitrate, copper sulphate, cupric chloride, Mercuric chloride, Mercuric sulphate, etc. were highly toxic to the slug. Kalyani (1990) while working on effect of feeding copper sulphate to *Achatina fulica*, suggest that reduction or cessation of egg laying in response to high levels of added dietary copper is due to the effect of copper on protein of albumen gland than polysaccharide.

In the present investigation on the artificial control of *Macrochlamys*, dusting the powder of copper sulphate, gives immediate and profuse sliming, rapid movement twisting of body, tentacle protrude out within 15 to 20 minutes.