Chapter 2

REVIEW OF LITERATURE
Chapter 2

Review of literature

Chapter 1

Molluscs are the second largest group of the animal kingdom after insects and they are important invertebrates of the world. Snails and Slugs belong to the class Gastropoda. Snails and slugs are molluscs, a group of invertebrate animals with soft unsegmented bodies. The terrestrial molluscs including snails and slugs are destructive agricultural pests causing economic damage to a wide variety of plants along with horticulture, field crops and forestry. The economic importance of land slugs and snails and the problems associated with their control have been discussed by various workers. Damage caused by snails depends not only on their activity and population density, but also on their feeding habits, which differ from one species to another. The land snails feed on leaves, roots, tubers and ornamental plants. Land snail causes heavy damage to seed of oil plants and leaves of ornamental plants as well as citrus, peach, palm and vegetable, i.e. cabbage, carrot and bean. In addition, during movement snails cause an undesirable smell to plants which prevents men and even animals from feeding on these contaminated plants (El-Okda, 1979; 1981; 1984; El-Deeb, et al., 1999; Ismail, et al., 2003; Lokma, 2007 and Shahawy, et al., 2008). Snails are of great concern in agriculture, medical and veterinary practices due to their damage in agriculture, horticulture and forestry as well as their main role as intermediate hosts for the trematodes causing schistosomiasis and fascioliasis in humans and domestic animals (Godan, 1983). Crops contaminated by snail slime lose their marketability and hence their export potential in many countries (Baker and Hawke, 1990 and Ittah and Zisman, 1992). The phylum Mollusca is probably the third most important animal group after the arthropods and vertebrates (South, 1992). In addition they are of importance in medical and veterinary practice, since they serve as intermediate hosts. Some of them are also intermediate hosts like Pila globosa, Lymnaea for parasites (Subba Rao, 1989).

Chapter 3

Problems caused by snail pests on agricultural crops were reported by many authors in most countries of the world i.e. Egypt (Kassab and Daoud, 1964 and El-Okda, 1980), Australia (Baker, 1989), Pakistan (Ali, 1991), Switzerland (Baur and Baur, 1993), China (Chen, 1994), England (Newman, et al., 1994), Spain (Castielleio,
et al., 1996) and Saudi Arabia (Lokma, 1998). Villalobos, et al. (1995) studied the life cycle and field abundance of the snail Succinea costaricana under field and laboratory conditions. Jahan, et al. (1996) studied the breeding biology of Macrochlamys sequax under laboratory conditions. Barrientos (1998) studied the life history of the terrestrial snail Ovachlamys fulgens under laboratory conditions. Jahan, et al. (2002) studied the comparative ecology of Macrochlamys indica and Macrochlamys opipar us under field and laboratory conditions which were reared on mulberry leaves and both have established themselves as major pest of mulberry plants in silk growing region of Bangladesh. Maltz (2003) studied life cycle and population dynamics of Helicodonta obvoluta in the field and under laboratory conditions. Datkauskiene (2005) observed the lifespan, period of reproduction, characteristics of clutches, eggs and duration of embryo development of Succinea putris. Carvalho, et al. (2008) determined the life history traits of Bradybaena similaris as growth, reproduction and longevity patterns, interrelationship of these traits and conclude that there is relationship between these traits due to a differential allocation of energy between somatic growth, homeostasis and reproductive activity. Silva, et al. (2008) studied to determine development and reproductive patterns in Bulimulus tenuissimus which has parasitological importance. Silva, et al. (2009) studied pattern of growth, fertility and lifespan of Habroconus semenlini under laboratory conditions. Kowalska and Roksela (2009) observed the life cycle parameters of Perforatella bidentata and revealed that the activity of P. bidentata was the greatest in spring and autumn and juveniles were more active than adults. Orstan (2010) studied biology and annual population cycle of Oxyloma retusum under laboratory conditions. Montresor, et al. (2011) studied the oviposition site, the time to sexual maturity and the influences of photoperiod and temperature on reproductive parameter of Omalonyx matheroni which were reared under laboratory conditions. Ying Wu, et al. (2011) conducted a comparative study on the reproductive and juvenile growth characteristics of Pomacea canaliculata and Pomacea scalaris and significant difference in growth between these two species were observed.

Chapter 4

Dallinger, et al. (1993) stated that terrestrial snails were useful in ecotoxicological studies, since they represent biological sinks for various metals, these animals have been greatly neglected as models in biomarker studies. Zhou, et al. (1993) studied the effect of Niclosamide and to aqueous and methanolic extracts of
Eucalyptis camaldulensis on Biomphalaria glabrata for 24h and recovered for 48h, all tested agents showed molluscicidal activity on exposed snails. Jantatae, et al. (1996) studied acute lead toxicity on snail Filopaludina martensi martensi, the 96h static bioassay was conducted in order to estimate the LC$_{50}$ concentration, the snail exposed to lead nitrate and the LC$_{50}$ for 24, 48, 72 and 96 hour were 319.47, 271.03, 235.35 and 191.69 mg/L respectively. Hussein, et al. (1999) found that the molluscicidal activity of a cardenolide extract from Pergularia tomentosa (L.), methomyl and methiocarb was evaluated against the land snail Monacha obstricta, the LD$_{50}$ value of the plant extract after 24h of treatment was 60.9µg/snail, whereas the LD$_{50}$ values of the two tested carbamate pesticides after 72h of treatment were 11.9 and 27.4µg/snail, respectively. Giovanelli, et al. (2002) studied molluscicidal activity of niclosamide on Melanoide stuberculata and Biomphalaria glabrata. Both species were exposed to 14 different concentrations of niclosamide to determine the LC$_{50}$ and LC$_{90}$. The LC$_{50}$ and LC$_{90}$ values for B. glabrata were 0.077 mg/l and 0.175 mg/l resp. and the LC$_{50}$ and LC$_{90}$ values for M. tuberculata were 0.082 mg/l and 0.221 mg/l respectively. Heiba, et al. (2002) studied effect of Lannate on Eopania vermiculata and Monacha contiana, the pesticide LD$_{50}$ for E. vermiculata found to be 30.27 mg/kg body weight while its LD$_{50}$ for M. contiana was found to be 37.18 mg/kg body weight. Shmuel, et al. (2004) tested two formulations of water dispersible granules contained 61.4% and 53.8% of copper hydroxide. The 0.1% concentration of either formulation was sufficient for the management of the land snails Monacha syriaca and Theba pisana populations. El-Zemity (2006) studied a series of novel N-Methyl carbamate derivatives based on naturally occurring monoterpenoids were synthesized and tested against Helix aspersa snails, the results showed that the new synthesized carbamate derivatives in particularly of broneol proved to be highly potent against the snail and joint action effects of the four active derivatives i.e. broneol, carvacrol, chlorothymol and thymol with either piperonylbutoxide enhanced the molluscicidal activity over the standard molluscicide. Arijo, et al. (2007) found that, dose of niclosamide according to snail size showed that juvenile snails were more susceptible to chemical compared with adult Biomphalaria glabrata. Concentrations of 0.067 and 0.109 mg L$^{-1}$ were required to kill 50 and 90% snails respectively in exposure period of 24h. Marwa and Mostafa (2008) studied molluscicidal activity of six pesticide against Monacha cantiana and Eobania vermiculata and revealed that the toxic effect of all tested pesticide bait with mortality
percentage increasing with an increase in exposure period. Deltamethrin showed high initial toxicity of 70.0% and 93.3% against *M. cantiana* and *E. vermiculata* respectively after three days of exposure. El-Gendy, *et al.* (2009) who investigated oxidative stress markers in the land snail *Theba pisana* exposed to sub lethal doses (40% and 80% of LD$_{50}$ after 48h) Copper based pesticides. Toche, *et al.* (2009) studied molluscicidal activity of quinolone substituted pyrazoline and isoxazolin derivatives against *Macrochlamya indica*. The pyrazoline and isoxazoline derivatives showed good molluscicidal activity with LC$_{50}$ 0.7876 and LC$_{50}$ 0.7765 respectively. Abd El-Aal and Hamed (2010) tested five pesticides against the *E. vermiculata* and *M. cartusina*. The molluscicide efficiency of the tested pesticides according to mortality after 15 days treatments for two snails were profenofos, ethoprofos, metaldehyde, oxamyl and anilofos, toxicity studies showed that metaldehyde and profenofos were most toxic to both species with 88.6, 97.3, 100.0 and 100.0 respectively, while, anilofos was least toxic. Amaeze, *et al.* (2011) studied effect of Boost Xtra and synthetic pyrethroid pesticide, Cypercot against *Archachatina marginata* the result of 96h acute toxicity test with LC$_{50}$ 250.935 ml/L and 74.286 ml/L respectively. Abog, *et al.*, (2012) studied the acute toxicity of Thiamethoxam (Actara® 25WG) against *Achatina fulica*. The LD$_{50}$ determine in the study i.e. LD$_{50}$ per body weight of *A. fulica* was 90.09±23.60µg/kg body weight. The use of Thiamethoxam in the control of *A. fulica* populations was only recommended when in conjunction with the control of target pest insects.

**Chapter 5**

Aurangzeb and Siddiqi (1984) studied the reproductive system of *Bensonies jacquemonti*, composed of three divisions female and male genital tract and hermaphrodite gland and duct. There is no superficial separation of male and female system. Bhatlawande (1989) studied the effect on hepatopancreas of a terrestrial snail, *Cerastus moussonianus*. Ireland and Marigomez (1992) studied histological changes in digestive tubule epithelium of *Achatina fulica*, after exposure to heavy metals. Zhou, *et al.* (1993) studied the effect of niclosamide and to aqueous and methanolic extracts of *Eucalyptis camaldulensis* on *Biomphalaria glabrata* for 24h and recovered for 48h, histochemical changes were observed in the intestines, digestive gland and ovotestis of the molluscicides treated snails. Jantataeme, *et al.* (1996) revealed that the snail exposed to lead nitrate and the bioaccumulation experiment snail exposed to
10% of 96h LC$_{50}$ during 42 day exposure period and 30 days recovery time. Lead uptake occurred greatest in the intestine and less in the prostate gland, digestive gland, ovary and albumen gland, testis, stomach and cerebral ganglia and during 30 day recovery period lead concentration decreased in all organs. Jonnalagadda and Rao (1996) studied the effect of endosulfan, methylparathion, quinalphos and nuvan on hepatopancreas, foot and mental tissues of fresh water snail Bellamya dissimilis and found that histological changes in treated tissues of exposed snails, Nuvan was more toxic than organochlorine and endosulfan. Kruatrachue, et al. (1996) reported the effect of vertebrate hormones on the reproductive system of Achatina fulica. Hamed, et al. (2007) studied the histological alteration in digestive gland of Eobania vermiculata exposed to methomyl and methiocarb. These alterations in digestive gland includes hemocyte infiltration, bizarre nuclei that ranged in their degenerative changes from karyolysis to severe karyorrhexis and complete pyknosis, after methomyl treatment and extensive destruction and disorganization of the intertubular connective tissue after methiocarb treatment. Radwan, et al. (2008) studied the effect of carbamate pesticides methomyl and methiocarb on digestive gland of Eobania vermiculata snails, and observed different cellular populations in the epithelium of gland and changes in lipid, carbohydrate and total protein in the digestive gland cells of snails. Amaeze, et al. (2011) observed histology of the gut and reproductive tract of the mollusc exposed to different sub-lethal concentrations of the Boost Xtra which was much more persistent than Cypercot causing severe necrosis and sloughing of the gut epithelium at 1/10$^{th}$ of LC$_{50}$ (55.3ml/L). Cypercot induced no visible lesion in the gonadal epithelium while the sub-lethal exposure to Boost Xtra initiated massive necrosis in the gonadal duct. Hasheesh, et al. (2011) studied the effect of fungicide Difenoconazole and Asparagus densiflours and Oreopanax guatemalensis plants against Biomphalaria alexandrina snails, the histological examination showed that a severe damage in both secretory cells and digestive cells of digestive gland of snails after 2 weeks of exposure especially in case of A. densiflours and Difenoconazole. Deshmukh, et al. (2012) studied the reproductive system of Macrochlamys petrosa, which was highly complicated with its elaborate arrangement of the convoluted glandular duct system. Hamlet, et al. (2012) conducted bio-assay to study the effect of Thiamethoxam on histological changes in hepatopancreas of Helix aspersa after a treatment of six weeks. The result revealed the degeneration of the digestive tubules.
and the breakdown of the basement membrane in dose-dependent manner, leading to severe deterioration of the tissues in the concentration of 200mg/L Thiamethoxam.

Chapter 6

Kulkarni and Utkar (1981) studied the carbohydrate metabolism in fresh water snail *Viviparous bengalensis* was studied by. Rao and Jayashree (1990) investigated the changes in the glucose, glycogen, total lipids and total protein levels in foot, mantle and digestive gland of the adult *Bellamya dissimilis* exposed to 96h LC$_{50}$ concentrations of Copper sulphate and Zinc sulphate and they found marked decrease in all the four biochemical parameter in the treated snails.

Kandil, *et al.* (2009) observed the effect of methomyl (20%), abamectin (1.8%) and their mixture with acetylsalicyclic acid on *Eobania vermiculata* and *Monacha obstruca*, and showed that acetylsalicyclic acid exhibited clear influence on total proteins and alkaline phosphatase while its effect was more when mixed with tested compounds especially with methomyl. Kushwaha and Singh (2010) studied the effect of Uscharin on *Lymnaea acuminata*, the biochemical analysis revealed significant decrease in protein, amino acid, DNA, RNA and glycogen level in the ovotestis of the snail exposed to sub lethal concentrations of Uscharin. Hasheesh, *et al.* (2011) studied the effects of sublethal concentrations of methanol extracts of *Sebcania sesban* on glucose level in haemolymph of exposed snails which was elevated while the glycogen, protein content decreased in soft tissues when compared with control group. Kumar, *et al.* (2011) noted that the snail fed with sub-lethal dose i.e. 20% and 60% of 24h and 96 hLC$_{50}$ of different molluscicides inside snail attractant pellets, caused a significant change in free amino acids, proteins, nucleic acids in the ovotestis of snail *L. acuminata*. Patil, *et al.* (2011) observed that sub lethal concentration of Mercuric chloride (0.1 ppm) and Zinc sulphate (2.00 ppm) on *Indoplanorbis exustus* showed significant decrease in the level of glycogen and increase in the level of protein and insignificant decline in the level of lipids. Hamlet, *et al.*, (2012) noted effect of Thiamethoxam on biochemical parameters of *Helix aspersa* after a treatment of six weeks. The result of the biochemical dosages, the total carbohydrates, total proteins and total lipids showed significant decrease at 100 and 200 mg/L of concentration of Thiamethoxam.
Chapter 7

Munzinger and Guarducci (1998) exposed *Biomphalaria glabrata* to Zn, observed a reduction of not only growth rate at the lowest investigated concentration (500 µg/L), but also a reduction in fecundity and embryonic hatching rate and a delayed attainment of sexual maturity. Coeurdassier, *et al.* (2003) exposing *Lymnaea palustris* to Cd, found median inhibitory concentrations (EC$_{50}$) for growth (58 µg/L) and reproductive output (number of eggs or egg masses per individual) (60 µg/L), but observed that embryos were unable to hatch at concentrations as low as 40 µg/L. Sukumaran, *et al.* (2004) studied the molluscicidal effect of nicotinanilide and niclosamide against eggs, immature, young mature and adults of *Lymnaea luteola*. The lethal concentrations i.e. LC$_{50}$ and LC$_{90}$ showed toxic effects against eggs immature and adults. The mortality to LC$_{90}$ concentration of both molluscicides showed niclosamide to kill faster (Within 8 to 9h) than nicotinanilide (26 to 28h).

Edward and Sogbesan (2007) studied the acute toxicity of Temephos on *Bulimus globosus* on *Lymnaea natalensis*, the 24h LC$_{50}$ was 0.021 mg L$^{-1}$ (0.01-0.03 mg L$^{-1}$) for adult of *B. globosus* and 0.021 mg L$^{-1}$ (0.007-0.066 mg L$^{-1}$) for the juveniles of the same species, while 24 h LC$_{50}$ was 0.021 mg L$^{-1}$ (0.007-0.064 mg L$^{-1}$) for adults of *L. natalensis* and 0.019 mg L$^{-1}$ (0.11-0.32 mgL$^{-1}$) for the juveniles respectively. Temephos was also found to be ovicidal to the eggs of both species at 0.03 mg L$^{-1}$ and above where it gave 100% mortality. Shoaib, *et al.* (2010) observed the effect of Nimbecidine$^®$ on the snail *Monacha obstructa* on food consumption and egg hatchability. At the highest concentration (10 ml/L), the snails avoided contacting with food completely. LC$_{50}$ of Nimbecidine$^®$ for the treated eggs was 2.18 ml/L and eggs failed to hatch at concentration of 10 ml/L. Nimbecidine$^®$ showed sufficient biological activity against the food consumption and eggs viability of *M. obstructa*. Chauhan, *et al.* (2011) observed toxicity effect of *Lantana indica* against *Lymnaea acuminata*. Treatment of snails with sub-lethal doses (20% and 40% of 24h LC$_{50}$) of the plant extracts affected reproductive process by reduction in the fecundity and hatchability. Ferreira, *et al.* (2011) studied the influence of thymol+DMSO on survival, growth and reproduction of *Bradybaena similaris* under laboratory conditions to evaluate the effect. Result showed that thymol+DMSO (2.5g/L and 5g/L) affected the hatching success by acting as an ovicide and regard to growth the results were not significant. Hasheesh, *et al.* (2011) studied the effects of sub-lethal concentrations of methanol extracts of *Secbania sesban* on survival rate egg laying.
and hatchability of *Bulinus truncates* snail. The sublethal concentration of the tested compound (LC₀, LC₁₀ and LC₂₅) caused considerable reduction in survival rates, egg production and hatchability of *B. runcates* snail. Hasheesh, *et al.* (2011) studied the effect of fungicide Difenoconazole and *Asparagus densiflours* and *Oreopanax guatemalensis* plants against *Biomphalaria alexandrina* snails, the sub lethal concentrations (LC₁₀ and LC₂₅) of *A. densiflours* and Difenoconazole have more destructive effects on survival, growth and reproductive rates of the juvenile snails than the concentrations of *O. guatemalensis* plant.