CHAPTER - 2

REVIEW OF LITERATURE
Hampson (1896) described structural features of adult *Glyphodes pyloalis* Wlk. A descriptive key for the identification of 47 other species falling in the same genus has also been given.

Ladell (1936) developed a new apparatus for separation of insects and other arthropods from the soil. He followed the principles of flotation by dense liquid aided by stirring of soil.

Benton and Crump (1939) made observations on aggregation and overwintering in *Coleomegilla maculate* Degeer. Aggregation site was found to include three physical components, willow trees, a small pond and a south-facing slope. The beetles were found to over winter on willow leaves especially the dead dry leaves.

Mathur (1959a) observed that many kinds of insect larvae, particularly those of Lepidoptera and Coleoptera were parasitized in nature by *Mermis, spp.* (Mermithidae, Ascaroidea. Nematoda) in Dehra Dun. Only one worm was found in each host, except in larva of *Epiplена* spp. More than 20 insect pests were found to be attacked by this parasite like *Glyphodes pyloalis* Wlk. *M. hilaralis* Wlk. *Sylepta talteata* Fab. *Calopepla leayana* Latr. etc.

Mathur (1959b) made observations on the biology of *Cedria paradoxa* Wilk. which is an ectoparasite of *Glyphodes pyloalis* Wlk. Life cycle was found to be completed in 10-33 days. Sex ratio was found to be 80 females per 20 males. Copulation period was found to last only 12 to 20 seconds and each female was noted to deposit 12 to 38 eggs.

Paul, *et al.* (1965) evaluated the toxicity of petroleum ether extracts of *Acorus calamus* to the adults of *Sitophilus oryzae*, *Letheticus oryzae* *Tribolium castaneum* and *Heterotemes indicola*. It was found to be more toxic
to *L. oryzae* than to *S. oryzae* by topical application. *Tribolium castaneum* was least susceptible to the material.

Aratake and Kayamura (1974) examined cross transmission of cytoplasmic polyhedrosis virus of the pine caterpillar, *Dendrolimus spectabilis* to other lepidopterous insect species. It was found that the virus was infective to some lepidopteran moths but not to others like *Glyphodes pyloalis*, *Spilosoma subcarnea* etc.

Thompson (1975) defined meridic and holidic diets and aseptic feeding procedures for artificially rearing the ectoparasitoid *Exeristes roborator* Fab. The most successful diet described was found to contain 6% proteins in the form of a mixture of 19 free L-amino acids, 2% carbohydrates, 0.25% lipids, 0.25 % vitamins and 0.5 inorganic salts. The growth and development of *E. roborator* on this diet were comparable and in some cases superior to growth and development on two lepidopterous host species, *Pectinophora gossypiella* and *Gnorimoscherna operculilla*, used for comparison.

Kikuchi (1976) provided information on the pest complex associated with mulberry in Japan. Out of 200 species of insects that attack mulberry, the most important mentioned were *Diplosis mori*, *Apriona japonica* and *Glyphodes pyloalis*.

Hagstrum and Smittle (1977) made observations on host-finding ability of *Bracon habetor* Say and its influence upon adult parasite survival and fecundity. It was noticed that wandering host larvae were attacked 10 times more often than confined hosts. Survival and fecundity of adult female parasites were found to be directly related to the frequency of host-finding.

Jukes (1977) described a non-destructive, wet technique to extract sawfly cocoons from a variety of soil and surface litter types. The system
involving a pair of tilting, curved sieves was developed to extract cocoons of the European spruce sawfly, *Gilpinia hercyniae*.

Teotia and Tewari (1977) made a quantitative assessment of the ether and petroleum ether extracts of *Melia azadarach* drupes and *Acorus calamus* rhizomes for their contact toxicity and residual toxicity against adults of *Sitotroga cerealella* Olv. Petroleum ether extract of *Melia azadarach* was found to be most toxic while ether extract of *Acorus calamus* the least toxic.

Butani (1978) provided a detailed list of insect pests attacking different parts of mulberry in India. Information concerning host plants, distribution, nature of damage and control measures has been provided.

Hagstrum and Smittle (1978) studied the relationship between host age and its rate of utilization by parasite. It was found that when *Ephesia cautella* Wlk. Larvae, paralyzed by *Bracon hebetor* Say, were aged the number of hosts remaining moist and thus suitable to the parasites for adult feeding, oviposition and offspring development declined by 15%. It was also observed that parasites given a choice between aged and freshly paralyzed hosts laid 68.7% of their eggs on the fresh.

Legner and Medved (1979) studied the influence of parasitic hymenoptera in the regulation of *Pectinophora gossypiella* on cotton in the Lower Colorado desert. Fourteen important parasitic hymenoptera were released out of which *Chelonus* spp. showed the best performance.

Montgomery, *et al.* (1979) described an apparatus for recovering insect eggs and larvae from soil. The machine consisted of a wash tank and a series of screen sieves. Complete processing of large and difficult samples could be accomplished with in 20 minutes.
Teotia and Panday (1979) tested insecticidal properties of alcoholic, petroleum ether and ether extracts of *Acorus calamus* Linn. rhizomes against *Sitophilus oryzae* Linn. All the extracts of *A. Calamus* were found to be more or less toxic to *S. oryzae* and the order of toxicity was acorus petroleum ether extract > acorus ether extract > acorus alcoholic extract.

Hafez, et al. (1980) described the morphology of the preadult stages of *Chelonus inanitus* L. Rearing of this parasite in laboratory on *Spodoptera littoralis* and *Ephestia kuchniella* Zell was also described.

Mathur (1980) made observations on the biology of *Glyphodes pyloalis* Wlk. He found that duration of egg hatching, larval and pupal period was 2-3, 17-30, 6-9 days, respectively.

Hafez, et al. (1981) studied the biology of *Chelonus inanitus* L. in laboratory. It was observed that both males and females were able to mate more than once, but a single mating was sufficient for the production of progeny with normal sex ratio.

Hoshikawa (1981) carried out field studies in Japan to determine the most important colony factors that influence the activity of *Polistis chinesis* var. *antennalis* Perez, considered an important predator of lepidopterous larvae.

Iwashita and Fukui (1981) described the life-history and morphology of *Hexamermis microamphidis* Steiner, parasitic on the larvae of *Glyphodes pyloalis* Wlk. Studies were made with the help of light microscopy and scanning electron microscopy.

Nickle and Hagstrum (1981) observed that the parasite *Bracon hebeto* Say, controlled the peanut pest, *Ephestia cautella* Wlk. more efficiently when parasites were supplied at the time of release with preparalyzed hosts. It was
observed that these paralyzed hosts provided female parasites with a readily available food source which increased parasite longevity and fecundity and an alternate oviposition site allowing the parasite to increase in advance of the pest population.

Siddiqui (19781) reported for the first time that the caterpillars of moth *Amsacta moorei* Butl. were being parasitized by two braconid species namely, *Apanteles obliquae* Wlk. and *Meteorus* spp. Parasitization due to *A obliquae* was found to be 17.5% while 13.3% parasitisation was due to *Meteorus* spp.

Ahmed, *et al.* (1982) studied the impact of temperature on the biology of *Bracon hebetor* Say. It was found that the developmental time from egg to adult was 9.8 days at 25°C and 7.5 days at 30°C. It was found that lower temperature was more favorable to adult emergence, life span and egg hatching.

Deshmukh, *et al.* (1982) observed the insecticidal property of 20 indigenous plants, out of which extracts of *Acorus calamus, Allium sativum, Artemisia vulgaris, Azadirachta indica, Piper nigrum, Vitex negundo* and *Coimum sanctum* were found to be the most promising insecticides.

Rajashekhargouda *et al.* (1982) for the first time recorded *Euproctis subnotata* damaging the leaves of mulberry. Detailed biology for this pest was studied under laboratory conditions during 1982.

Sasty and Singh (1982) reported the antiviral activity of 10 medicinal plants like *Dioscorea floribunda, Datura stramonium, Chrysanthemum cinerarifolium* etc. against TMV.

Weseloh and Anderson (1982) made observations on the release of *Brachymeria lasus* and *Pimpla disparis*, two exotic gypsy moth parasitoids, in
Connecticut. Habitat preference and over wintering potential of these pupal parasitoids were also studied.

Houston (1983) designed a motorized mechanical sieve to extract adult and immature dung beetles from soil. The sieve was fitted with a readily interchangeable mesh and soil was processed about 8-10 times as fast as in a hand-held sieve.

Jaipal, et al. (1983) observed that crude wood and bark extracts of *Melia azedarach*, *Azadirachta indica*, *Eucalyptus naundina*, *Launtna camara* and *Cassia fistula* inhibited *Dysdercus koenigii* metamorphosis to varying degrees. It was found that resultant individuals were incapable of reproduction and died instantly.

Mathur and Singh (1983) presented a list of insect pests of forest plants in India and the adjacent countries. Many insect species belonging to diverse orders, including *Glyphodes pyloalis* Wlk. attacking different species of mulberry have been enlisted.

Mishra and Kumar (1983) carried out studies with steam-distilled oil fraction of *Mentha piperita* for exploring its fumigant action against different developmental stages of *Tribolium castaneum* Herbst. LC50 values of oil to first, second, third and fifth larval instars were 0.7, 2.14, 11.88 and 20.04 ul/100cc, respectively. Corresponding values for adults after 24 and 48 hours of exposure were 3.04 and 3.21 ul/100cc, respectively.

Srivastava and Pandey (1983) studied the importance of *Mentha viridis*, *Ocimum basilicum* and *O sanctum* on growth, development and reproduction of *Diacrisia obliqua* Wlk.
Bestmann, *et al.* (1984) evaluated the insecticidal property of essential oil of the leaves of *Chrysanthemum balsamita* against aphids. About 30 compounds were identified in the essential oil to have insecticidal property.

Pandey, *et al.* (1984) evaluated the effect of some plant extracts against *Pyrilla perpusilla*. It was found that *Chrysanthemum cinerarifolium* flower extracts were most toxic to leaf hopper followed by extracts of *Gynandropsis pentaphylla* seeds, *Acorus calamus* rhizome and seeds of *Croton sparsiflorus*.

Patil and Thontadarya (1984) studied the efficacy of three trichogramma species viz. *T. evanescens* Westwood, *T. braziliensis* Ashm. and *T. pkcal* in parasitizing the egg of teak skeletonizer, *Pyrausta machaeralis* Wlk. under field conditions. Duration of survival for *T. Pkcal*, *T. brasilienis* and *T. evanescens* was found to be 105, 90 and 60 days respectively.

Balasubramanian, *et al.* (1985) carried out field studies in Tamil Nadu, India, to determine the effect of various meteorological factors on collections of *Spodoptera litura* in a modified Robinson light trap. It was found that collections of moths had significant positive relationship with sunshine hours and negative relationship with wind velocity.

Prakash and Mathur (1985) reviewed the literature on the use of plant products for insect pest management in stored grains and active principles in some of the oils, fractionated from various plant products viz. *Azadirachta indica* A. Juss. *Acorus calamus* L., *Allium sativum* L. and *Citrus aurantium* were reported to exhibit insecticidal or insect repellent properties against storage insects.

Srivastava, *et al.* (1985) examined juvenoid activity in extracts of certain plants against *Dysdercus cingulatus* nymphs. It was seen that out of 20 plants studied, maximum activity was shown by *Ageratum conyzoides* followed by *Tridex procumbens* and *Arlimisia imaritima*, while some plants did not show any Juvenoid activity.

Tewari and Moorthy (1985) evaluated the impact of petroleum-ether extract of *Melia azedarach* L. drupes, *Acorus calamus* rhizomes and *Azadirachta indica* seed oil on *Henosepilachna vigintioctopunctata* Fab. and its parasite. All plant products showed varying degrees of antifeeding effects both against grubs and adults. Concentration of 0.5 and 0.1 % of all the plant substances were found to give 100% protection to leaf. The degree of parasitization by *Pediobius foveolatus* was found to be less when grubs were freshly treated with antifeedants.

Chander and Ahmad (1986) assayed the oil extracted from five medicinal plants for their ovicidal, repellent and protectant properties against *Callosobruchus chinensis* L. It was found that percent oviposition on seeds got reduced significantly when oils from rhizomes of *Acorus calamus* and *Curcuma amada* and seeds of *Copticum* and *Bassia longifolia* were applied at doses of 0.25 and 0.50 ml/kg seed. Oils of *A. calamus* at 1 ml/kg seed were found to offer protection upto 135 days while oils of *C. amada* and *C. copticum* at the same concentration protected the seeds upto 90 days only.
Gupta and Veer (1986) conducted Laboratory bioassay tests of 19 insecticides as contact poisons against third instar larvae of *Glyphodes pyloalis* Wlk. Highest toxicity was found in chlordimeform (0.006518) followed by formothion (0.007197) while gamma BHC showed the least toxicity (0.3098) in terms of LC$_{50}$ value.

Khan (1986) conducted an experiment to study the efficacy of *Acorus calamus* L. rhizome powder in the control of *Callosobruchus chinensis* L. infesting stored Bengal gram. It was revealed that 0 to 120 DAT recorded significantly lesser infestation as well as lesser increase in number of insects as compared to untreated control. The residual affect of *Acorus calamus* treatment was found to persist well upto 90-120 days.

Kumari, *et al.* (1986) studied the impact of water and methanolic extracts of leaves, stems and buds of *Datura stramonium, Ipomea carnea, Tagetes patula* and *Lawsonia alba* on the larvae of *Tylenchulus semipenetrans* and *Anguina tritici*. It was found that methanolic extracts of all these plants caused 75-100% larval mortality of both types of insects at 4 mg/ml.

Seol, *et al.* (1986) observed mating behavior and sex pheromone of *Glyphodes pyloalis* Wlk. The mean mating time preceded the mean calling time by 3.5 to 5 hrs on day 2 to day 4 after emergence. In the laboratory bioassay, the males strongly responded and were attracted to the abdominal tip extract of virgin females. In the field cage bioassay also 88% of the released males were attracted and trapped in the virgin female trap and 40% in the crude extract trap.

Seol, *et al.* (1986) prepared an artificial diet for mass-rearing of *Glyphodes pyloalis* Wlk. It was found that addition of the juice of frozen mulberry leaves or young mulberry leaf powder into the artificial diet improved the quality of diet. It was also noticed that pupal and adult yields on
the improved diets were larger than those on the basic silkworm diet. Out of the three artificial diets tested, SM-diet was found to be superior to MJ-diet and YAKULT- diet.

Thompson (1986) provided information regarding nutrition and in vitro culture of many insect parasitoids. Many hymenopterous parasitoids like *Diadromus pulchellus*, *Pimpla instigator*, *Pteromalus puparum*, *Exeristes roborator* etc. were mentioned.

Seol, *et al.* (1987a) performed crossing experiments and did behavioural study of two types of *G. pyloalis* Wlk. No significant difference in emergence, calling or mating time between the two types was observed. They were noted to mate at random with each other in the laboratory and females of both types showing high cross-attractiveness to males in a field cage. It was concluded that no reproductive isolation appeared to have occurred between the two types.

Seol, *et al.* (1987b) conducted the purification and identification of the sex-pheromone of the female of *Glyphodes pyloalis* Wlk. It was concluded that major component of the sex-pheromone was 10, 12, 14-hexadecatrienyl acetate.

Ando, *et al.* (1988) carried out synthesis and NMR analysis of eight geometrical isomers of 10, 12, 14 hexadecatrienyl acetate, sex pheromone candidates of *Glyphodes pyloalis* Wlk.

Gouda and Devaiah (1988) studied the life cycle of *Amata passalis* Fb. under laboratory conditions. Duration of incubation, larval and pupal periods were found to be 5.00, 34.2 and 9.7 days, respectively.
Wang, et al. (1988) made epidemiological study of a densonucleosis virus in *Bombyx mori* L. They observed that virus dispersed early in rearing room and was carried by *Margaronia pyloalis* and *Exartema morivorum*.

Watanabe, et al. (1988) investigated that larvae of *Glyphodes pyloalis* were frequently infected with nonoccluded viruses that are serologically indistinguishable from the desnonucleosis viruses (DNV-1, DNV-2) and the infectious flacherie virus (IFV) of *Bombyx mori*. It was revealed through histo-chemical investigations that viruses multiply only in a small number of midgut cells. It was concluded that Bombyx DNV-I, DNV-2 and IFV originated from the Glyphodes nonoccluded viruses and mulberry pyralid could be a common habitual host of these viruses.

Ghorpade and Patil (1989) studied bionomics of *Glyphodes laticostalis* Guenee, reported as a serious pest of forest plantation in Konkan region of Maharashtra State, India. The average duration of incubation period, larval and pupal life was found to be 6.5, 16, 11.5 days, respectively.

Kaur, et al. (1989) studied the impact of topical application of methanol extract of leaves of *Chrysanthemum indicum* on the growth and development of 5\textsuperscript{th} instar nymphs of *Dysdercus similes*. Dose related inhibition with regard to growth and development was reported. Besides, production of super-nymphs, adultoids and adults with malformed wings was noticed.

Khan and Trag (1989) reported for the first time *Minastra cyanura* Hope as a pest of mulberry from Jammu region of J&K state. Infestation period was found to be from April to July.

Mcgeachie (1989) made observations on the effect of moonlight illuminance, temperature and wind speed on light trap catches of moths. It
was observed that different moth families reacted to these factors differently in terms of light trap catches. It was found that noctuid moths were unaffected by variation in mean illuminance, although they were influenced by variation in mean temperature and mean wind speed.

Bandara, *et al.* (1990) evaluated insecticidal property of *Acorus calamus* L. and *Glycosmis maurotiana* against *Aphis craccivora*. It was found that dichloromethane extract of *Acorus calamus* rhizome recorded the highest aphidicidal activity.

Banerji, *et al.* (1990) made observations on toxicity of capillin, the insecticidal principle of *Artemisia nilagirica* Clarke, against the larvae of mosquito.

Honda, *et al.* (1990) identified (E, E, Z)-10, 12, 14 hexadecatrienyl acetate as evidenced by analysis of ovipositor extracts by GLC and HPLC as female sex pheromone of *G. pyloalis* Wlk. The amount of pheromone produced was found to be 1-2 mg/female. Field tests of all possible geometric isomers of synthetic 10, 12, 14-hexadecatrienyl acetate showed that only (E, E, Z)- configuration had activity.

Honda, *et al.* (1990) identified major components of sex pheromone of females of *Glyphodes pyloalis* Wlk. as (10E, 12E, 14E)-10, 12, 14 hexadecatrienyl acetate. The amount of pheromone produced was 1-2 mg/female.

Matsuyama, et al. (1991) isolated an oviposition stimulant for *Glypodes pyloalis* Wlk. from an acetone extract of mulberry (*Morus alba* L.) leaves and its structure was identified as 2-(3',5'-dihydroxy-4'-prenylphenyl)-6-hydroxybenzofuran, viz. moracin C (1), a known phytoalexin from fungus-infected mulberry shoot.

Singh and Singh (1991) reported *Pealius mori* Takahashi, belonging to order Hemiptera, as pest of mulberry for the first time from India. Some aspects of its biology, nature and extent of damage to mulberry have also been studied.

Sukari, et al. (1992) studied toxicity of several plant extracts against some fishes and insects. Extracts of *Mentha arvensis*, *Ocimum sanctum* *Lindera pipericarpa* were used against mung bean weevil and two fish species.

Ahmad, et al. (1993) reported that essential oils from various plants like *Artemisia vulgaris*, *Chrysanthemum balsamita*, *Swartia japonica* etc. had insect repellent, nematicidal and insect attractant activities.

Ando and Ohsawa (1993) synthesized and found chemical characteristics of double bond positional isomers of 10, 12, 14 hexadecatrienyl acetate which is an important sex-pheromone of *Glyphodes pyloalis* Wlk.

Nath, et al. (1994) made studies on the extent of mulberry leaf destruction by *Diacrisia obliqua* Wlk. It was calculated that a larva required 1008 mg (dry weight) of mulberry leaves to complete its larval life with in a period of 18 days. It was also noted that major portion of the total leaf destruction was during the last two instars.
Prabhakar and Rao (1994) evaluated the relative toxicity of four botanical products, viz., Annmet (Annona product), Allitin (Garlic product), Neemguard (Neem product) and RD-9 Repelin (product of neem, karanjin, castor, mahua and gingelly) against *Aproaesema modicella* which mines in groundnut leaf. Neemguard, RD-9 repelin and allitin were found to induce maximum larval mortality (99.16-100%) followed by Annmet (86.16%)

Katiyar, *et al.* (1995) made observations to identify natural enemy complex of important pests of mulberry in mulberry gardens of Karnataka, Andhra Pradesh and Tamil Nadu. In all, 13 natural enemies were recovered including 2 predators, 9 parasitoids and 2 pathogens.

Takahashi, *et al.* (1995) investigated survival and population proportion of ice nucleation-active (INA) bacteria on mulberry tree and in mulberry pyralid, *G. pyloalis* Wlk. Two groups of bacteria, *Pseudomonas syringae* and *Erwinia ananas* were found to form dominant bacterial flora of mulberry pyralid.

Chomchalow (1996) presented an overview of botanical pesticides derived from medicinal and aromatic plants in Asia and Pacific. Plants like *Azadirachta indica*, *Annona squamosa*, *Chrysanthemum cinerariaefolium*, *Datura metal* etc. were mentioned.

Franzio, *et al.* (1997) screened various species of mint for their insecticidal property. It was found that essential oils of *Mentha pulegium* and *M. spicata* showed strong insecticidal activity, while the oil of *M. spicata* showed mutagenic activity as well.

Myartseva (1997) presented a list of insect pests attacking different plants in Turkmenistan. The pests mentioned were *Bemisia tabaci*, *Liriomyza bryoniae*, *Glyphodes pyloalis* Wlk. etc.
Pandey (1997) followed an ecofriendly approach such as organic soil application in the form of neemoil seed cake and dried leaf powder in combination with few plants viz., *Adhotoda vasica* Nees, *Mentha arvensis*, L. and *Murraya Koengii* L. Significant reduction in the population of root knot nematode, *Meloidogyne incognita* on black henbane, *Hyoscymus niger* L. was reported.

Philip and Sharma (1997) evaluated fungitoxic effect of the extracts of leaf and oil cake of *Azadiracta indica* A. Juss and *Pongamia glabra* L. on the mycelial growth, spore production and seed germination of *Fusarium solani* and *Fusarium oxysporum*, causing root rot disease in mulberry. Except Karanj leaf extracts, all other extracts tested were found to be very effective in either suppressing the mycelial growth, spore production or spore germination.

Singh and Kumar (1997) evaluated powder of six plant products viz. ,Kernel and leaves of dharak, *Melia Azadirach L.* kernal and leaves of neem, *Azadirachta indica*, leaves of datura, *Datura albanees* and leaves of oak, *Calotropis procera* Br. with doses 2.5 and 5.0g/100g of grain as grain protectants under laboratory conditions against lesser grain borer *Rhizopertha dominica* Fb. Dhark kernel powder at 5 g/ 100g of grain was found to cause maximum mortality (62.56%) of adult beetles and the grain damage was only 8.5% against 52.6% in control.

Fotadar, *et al.* (1998) screened 58 genotypes of mulberry, belonging to 5 species, against two fungal diseases and *Margaronia pyloalis* Wlk. The varieties of temperate origin such as Ichinose, Serpentina, Ichehei, K.N.G, Limoncina, French and Spanish-5 and the tropical ones namely, Tr8, Tr10, C73, C77, C1735, Acc31, S41, S146, S1301, S1531 S1708, ACC 32, Mandalay and female local were found to be field resistant (0-5% infestation) to *Margaronia pyloalis*. 
Khan, et al. (1998) studied the phytotoxicity and residual effect of monocrotophos (0.05% and 0.1%) and dichlorovos 0.04%) against G. pyloalis Wlk. and silk worms. It was found that these pesticides gave highest mortality percentage (90-96%) for Glyphodes pyloalis Wlk. It was also observed that unlike Monocrotophos (0.05% and 0.1%), Dichlorovos (0.04%) was relatively safe for silkworm rearing after 9th day of spray.

Rajadurai (1998) studied occurrence, life cycle and nature of damage caused by bagworm, Amieta spp. (Psychidae: Lepidoptera) in mulberry gardens of Karnataka. Besides, various measures for the control of this pest were suggested.

Sen and Rajadurai (1998) developed an IPM package against Diaphania pulverulentalis Hampson which comprised components like Mechanical, cultural, Chemical and biological control. Five parasitoids and four predators of the pest were also recorded.

Singh and Mehta (1998) screeed some plants for their repellent and insecticidal properties against Callosobruchus chinensis L. and Musca domestica. Oils of Cedrus deodara and Matricaria chamomilla gave 58.67% and 55.10% mortality results, respectively, against pulse beetle. while oils of Mentha arvensis, Cymbopogon martinii, C. winterianus and Cedrus deodara gave 93.33, 86.67, 86.67 and 66.67% mortality, respectively.

Veeranna (1998) discussed insect pests of mulberry in china and their management. Out of 54 species of insect pests associated with mulberry in china, species like Bombyx mandarina, Rondotia menciana, Hemerophila spp., Mimastra Cyanura Hope, etc. were mentioned.
Bajw and Ashiq (1999) screened five exotic mulberry varieties for selective resistance against *Glyphodes pyloalis*. It was found that local variety was relatively most resistant with a mean infestation of 25.9%.

Bandyopadhyay *et al.* (1999) recorded a new homopteran pest on *Morus alba* L. from West Bengal, India. The new pest, *Dialeuropora decempuncta* was found to appear during March and attain its peak pop. during September.

Chauhan, *et al.* (1999) made survey of pests of mulberry in Uttar Pradesh and found that *Spilosoma obliqua* Wlk; *Glyphodes pyloalis* Wlk. and *Mimastra cyanura* Hope formed the dominant group. Besides, damage to mulberry leaf by *G. pyloalis* Wlk. was also studied.

Hayasaka and Yonemura (1999) investigated infection and development of *Nosema* spp. N1S H5, a microsporidian parasite which was isolated from *Antheraea pernyi*. Infectivity test to 12 lepidopteran species revealed that *Nosema* spp. was infectious to *Bombyx mandarina*, *Antheraea pernyi*, *Antheraea yamanai*, *Hemerophila atrilineata*, *Spilarctia imparilis*, *Hyphantria cunea*, *Glyphodes pyloalis*, *Leucania separata*, *Spodoptera litura*, *Pieris rapae craccivora*, *Lymantria dispar* and *Euproctis similis*. It was concluded that *Nosema* spp. was not infectious to *B. mori* L and was having a wide range of hosts among lepidopteran species, suggesting that *Nosema* spp. could become a very promising agent for the microbial control of insect pests.

Reddy and Narayanaswamy (1999) reviewed literature on the mulberry infesting thrips with regard to their distribution, influence of abiotic factors on their incidence, nature, extent of damage, symptoms, nutritional loss caused, biology and management. 35 species of thrips have been found to inflict damage to mulberry from different parts of world.
Sharma and Sheikher (1999) reported that neem leaf extracts (aqueous, ethanol and acetone) reduced the gonadal weight in *Helicoverpa armigera* when applied at 0.125, 0.25 and 0.50% against 1\textsuperscript{st}, 2\textsuperscript{nd} and 3\textsuperscript{rd} instar larvae, respectively. A reduction in weight was found to be 5.45-13.05% in testes and 3.0-20.05% in ovaries. Fecundity and egg fertility was also found to be affected.

Singh and Rao (1999) tested various extracts of *Artemisia vulgaris* against *Spodoptera litura* and *Schistocerca gregaria* for their effect on feeding, development and reproduction. Although no antifeedancy was noticed but development and reproduced were found affected in both the insects.

Desai and Desai (2000) screened eleven locally available plant species in Maharashtra, India, for their insecticidal properties, both as aqueous suspensions and as cold alcoholic extracts, against *Spodoptera litura* Fab. and *Lipaphis erysimi* Kalt. It was found that cold alcoholic extract of *piper nigrum* Linn. caused greatest larval mortality in both types of insects under laboratory conditions.

Marimadaiah and Geetha Bai (2000) reported parasite complex of *Diaphania (= Margaronia) pulverulentalis*. a serious pest of mulberry in South India. *Phanerotoma navesi* zettel was found to be predominant parasitoid of *D. pulverulentalis* while *Apanteles bisulcata* was recorded for the first time from this pest.

Raman, *et al.* (2000) evaluated custard apple, *Annona squamosa* formulations against *Spilosoma obliqua* and *Bombyx mori* L. Annona oil based formulations were found to be best antifeedants followed by Annona seed extracts and leaf extracts. The residual toxicity to silkworm was found to last only up to 10-13 days.
Zeya et al. (2000) conducted an extensive survey in various agroclimatic zones of J&K in order to identify the pests and diseases of mulberry, besides assessing the loss caused by them to mulberry plants. During the survey, in addition to already reported insect pests, *Amsacta lactinea* Cramer, *Porthesia scintillans* Wlk. and *Hemerophila atrilineata* Butler were found to be new records on mulberry from J&K.

Gowda, et al. (2001a) made observation on seasonal incidence of *Diaphania pulverulentalis* in Karnataka, India during 1999-2000. The first appearance of the pest was noticed in July 1999 while its peak incidence was recorded during January 2000.

Gowda, et al. (2001b) studied the incidence of natural enemies on the leaf roller *Diaphania pulverulentalis* infesting mulberry crop in Bangalore. Two braconid parasitoids i.e. *Apanteles* spp. and *Chelonus* spp. were found to be active from September to January and October to January respectively. One larval predator *Calosoma* spp., and two fungal pathogens *Aspergillus lamarii* and *Beauveria bassiana* were observed to infect the pest.

Narayanaswamy, et al. (2001) provided a detailed information regarding the lepidopteran insect pests associated with mulberry in different moriculture regions of the world. Data regarding distribution, bio-ecology and nature of damage with respect to these pests has been provided.

Vidyasagar and Rajasab (2001) tested different concentrations of lead extracts of neem and parthenium and bulb extracts of garlic to assess their effect on conidial germination of *Phyllactinia coreylea* and powdery mildew disease development on mulberry leaves. Foliar spray with neem, parthenium and garlic extracts on mulberry leaves was found to reduce percent disease index (PDI) from 50 to 5.8, 51 to 7.4 and 52 to 0.6 percent, respectively.
Bai, et al. (2001) made a feasibility study on application of abamectin to control insect pests on mulberry. It was diluted to 2000, 4000 and 6000 times and then sprayed for the control of 5 kinds of main insect pests of mulberry like *Bombyx mandarina*, *Rondotia menciana*, *Gyphodes pyloalis* etc.

Ahmad, et al. (2002) compiled information on Indian species of *Trichogramma* with short description of species along with the host insects, host plants and their distribution. So far 17 species like *T. Chilonis*, *T. Japonicum*, *T. Australicum* etc. have been reported from different states of India.

Ali, et al. (2002) conducted field experiments to evaluate the efficacy of neem products and phosphamidon (0.05%) against linseed budfly, *Dasyneura lini* Barnes. Out of seven neem based insecticides, Viz. Nimbecidine 2%, NSKE 3%, Neemazol 2%, Rakshak 2%. none was found superior to two chemical synthetic insecticides, viz., Phosphamidon and endosulfan.

Bandyopadhyay, et al. (2002) evaluated the effectiveness of neemoi against whitefly and its impact on silkworm rearing. It was observed that by the second day of insecticidal application, the whitefly, *Dialeuropora decempuncta* Quaintance and Baker. population had declined to nil in plots treated with 1% and 1.5% neemoi solution.

Karmarkar, et al. (2002) studied the persistant toxicity (antifeedency) of some neem products like neemoi, Nimbecidine, Neemark and Nimbitor against *Spodoptera litura* Fab. It was observed that toxicity of 2% Nimbecidine. Neemark and Nimbitor persisted for 5 days while for the rest of the treatments it persisted for 4 days only.
Katiyar, *et al.* (2002) studied the incidence, life history and nature of damage of *Spilosoma obliqua* in Maharashtra, India. Various control measures for this leaf-eating pest like mechanical, chemical and biological methods have been suggested.

Nighat, *et al.* (2002) made preliminary studies on the natural enemies of *Glyphodes pyloalis* Wlk. from various sericultural regions of Kashmir. During the survey, caterpillars of this pest were found to be parasitised by *Apanteles glomeratus* (Braconidae: Hymenoptera) and pupae by *Chelonus* spp. (Braconidae: Hymenoptera). Out of these, *Apanteles glomeratus* was found to be most abundant natural control agent of *Glyphodes pyloalis* Wlk. in Kashmir.

Philip, *et al.* (2002) conducted a survey on the incidence of major insects pests on mulberry in some districts of Kerala. A few tips for checking pest infestation in mulberry gardens in Kerala were also presented.

Sharma, *et al.* (2002) evaluated azadirachtin for its insecticidal and growth inhibitory effects against final instar larvae of *Notolophus antiqua* Linn. Dose dependent mortalities were found to be occurring in larvae. Besides, larval and pupal duration was found to increase in a dose dependent manner.

Zeya, *et al.* (2002) studied cross-infectivity of different pathogens of mulberry silkworm *Bombyx mori* L. to insect complex available in mulberry gardens, rearing houses and surrounding agricultural crops. It was observed that insect pests of mulberry like *Glyphodes pyloalis* Wlk. *Altica himensis* Shukla, *Pieris brassicae* L. and *Lymentria obfuscata* Moore, were susceptible to the *Beauveria bassiana* (Bals.) Vuill. causing white muscardine in *Bombyx mori* L. which proves that they are alternate insect hosts of *B. bassiana*. A new
species of Beauveria isolated from *Altica himensis* was found to be highly pathogenic to *Bombyx mori* L.

Ertian (2003) provided detailed information about *Glyphodes pyloalis* covering various aspects like biology, distribution, damage, natural enemies, forecast of incidence etc.

Hemalatha and Govindan (2003) revealed the occurrence of leaf cutter bee, *Megachile* spp. on the mulberry in Karnataka. The bee was observed to cut the circular pieces of leaves from the margin of mulberry plant to construct the nest on the lower canopy of the trees.

Hong and Qin (2003) made investigations on parasitic bees of *Diaphania pyloalis* in China. Five larval parasitic bees viz. *Atlacocentrum confusum* H., *Apanteles heterusiae* Wilk., *Chelonus* spp., *Phanerotoma philippinensis* Ashm. and *Pristomerus erthrothoracis* Uchid were described. Three pupal parasitic bees viz. *Xanthopimpla punctata* Fab. *Brachymeria lasus* Wilk. and *Pediobius* spp. were distinguished. Likewise three hyperparasitics viz. *Stictopisthus chinensis* Uch., *Brachymeria secundaria* Rus. and *Euryctoma* spp. were observed.

Misra. *et al.* (2003) reported mulberry as a new host for *Oxyrachis tarandus* Fb. (Membracidae: Hemiptera) in Andra Pradesh, India. Pest was found to cause foliar distortion by sucking cell sap and injection of Toxins though its saliva.

Rajadurai and Thiagarajan (2003) undertook a study focused on the sap sucking pest complex existing in mulberry crop system. Amongst sap suckers, 18 heteropteran, 10 homopteran and 2 thysanopteran species were recorded. Various parameters like life cycle, damage, symptoms and methods of control of these pests were also studied.
Rajadurai, et al. (2003) studied the impact of infestation of leaf roller, *Diaphania pulverulentalis* Hampson, on the growth and yield of mulberry in relation to plant age in South India. It was noticed that tolerance of the plants to leaf roller larvae began to increase with the advancement of plant age.

Sultana (2003) studied the effects of parasitism of braconid wasp, *Apanteles obliquae* Wlk. on the developmental stages and food consumption of larva of *Spilosoma obliqua* Wlk. A reduction in host size and its food consumption was recorded. It was observed that larva parasitized at 3rd instar stage caused less damage (one third of healthy larva) to host plant than non-parasitized larva.

Zeya, et al. (2003) discussed the insects pests attacking mulberry in J&K. Nature of damage and methods of their control have also been ascertained.

Guanqin, et al. (2004) studied bionomics of *Macrocentrus philippinensis* Ashm. The parasitic rate of *M. Philippinensis* to *Diaphania pyloalis* was also investigated and rate of parasitism was 2.09-27.42%.

Khan, et al. (2004) studied incidence, percent population and yield loss caused to mulberry by *Glyphodes pyloalis* Wlk. It was found that among different varieties, highest pest incidence was on Chinese white (27.52%) followed by Goshoerami (13.99%). Likewise, highest pest population was noted on Goshoerami (23.87%) followed by Chinese white (20.88%).

Reddy and Srinivasa (2004) conducted a field study during Kharif of 1998 and summer of 1999 to evaluate different botanicals for control of bringal shoot and fruit borer, *Leucinodes orbonalis* Guen. Results revealed that pongamia oil at 1 to 2% recorded low borer damage (11.40-12.70%) in Kharif which was at par with aqueous leaf extract of *Vitex negundo* at 4 to 5%
during summer. Neem and pongamia oil at 2% were found effective in reducing the fruit damage (19.60 to 20.30%)

Sharma et al. (2004) worked out the safe period of azadirachtin for tasar silkworm, *Antheraea myliita* D. It was found that mortality of larvae decreased with increase in time interval between brushing of silkworm larvae and foliar spray. It was found that silkworms could be reared safely after five days of application of aqueous solution of azadirachtin without affecting important parameters of tasarworms.

Shukla and Kumar (2004) determined relative toxicity of some pesticides viz. beta-cyfluthrin, endosulfan, azadirachtin, spinosad, diflubenzuron and B.T.K against 3rd and 4th instar larvae of *Plutella xylostella* L. Highest toxicity was found in Beta-cyfluthrin while azadirachtin showed lowest toxicity in terms of LC_{50} value.

Doyon and Boivin (2005) studied the effect of development time on the fitness of female *Trichogramma evanescens*. It was observed that early emerging females did not live longer and did not produce progeny with a different sex-ratio than females that emerged later. They were larger and produced more progeny than late females. It was concluded that early emerging females have a higher fitness than late emerging females.

Gupta et al. (2005) studied the effect of *Mentha piperita* leaf powder on the developmental stages of *Trogoderma granarium*. Egg, larval and pupal mortality at 2% treatment was found to be 29%, 31.1% and 0.3-57% respectively.

Kathuria and Kaushik (2005) evaluated potential of Eucalyptus species in insect pest management. Oil, powder and extracts of various parts of different Eucalyptus species were evaluated.
Kumar and Mukhopadhyay (2005) tested the efficacy of botanical insecticides for management of mulberry pests and their bio-safety to silkworms and natural enemies. Neem oil, Pongamia oil and Nicotine extract were tested against Mealy bug, thrips and whitefly.