

1. INTRODUCTION

The scarabaeid beetles are the most common leaf chafers, whereas larvae are among the most destructive soil pests. The larvae of family Scarabaeidae are recognized as pests of planted crops in many parts of the world and are almost universally known as 'whitegrubs'. The whitegrub family, Scarabaeidae is second largest family within the order Coleoptera and is cosmopolitan in distribution. Among the soil macro fauna, the whitegrubs form a major component both in number of species and diversity of habits in Indian sub-continent (Veeresh 1988). The world fauna of whitegrubs exceed 30,000 species (Mittal 2000), and the maximum number occurs in the tropical areas of the world, particularly in the African and oriental regions. The fauna of the Indian sub-region is very rich and diverse, but it is yet to be fully explored (Mishra and Singh 1999). Ali (2001) reported that the family Scarabaeidae represents about 2500 species from the Indian sub-region. This is a polyphagous pest both in the grub and adult stage and inflicts heavy damage on various fruit/ forest trees, their nurseries, vegetables, lawns and field crops (Chandel and Kashyap 1997).

The adult scarabaeids constitute a large distinct group of highly specialized beetles, which could easily be recognised by their lamellate antennae (Gardner 1935), and are also called as lamellicorn leaf chafers. The common name 'leaf chafer' comes from the fact that beetles are defoliating pests and damage a large number of fruit crops and forest trees as a result of feeding on apical buds and tender leaves (Chandel and Kashyap 1997). Beetles usually remain unnoticed throughout the year, and their appearance in large numbers occur just after break in monsoon for a month or two, and feed on the foliage of different fruit and forest trees. Many species are crepuscular or nocturnal, rarely seen by casual observers except when the beetles are attracted to light. Some are diurnal, occasionally found feeding on flowers and fruits (Mehta et al. 2010).

Ritcher (1958) reported that different subfamilies of Scarabaeidae fall into two main groups, one group including Coprinae, Aphodiinae, Geotrupinae and Troginae which are either saprophagous or fungus feeders and form a separate group 'Laprosticti'. The second group includes the subfamilies Melolonthinae, Rutelinae, Dynastinae and Cetoniinae which are strictly phytophagous forming 'Pleurosticti' which is the topic of present study.

Although the lamellicorn leaf chafers are placed in one general group on the basis of their feeding on living tissue, however, there exists a great diversity in their food habits. Adults of Melolonthinae and Rutelinae devour plant tissue, especially leaves, flowers or young fruits. In contrast, adults of Dynastinae usually attack stems or roots of plants in their search for liquid nourishment, often feeding underground. Adults of the Cetoniinae are also largely liquid feeders, but feed above ground, preferring nectar or sap or the juices of ripening fruits and vegetables. Some species feed on pollen. There are species in each of the subfamilies Melolonthinae, Rutelinae and Dynastinae which do not feed at all during the adult stage (Ritcher 1958).

There are more than 50 pest species of whitegrubs in India, of which *Holotrichia serrata* Fabricius, *Holotrichia consanguinea* Blanchard, *Holotrichia longipennis* Blanchard, *Brahmina coriacea* (Hope), *Holotrichia seticollis* Moser, *Anomala dimidiata* (Hope), *Holotrichia reynaudi* Blanchard, *Leucopholis lepidophora* Blanchard, *Leucopholis coneophora* Burmeister, *Melolontha* spp. and *Lepidiota* spp. are the key pest species attacking different plants in different regions of the country (Yadava and Sharma 1995).

In Himachal Pradesh, adults of *B. coriacea*, *H. longipennis* and *Anomala lineatopennis* Blanchard severely attack the leaves of apple (Mehta et al. 2008). In Uttarakhand, adults of *H. longipennis* feed on leaves of walnut, chestnut, apple and plum (Mishra 2001). Veeresh (1977) in Karnataka found adults of *H. serrata* feeding on neem, guava and grapes. According to Yadava and Sharma (1995), adults of *H. consanguinea*, occurring in Rajasthan, Gujarat, Uttar Pradesh and Bihar, prefer foliage of *ber*, *neem*, *Jamun* and drumstick, sometimes causing severe defoliation. *Maladera insanabilis* Brenske is an important defoliating beetle of mulberry plants in Jammu region of Jammu and Kashmir (Sharma and Tara 1985). In Karnataka, the beetles of *Popillia pulchripes* Arrow have been reported to cause damage to newly emerging leaves of local banana (Thyagaraj and Gubbaiah 1996). Dhaliwal and Mehndiratta (1994) found beetles of *Chiloloba acuta* Arrow severely attacking sorghum seed crop in Punjab.

Since many species of whitegrubs are root feeders, they are also called as root grubs, but all whitegrubs are not root grubs (Mehta et al. 2008). De Fluiter (1941) divided whitegrubs into three categories according to their feeding habits; i) grubs feeding only

on dead organic matter (Cetoniinae); ii) grubs which normally feed on dead organic matter but will attack living roots in its absence (Certain Rutelinae and Dynastinae); iii) grubs feeding by preference on living roots of crop plants (Melolonthinae).

Most of the whitegrubs are similar in shape and colour and have fleshy curved bodies with brown heads and well developed legs which are hardly used for locomotion (Mehta et al. 2010). The whitegrubs can be easily distinguished from similar looking grubs by the presence of two rows of minute hairs on the undersurface of the last segment of abdomen (Khan and Ghai 1974). They live concealed and suddenly increase their population in places having enough food and least disturbance of soil (Chandel and Kashyap 1997). Whitegrubs are favoured by light soil, fibrous rooted plants and high particulate organic matter content and are not abundant in waterlogged, compacted, stony soils or lands lacking vegetation (Mehta et al. 2008).

In many parts of the world, larvae of Melolonthinae cause extensive damage to the roots of grasses, legumes, small fruit plants, shrubs and trees. Larvae of greatest economic importance belong mainly to the tribe Melolonthini (Ritcher 1958). In India whitegrubs are pest of national importance and their economic importance is primarily due to the feeding of third instar grubs (Mehta et al. 2010). First stage larvae feed, in part, on organic matter in the soil; second and third instars feed largely on roots or underground stems. Grubs prefer to feed on fibrous roots for normal growth and the crops with tap root system suffer more as compared to adventitious root system (Yadava and Vijayvergia 2000). In general, the underground parts of all plants are subjected to grub feeding. The symptom of injury is root pruning by grubs showing varying degrees of wilting, yellowing, browning and eventually death. In crops like potato and ginger, large holes are made in the tubers/rhizomes rendering them unfit for marketing. Almost all the crops grown during *kharif* season are damaged and extent of loss varies from area to area (Mehta et al. 2010).

Throughout Rajasthan, Bihar, Gujarat, Uttar Pradesh, Haryana and Punjab larvae of *H. consanguinea* are of major importance attacking groundnut and sugarcane. In endemic areas, the damage to groundnut ranges from 20-100 per cent. *H. serrata* larvae are destructive to the roots of vegetables, pulses, oilseeds, cereals, millets, tobacco, sugarcane and sorghum in Karnataka, Maharashtra, Andhra Pradesh, Tamil Nadu, and

Kerala. In peninsular India, *Leucopholis* larvae injure the roots of coconut palms and also attack cassava, sweet potatoes, yams and *Colocasia* (Nirula et al. 1952). The larvae of *Lepidiota* spp. feed on the roots of sugarcane in Indo-Gangetic plains of North India, maize in Himachal Pradesh and potato in Assam (Mehta et al. 2010; Bhattacharyya et al. 2011).

In entire North Western Himalaya, the grubs of *B. coriacea*, *H. longipennis* and *Melolontha* spp. cause wide spread damage to potato, vegetables, groundnut, sugarcane, maize, pearl millet, sorghum, cowpea, pigeonpea, green grass, cluster bean, soybean rajmash, ginger, pea, rice, strawberry etc. The problem of whitegrubs is quite serious in hilly states where potatoes are grown during summer season as rainfed crop under long day conditions (Misra and Chandel 2003). In potato, the tuber damage often exceeds 50 per cent in endemic areas in Shimla hills (Chandel and Chandla 2003). In forest nurseries up to 30 per cent infestation due to grubs of *B. coriacea* have been reported in mid hills of Himachal Pradesh (Chandel et al. 2009). More than 100 species of phytophagous whitegrubs have been reported to occur in North Western Himalaya, however, large number of species are still unidentified and there exists lot of variation in their behaviour and biology. This poses problem in the development of effective integrated pest management schedules against these pests. To combat the burgeoning problem of whitegrubs, it is imperative to understand the species distribution in the region and also their host preference, so that a focused strategy may be formulated for their management. Keeping these points in view, proposed problem on whitegrubs was contrived to find more details related to distribution and development of whitegrubs in Himachal Pradesh with the following objectives:

- i) To map out the scarabaeid fauna of Himachal Pradesh,
- ii) to study the damage relationships of whitegrubs and beetles in different crops,
- iii) to generate information on life history and economic relations of important species of whitegrubs and May-June beetles.