

## 5. SUMMARY AND CONCLUSIONS

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The light trap studies were carried out in eight whitegrub endemic locations from six districts of Himachal Pradesh during 2011 and 2012. A total of 13,569 scarabaeid beetles, representing 20 genera and 55 species were collected by light traps. At Palampur 29 species were collected and maximum percentage of total catch in a year was for that of *M. insanabilis* (12.3% in 2011 and 13.66% in 2012). *A. lineatopennis*, *A. lasiopygus*, *H. longipennis*, *A. pallens* and *A. varicolor* were the other dominant species having relative abundance of  $\geq 5$  per cent at Palampur. These species were recorded most frequently on light trap with 75-100 per cent of frequency. In Kullu valley, 21 species were collected on light trap and *B. coriacea* and *A. phthisica* were the most predominant species. They comprised 12.58-12.88 Per cent and 12.13-14.25 Per cent of total catch during 2011-2012, respectively. Total eight species were categorized as dominant ( $\geq 5\%$ ) in Kullu valley, and out of these, *B. coriacea*, *A. phthisica*, *H. sikkimensis*, *A. rufiventris* and *H. longipennis* were recorded most frequently.

At Dallash, there was overall dominance of rutelinids, and *A. bimarginatus* and *A. lasiopygus* were the most predominant species. *A. bimarginatus* constituted 11.37 and 9.54 per cent and *A. lasiopygus* comprised 11.18 and 10.09 per cent of total catch during 2011 and 2012, respectively. Other dominant species ( $\geq 5\%$ ) recorded most frequently (75-100% frequency) on light trap at Dallash were *M. insanabilis*, *H. longipennis*, *A. dimidiata*, *M. fulgidivittata* and *H. sikkimensis*. Light trap studies in Shillaroo area revealed that only *B. coriacea* occurred most frequently on light trap (100% frequency), and it constituted 70.52-72.39 per cent of total catch during 2011-2012 at Shillaroo. Similarly, in Kheradhar area, *B. coriacea* was the most preponderant species comprehending about 21.23 and 19.23 per cent of total catch during 2011 and 2012, respectively. At Kwagdhara, *A. lineatopennis* was the most predominant species and its relative abundance was recorded to be 29.39 and 28.37 per cent during 2011 and 2012, respectively. Other leading species at Kwagdhara were *A. varicolor* (16.08-24.13% of total catch) and *A. pallens* (18.38-23.88%). The species which occurred most frequently on light trap (75-100% frequency) at Kwagdhara were *A. varicolor*, *A. pallens*, *M. insanabilis*, *B. coriacea* and *H. longipennis*. *A. lineatopennis* occurred at regular interval with 50-75 per cent frequency of occurrence.

In dry temperate zone of Himachal Pradesh, monitoring was done at Bharmour and at Reckong Peo. At Bharmour, maximum percentage of total catch in a year was for that of *A. rufiventris* (13.93-14.03% in 2011-12) followed by *A. lasiopygus* (12.75% in 2011 and 11.87% in 2012) and *B. coriacea* (10.12-11.03% in 2011-12). Out of 15 species collected at Bharmour, 11 species were categorized as dominant ( $\geq 5\%$ ) during both the years. *A. rufiventris*, *A. lasiopygus*, *M. furcicauda*, *M. cupresens*, *P. neglecta* and *H. longipennis* appeared most frequently (75-100% frequency) on light trap. In Reckong Peo area, *M. insanabilis* was the most predominant species and it accounted for 16.74-19.42 per cent during 2011-12. Other leading species in this area were *A. lasiopygus* (12.86-13.74%) and *B. coriacea* (11.55-12.38%).

The light traps were operated for 4 months from May to August and 50.79 per cent of the scarabaeid beetles were captured only in the month of June. The five most common species in Himachal Pradesh on light trap were *B. coriacea*, *A. lasiopygus*, *A. lineatopennis*, *M. insanabilis* and *H. longipennis*. They comprised 9.88-10.05, 7.18-7.76, 7.13-7.27, 6.80-7.62 and 5.22-5.30 per cent during 2011-12, respectively.

The value of Shannon index ( $H'$ ) was found to be maximum ( $H'=3.01-3.03$ ) at Palampur and the value of Pielou's evenness index ( $J'$ ) ranged from 0.89-0.90. These values indicate maximum abundance of species at Palampur with higher evenness in community between different species of scarabaeid beetles. The Shillaroo area had the lowest Shannon index ( $H'=1.12-1.17$ ) and Pielou's evenness index ( $J'=0.46-0.49$ ). This shows that the beetle community in Shillaroo area is highly diverse numerically. This unevenness of scarabaeid community is mainly due to the sole dominance of *B. coriacea* which comprised more than 70 per cent of total beetle catch in Shillaroo area of Shimla hills.

The scarabaeid beetles are highly polyphagous and large flights of these beetles were noticed during May-June on the foliage of different fruit/forest trees. Data on relative abundance of scarabaeid beetles on host trees were collected at 9 locations during 2011 and 2012. At Palampur, 24 species were collected during 2011-2012 and *H. longipennis* was the most predominant species comprising 30.94 and 28.69 per cent of total catch during 2011 and 2012, respectively. The beetles of *H. longipennis* were collected mainly from *toon* trees and there was 88.6-90.0 per cent defoliation of *toon* leaves due to feeding of *H. longipennis* beetles. In Kullu valley, 20 species were collected

on apple, pear, peach, plum, wildrose, *Ficus* and pomegranate. *B. coriacea* was the most prominent species and its relative abundance was recorded to be 48.18 and 46.83 per cent during 2011 and 2012, respectively. *A. phthisica* constituted 21.07-22.16 per cent of total beetle catch during 2011 and 2012 followed by *Schizonycha* sp. 1 (10.17-11.64% of total catch). *B. coriacea* constituted 84.19-87.07 per cent on apple during 2011-2012. The *Schizonycha* sp. 1 was predominant on pear comprising about 92.82 and 91.44 per cent of total beetle catch on pear during the study period. *A. phthisica* exhibited distinct preference for peach. Maximum defoliation at Kullu was recorded on peach (84.00-85.40% in 2011 and 2012) mainly due to feeding of *A. phthisica*. On apple, 64.5 and 60.2 per cent of the leaves were found to be defoliated by chafer beetles.

In Dallash area of Kullu district, *B. coriacea* contributed 25.86-26.06 per cent of total adult beetles on different fruit and forest trees. The population of *H. longipennis* and *M. insanabilis* ranged from 9.68-9.97 and 9.02-9.55 per cent during 2011 and 2012, respectively. *B. coriacea* and *H. longipennis* displayed distinct preference for apple for mating and feeding. *B. coriacea* comprised 63.68 and 46.53 per cent on apple during 2011 and 2012, respectively. *M. insanabilis* beetles demonstrated clear cut preference for peach comprising 32.17 and 32.0 per cent of total beetle catch on peach (67.01-68.1%) followed by apple (56.9-58.0%).

At Nauni, out of 23 species, *B. coriacea* comprised 22.87-24.02 per cent of total catch during 2011-2012 on different host trees. *M. cotesi* constituted 13.53 and 13.25 per cent during 2011 and 2012, respectively. *B. coriacea* beetles were collected on apple, pear, apricot, *Robinia*, peach and *kachnar* leaves, however, there was decided preference for apricot. *M. cotesi* was recorded chiefly on pear and *toon*. At Nauni, there was 53.8-55.3 per cent leaf defoliation on apricot and 57.2-58.0 per cent on *toon* during the study period. There was complete dominance of *B. coriacea* in Shillaroo area constituting 97.51 and 97.17 per cent of total catch during 2011 and 2012, respectively. At Shillaroo, *B. coriacea* exhibited distinct preference for walnut and apple among the fruit trees. In case of walnut, 93.7-95.1 per cent leaf defoliation was recorded during 2011-2012. Similarly, at Kheradhar, *B. coriacea* was the most predominant species and it constituted 57.17-58.46 per cent of total beetle catch during 2011-2012. *A. lasiopygus* comprised 5.53-6.47 per cent of total population during 2011-2012. *B. coriacea* comprised 63.21

and 46.3 per cent on apple during 2011 and 2012, respectively. The leaf defoliation on apple ranged from 60.6-61.5 per cent.

At Kwagdhar, *A. lineatopennis* and *B. coriacea* were the most leading species. *A. lineatopennis* comprised 34.05-36.06 per cent of total catch on different fruit trees, followed by *B. coriacea* (16.23-19.01%). Maximum beetles of *A. lineatopennis* were collected on apple (71.13-79.02%). The leaf defoliation was recorded to be 79.9-87.9 per cent during 2011-2012 at Kwagdhar. In Bharmour area, 18 species were collected on apple, pear, apricot, walnut and plum. Most prevalent species were *B. coriacea* (21.35-25.99%) and *H. longipennis* (9.95-18.06%). Greater proportion of *B. coriacea* beetles was taken on apple (42.22% in 2011 and 35.59% in 2012), followed by walnut (30.44% in 2011 and 30.5% in 2012). There was no appreciable defoliation of any of the fruit trees at Bharmour. In Reckong Peo area of Kinnaur district, *B. coriacea* and *M. insanabilis* are the two most important species. *B. coriacea* and *M. insanabilis* comprehended 20.64-25.59 per cent and 15.59-22.87 per cent of total beetle catch during the study period. *B. coriacea* constituted 62.16 and 39.13 per cent of total count on apple during 2011 and 2012, respectively. In case of *M. insanabilis*, the most preferred host was peach. Maximum leaf defoliation in Kinnaur district was recorded on walnut (28.0-43.4%).

The Shannon index ( $H'$ ) was calculated to be maximum at Nauni ( $H' = 2.48$ ) during 2011 and at Dallash ( $H' = 2.49$ ) during 2012. The calculated value of Pielou's evenness index ( $J'$ ) was maximum at Dallash. Thus maximum evenness of allotment of individuals among the species was there at Dallash. The Shannon index was lowest at Shillaroo ( $H' = 0.15-0.17$ ). The value of Pielou's evenness index ( $J'$ ) was approaching almost zero ( $J' = 0.06-0.07$ ) demonstrating complete unevenness of individuals among the species. At Shillaroo, *B. coriacea* alone constituted 97.16-97.51 per cent of total catch which explains the very low value of Pielou's evenness index ( $J'$ ). At Palampur, 24 species were collected, and the value of Simpson's index of diversity ( $D$ ) varied from 0.85-0.86. However, at Dallash, 17 species were recorded, but value of Simpson's index of diversity was greater ( $D = 0.87-0.89$ ) as compared to Palampur. There exists less variation in scarab community between the species at Dallash as compared to Palampur, hence more value of Simpson's index of diversity ( $D$ ) was calculated at Dallash which otherwise represented 17 scarab species as against 24 species recorded at Palampur.

During the study period, a total of 32,967 beetles were collected on host trees representing 78 species of scarabaeid beetles. Melolonthinae comprised 58.97 per cent of total phytophagous scarabaeids, followed by Rutelinae (29.49%), Cetoniinae (7.69%), Dynastinae (2.59%) and Dynamopodinae (1.28%). On the basis of size of population, five most common scarabaeid species on host trees in Himachal Pradesh were, *B. coriacea* (48.4%), *H. longipennis* (9.70%), *A. phthisica* (5.19%), *M. insanabilis* (4.95%) and *Schizonycha* sp. 1 (3.88%). A comparison of light trap with host tree data revealed that *B. coriacea* constituted 48.54 per cent on host trees, whereas on light trap, it constituted nearly 9.96 per cent of total catch. Similarly, *H. longipennis* comprised 9.70 per cent on host trees, whereas on light trap its percentage was recorded to be 5.26 per cent. The population of *M. insanabilis*, *A. lineatopennis* and *A. lasiopygus* was more on light trap (6.8 to 7.72%) as compared to host trees (2.84 to 4.95%). This clearly showed that *B. coriacea* and *H. longipennis* are less phototactic in nature whereas *M. insanabilis*, *A. lineatopennis* and *A. lasiopygus* are more heliotactic in nature. Total 86 species were recorded from Himachal Pradesh and out of these, 26 species were not recorded on light trap, but these were found only on host trees. On the other hand there are five species viz. *H. nigricollis*, *A. carinata*, *A. pellucida*, *P. virescens* and *P. coensa* which were not recorded on host trees, but these were recorded only on light trap.

Twenty four species viz. *D. athleta*, *A. carinata*, *A. proxima*, *A. villosella*, *Sophrops* sp. 1, *Sophrops* sp. 2, *sophrops* sp. 3, *M. carinata*, *M. bimaculata*, *M. perpendicularis*, *M. piluda*, *M. simlana*, *T. umbrinella*, *A. comma*, *A. singularis*, *A. tristis*, *A. elata*, *A. pallens*, *A. lasiopygus*, *A. bimarginatus*, *A. pellucida*, *H. nigricollis*, *P. virescens* and *O. albopunctata* seems to be new records from Himachal Pradesh.

Data on whitegrub infestation were recorded in crops like potato, ginger, cole crops, peas, maize, capsicum, tomato and rajmash. In potato, it was observed that the problem of whitegrubs is quite serious in high hills, where the potatoes are grown during summer season as rainfed crop under long day conditions. Maximum tuber damage (40.8-45.6%) was recorded at Shillaroo and density of *B. coriacea* in potato fields at Shillaroo ranged from 14.9-16.1 grubs/ft<sup>2</sup>. At Baragran, Tar (Kangra district), Dhurla (Shimla district), Janjheli (Mandi district) and Kheradhar (Sirmaur district), the mean tuber damage ranged from 15.8-28.0 per cent during 2011-2012. The grub population ranged from 6.50±0.65 to 10.8±0.77 larvae/ft<sup>2</sup> in 2011 and 6.1±0.745 to 12.1±1.05 larvae/ft<sup>2</sup> in

2012, at these locations. In ginger, maximum rhizome damage was recorded at Sangrah (20.3% in 2011 and 17.8% in 2012) and Chereu (16.25% in 2011 and 18.0% in 2012) in Sirmaur district. The predominant species in ginger was *H. longipennis* with population ranging from  $3.2 \pm 0.61$  to  $3.50 \pm 0.34$  and  $2.1 \pm 0.53$  to  $2.6 \pm 0.62$  grubs/ft<sup>2</sup> during 2011 and 2012, respectively at Sangrah and Chereu.

In rajmash, the grubs of *Melolontha* spp. were observed to cause damage. Maximum mortality in rajmash occurred during May-June when plants were at 5-6 leaf stage. At Baragran in Kangra district, the plant mortality in rajmash was found to be ranging from 21.0-26.3 per cent during 2011-2012. The mean grub population of *Melolontha* spp. was estimated to be  $8.0 \pm 0.70$  and  $6.20 \pm 0.55$  grubs/ft<sup>2</sup> during 2011 and 2012, respectively. In Jokhari area of Solan district, there was moderate incidence of *P. dionysius* in capsicum (14.5-19.75%) and tomato (13.2-15.4%) during the study period. The average population of grubs ranged from  $2.3 \pm 0.50$  to  $2.8 \pm 0.47$  larvae/ft<sup>2</sup> in capsicum and tomato fields during 2011-2012. In cabbage, maximum damage (28.0-30.7%) was observed at Baragran in 'off season' crop. At Kothi-kohad, Kothi-swar and Barot, the infestation ranged from 15.3-20.2 per cent during 2011-2012. Accordingly, the grub population of *Melolontha* spp. was recorded to be maximum at Baragran ( $5.0$ - $5.50$ /ft<sup>2</sup>) followed by Kothi-swar ( $2.70$ - $3.90$ /ft<sup>2</sup>). In peas, whitegrub infestation was noticed in Kinnaur, Kangra and Mandi districts. Maximum damage was recorded in Janjheli area (21.75-25.0%), followed by Barot area (18.8-22.1%).

In maize, data on whitegrub infestation were recorded in six districts at nine locations. Maximum damage due to attack of *L. stigma* was recorded in river bed areas at Kheri village in district Hamirpur. It was interesting to note that *L. stigma* caused damage in alternate years. There was 40.2 per cent plant mortality during 2011 at Kheri, whereas in 2012, negligible plant damage (2.50%) was recorded. The damage was recorded in June when the plants were at 3-4 leaf stage.

Observations on biology and morphometrics of 16 commonly occurring species of whitegrubs were recorded. Full fed grubs of *B. coriacea* measured 23.97 mm and the head capsule width ranged from 3.85 to 4.17 mm. Adults are black in colour measuring 13.81 mm in males and 15.98 mm in female beetles. Total life cycle was completed in 285 days indicating a one year life cycle. In *B. flavosericea*, the larvae are similar in form, length (23.97 mm) and colour to *B. coriacea*. The head capsule width in *B.*

*flavosericea* was recorded to be 1.16, 2.13 and 3.30 mm for instar I-III, respectively. The adults are medium sized, elongate beetles with yellowish elytra. The body length of female beetles ranged from 15.36-16.01 mm, while the male beetles were 14.31-15.03 mm in their body length. There was a single generation per year and the duration of life cycle varied from 225-275 days.

In *H. longipennis*, grubs are large in size. Head capsule width averaged 1.74, 3.51 and 5.06 mm, in instars I-III. Mean body lengths during the three instars were recorded to be 8.86, 19.73 and 33.40 mm, respectively. The adult beetles are shining, light chestnut-brown in colour with light brown abdomen and dark brown legs. The female beetles have been recorded to slightly larger (20.44-21.98 mm long) than the male beetles (18.53-20.85 mm long) Total life cycle from egg to adult for *H. longipennis* occupied an average of  $308.06 \pm 3.68$  days with one generation per year. *H. sikkimensis* grubs are similar in size to *H. longipennis*. The length of full fed third instar grubs ranged from 32.97-36.11 mm and the head capsule width measured 5.11 mm. Adult beetles are dull brown in colour, often confused with *H. longipennis*. The male and female beetles measured 22.58 and 26.09 mm, respectively. Total life cycle from egg to adult emergence was of  $319.5 \pm 5.06$  days in *H. sikkimensis*. In *M. cotesi*, the grubs are larger than *B. coriacea* and smaller than *H. longipennis*. The fully fed third instar grubs are 32.67 mm in length and head capsule width averaged to be 4.98 mm. The adult beetles are elongate, parallel sided, smooth, dull brown in colour measuring 16.06 mm and 14.66 mm in females and males, respectively. Total duration of single generation ranged from 298-305 days.

In *M. cuprescens* and *M. virescens*, the life cycle was completed in two years. Total duration from egg to adult emergence required 675.80 and 618.40 days, respectively. The grubs are very large in size. Average body lengths attained by full fed third instar larvae were 61.78 and 55.38 mm for *M. cuprescens* and *M. virescens*, respectively. The respective head capsule widths were recorded to be 8.0 and 8.45 mm. The beetles of *M. cuprescens* are moderately large in size (Male: 26.23 mm; Female: 30.53 mm long), elongate, convex, brownish-red, covered all over with pale scales. Pygidium is long and projected behind into a slightly bifurcated tail. The adults of *M. virescens* are dark brown beetles, clothed very densely and evenly with pale scales. Pygidium is protected behind into a slightly bifid process. The female beetles are 26.99 mm long and males are 24.12 mm in body length. Like *Melolontha* spp., *L. stigma* is also

a large species taking two years (718.35 days) to complete a single generation. Third instar grubs were on an average 65.86 mm long. Adult beetles are dull brown in colour and the body is elliptical in shape. White spots are present near the tip of elytra. The average length of male and female beetles was recorded to be 38.96 and 40.68 mm, respectively.

*A. phthisica*, *M. insanabilis* and *Schizonycha* sp. 1 are small melolonthid beetles causing economic damage only in adult stage. In *A. phthisica* and *M. insanabilis*, one year life cycle was observed, whereas in *Schizonycha* sp. 1, two generations are expected in a year. In *A. phthisica* and *M. insanabilis*, the total durations of life cycle were recorded to be  $301.80 \pm 3.90$  and  $276.30 \pm 1.61$  days, respectively. In *Schizonycha* sp. 1, first generation occupied 78-90 days from April to June. However, 2<sup>nd</sup> generation was recorded from July-April having average duration of  $270.40 \pm 2.24$  days. The beetles of *A. phthisica* are oblong in shape and yellowish in colour. The female beetles measured about 7.66-8.15 mm long, whereas length of males ranged from 6.31-6.61 mm. The *M. insanabilis* are reddish brown beetles. The length of body ranged from 8.45-9.21 mm in females and 7.46-8.02 mm in male beetles. The beetles of *Schizonycha* sp. 1 are elongate, parallel sided, reddish brown and shining above. The female beetles are distinctly bigger (13.34 mm) than male beetles (12.10 mm).

In genus *Anomala*, observations were recorded on life stages of *A. dimidiata*, *A. polita*, *A. lineatopennis* and *A. varicolor*. All these four species completed their life cycle in one year. Total duration of life cycle ranged from 295 to 323, 294 to 332, 330 to 351 and 337 to 358 days in *A. dimidiata*, *A. polita*, *A. lineatopennis* and *A. varicolor*, respectively. The grubs of *A. dimidiata* and *A. polita* are larger in size as compared to *A. lineatopennis* and *A. varicolor*. The average body length in full fed third instar larvae of *A. dimidiata*, *A. polita*, *A. lineatopennis* and *A. varicolor* was recorded to be 37.82, 34.84, 26.26 and 24.65 mm, and width of head capsule averaged 5.39, 4.01, 4.10 and 3.50 mm, respectively. The body of *A. dimidiata* beetles is less convex and broadly oval in shape. They are apple green with metallic texture on the upper surface. The male beetles are 19.93 mm long, whereas females are 21.21 mm in body length. In *A. polita*, beetles are elongate, rather parallel sided, moderately convex and not very shiny. All margins of elytra are blackish in colour. The male beetles measured about 20.57 mm long and the female beetles measured 23.05 mm long. The beetles of *A. lineatopennis* are medium in

size (Male: 15.54 mm; Female: 18.64 mm) with dark coppery or greenish black above and beneath. The lateral margins of the pronotum and the elytra are straw coloured. The body of *A. varicolor* adults is shortly oval, convex smooth and shining. There is a variable patch on each side of pronotum, the extreme edges of elytra and a black spot on each shoulder. The male and female beetles are 13.59 and 15.42 mm long, respectively. Among dynastid beetles, data on biology of *P. dionysius* were recorded. There was single generation in a year and the duration of total life cycle ranged from 154 to 169 days. Adult formation occurred in October and the beetles remained in earthen cells till May, passing winter in adult stage. In all other studied species in the present research programme, overwintering occurred in grub stage and *P. dionysius* was exception to it. The adults of *P. dionysius* are compact, globose, chestnut red beetles and shining above. The male beetles are slightly bigger (19.96 mm) than female beetles (19.17 mm). In male beetles, cephalic horn is broad, strongly inclined backwards, triangular at extremity with acute apex.

The raster patterns have been generated for 16 species and they provide accurate measures for identification of each species during larval stage. The male and female genitalia have been taken from 13 and 11 species, respectively, and there exists definite variation in male genitalia and identification of scarabaeid beetles on the basis of male genitalia doesn't allow any error in identification.

**Conclusions:** A total of 86 species were recorded on light trap and host trees in Himachal Pradesh. Out of these, 55 species were recorded on light trap and 78 species occurred on host trees. *B. coriacea*, *A. lasiopygus*, *A. lineatopennis*, *M. insanabilis* and *H. longipennis* were the most predominant species on light trap. On host trees, *B. coriacea*, *H. longipennis*, *A. phthisica*, *M. insanabilis* and *Schizonycha* sp. 1 were the leading species. *B. coriacea* and *H. longipennis* were found to be less phototactic in nature whereas *M. insanabilis*, *A. lineatopennis*, and *A. lasiopygus* are more heliotactic in nature. The diversity indices indicate maximum species richness with more evenness in scarab communities at Palampur, Nauni, Dallash and Kwagdhar. In Shillaroo area only *B. coriacea* predominated indicating poor species diversity and complete unevenness of abundance in scarab community. Maximum emergence of beetles was recorded in the month of June during both the years, indicating that June month is most critical period requiring definite intervention to control whitegrubs in endemic areas. Whitegrub surveys

revealed that whitegrub endemic areas are located mostly in mid and high hill area of Himachal Pradesh causing damage to potato, ginger, rajmash, peas, cole crops, maize and summer vegetables. In potato, maximum damage occurs in high hills where potatoes are grown in summer season as rainfed crop. Species like *M. insanabilis*, *A. phthisica* and *Schizonycha* sp. 1 caused damage only in adult stage, whereas their larvae don't cause any economic damage. Biology of whitegrubs was studied for 16 species. *B. coriacea*, *B. flavocericea*, *H. longipennis*, *H. sikkimensis*, *A. phthisica*, *A. dimidiata*, *A. lineatopennis*, *A. varicolor*, *A. polita* had an annual life cycle. Adult emergence occurs in May-June every year with overwintering in third larval instar, whereas in *P. dionysius* adult formation takes place in autumn season and adult overwinters. In case of *M. cuprescens*, *M. virescens* and *L. stigma* life cycle was completed in two years. The third larval instar was the longest stage varying from 317-328, 305-311 and 328-333 days, respectively. In *Schizonycha* sp. 1, two generations are expected in a year. The raster patterns have been generated for 16 species and they provide accurate measures for identification of each species during larval stage. The male and female genitalia have been taken from 13 and 11 species, respectively, and there exists definite variation in male genitalia and identification of scarabaeid beetles on the basis of male genitalia doesn't allow any error in identification.