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DISTRIBUTION AND RELATIVE ABUNDANCE OF *LEPIDIOTA ALBISTIGMA* IN RELATION TO SOIL PHYSICO-CHEMICAL PROPERTIES OF LOWER BRAHMAPUTRA VALLEY OF ASSAM

Dhanalakhi Gogoi, **Badal Bhattacharyya, ***Himangshu Mishra, **Sudhansu Bhagawati and Snigdha Bhattacharjee[+]

MNCRC, Bholaguri, Golaghat, Department of Sericulture, Govt. of Assam
**AINP on Soil Arthropod Pests, Department of Entomology; ***Krishi Vigyan Kendra, Karimganj;
[+]Department of Entomology, Assam Agricultural University, Jorhat 700013

ABSTRACT

Population of *Lepidiota albistigma* grubs were estimated in five selected ecosystems of lower Brahmaputra valley of Assam during 2015-17. The study revealed that significantly higher numbers of grubs were collected from grassland near water sources (8.52 ± 0.97, 7.56 ± 0.59 and 8.72 ± 0.91), followed by open grassland (4.96 ± 0.75, 5.06 ± 0.82 and 4.60 ± 0.89) and cultivated field near water sources (2.74 ± 0.83, 2.38 ± 0.92 and 2.54 ± 0.86) during the three years of sampling periods *i.e.* 2015, 2016 and 2017, respectively. Existence of grubs in different soil depth measured during April, 2015 to March, 2016 in grassland and cultivated field revealed maximum grubs confined upto 20 cm.

Population estimation of various growth stages from March, 2016 to February, 2017 revealed that adults appeared in March (0.4 A) with maximum during April 2016 (1.6 A). Grubs appeared from May (1.6 G), 2016to January (0.6 G), 2017. Similar population of grubs (1.6 G) were recorded in May, July and September and peak population was observed in August 2016 (3G); pupae were observed in March (1.2 nos), April (0.8 nos), 2016 and February (1.4 nos) in 2017. Soil moisture studies revealed maximum in April (27.63 %) followed by July (24.38 %) and October (24.32 %).Correlation coefficients between grubs and sand (r = -0.693) and silt content (r = -0.845) were significant and negative, in contrast to clay content (r = 0.839). Soil organic matter content (r = 0.901) and available nitrogen (r = 0.963) had significant positive correlations.

Key words: *Lepidiota albistigma*, life stages, habitat selection, population dynamics, soil properties, physico-chemical, correlation coefficients

White grubs (Coleoptera: Scarabaeidae) are highly polyphagous and serious as pests of national importance. They are among the most destructive and troublesome soil dwelling insect pests. In India, the scarabaeid fauna is very rich and diverse, but it is yet to be fully explored (Mishra and Singh, 1999). White grubs have emerged as severe pests in the northeast India with their density increasing every year as evidenced by the several outbreaks that occurred over large areas during the recent past (Bhattacharyya et al., 2014). In India, the white grubs belonging to the genera, *Lepidiota* had been reported from Himachal Pradesh (Mehta et al., 2008), Uttarakhand (Chandra and Gupta, 2012), Uttar Pradesh (Sreedevi et al., 2014) and Assam (Bhattacharyya et al., 2015). Within this genus, species like *L. albistigma* was reported from Nepal (Yubak Dhoj et al., 2006). However, this species did not receive considerable attention because of its remote incidence and unpredictable occurrence in India (Gupta et al., 1969). The scarabaeid beetles were generally active from the Month of April-June as they emerged from the soil during that period when they received the first monsoon rain (Singh and Mishra, 2003).

This study deals with the population dynamics of life stages of *L alibistigma.*

MATERIALS AND METHODS

Estimation of grub/pupa/adult population of *L. albistigma* in soil was undertaken in the endemic areas of Sorbhog. Soil sampling was carried out by digging five pits of 1 x 1 x 1 m on each month starting from March, 2017 to February, 2018. The mean number of grubs, pupae and adults were recorded in each pit. In each sampling, soil was collected from different endemic sites, later used for the estimation of different soil physico-chemical parameters. Abundance of *L. albistigma* population were also determined in five different ecosystems *viz.,* Open grassland, Open cultivated field, Cultivated field near tree, Grassland near water sources and Cultivated field near water sources. Mean population then compared in each ecosystem and the datas were angular transformed.

To study the distribution and relative abundance of *L. albistigma* grubs in different soil types, standard method put forwarded by Cherry and Allsopp (1991) was followed. Abundance of grubs along with the physicochemical properties of soils collected from ten villages of Sorbhog was analysed. Ten fields were selected from different areas to represent different soil types and there was at least 1 km distance from the each surveyed field. Each plot was pre-sampled by digging the soil at different depth to determine the existence of grubs. 10 random samples were taken within the plot. Each sample consisted of a 50 cm × 50 cm area dug up to a depth of 40 cm. This volume of the soil was examined visually in the field and grubs were counted. A sample of 500 g of soil was collected from 10 cm depth near the centre of each area. The different physical and chemical properties of soils were determined in the laboratory of All India Coordinated Research Project (AICRP) on Water Management, Assam Agricultural University, Jorhat, Assam by the following methods:

Mechanical analysis was done according to the International Pipette method (Jackson, 1973).

Determination of moisture content in soil was measured on dry weight basis by following standard protocols (Schmitz, 2015). Bulk Density (BD) was determined from the soil cores (Chapman, 1965).pH was measured in 1:2 soil water suspension using Beckman glass electrode. Organic Carbon (OC)was determined by dichromate oxidation (Walkley and Black, 1934) method. Available N was determined by the alkaline potassium permanganate distillation method (Subbiah and Asija, 1956).Available Phosphorus (Av P_2O_5) in soil was determined by Bray's method (Bray and Kurtz, 1945) by extracting the soil with 0.03N NH_4F in 0.025 N HCl and determined colorimetrically. Cation Exchange Capacity (CEC)was determined by leaching the soil with neutral normal ammonium acetate (1N NH_4OAc, pH 7.0) solution followed by distillation method (Blake, 1965). Available Potassium (Av K_2O)was determined using 1N ammonium acetate extraction followed by emission spectrometry (Jackson 1973).

RESULTS AND DISCUSSION

Habitat selection

Data presented in Table 1 indicates the abundance of grub in five selected ecosystems. Experimental results revealed that significantly more grubs were recovered from grassland near water sources than all other ecosystems which is followed by open grassland and cultivated field near water sources during the three years of sampling periods i.e., 2015- 2017. There is no significant difference in between cultivated field near water sources and open cultivated field. It has already been reported that almost all white grub species belonging to the genus *Lepidiota* subsist either on the Islands or near the river valley (Gupta, 1969; Allsopp, 1989; Kuniata and Young, 1992 and Anon., 2011). The mean grub population recovered from grassland near

Table 1. Abundance of *L. albistigma* grubs in ecosystems

Ecosystem	Mean* population (±SD)/m3		
	2015	2016	2017
Open grassland	4.96 ± 0.75 (3.60 – 6.20)	5.06 ± 0.82 (3.40-6.40)	4.60 ± 0.89 (3.01 – 5.80)
Open cultivated field	2.12 ± 0.73 (0.80 – 3.41)	2.22 ± 0.68 (1.20 - 3.60)	2.2 ± 0.66 (1.20 – 3.60)
Cultivated field near tree	1.68 ± 0.56 (1.20 - 3.01)	1.74 ± 0.52 (0.81 - 2.40)	1.7 ± 0.59 (1.00 - 2.81)
Grassland near water sources	8.52 ± 0.97 (7.40 -10.41)	7.56 ± 0.59 (6.40 -8.21)	8.72 ± 0.91 (7.22-10.00)
Cultivated field near water source	2.74 ± 0.83 (1.20- 3.80)	2.38 ± 0.92 (0.82 -3.61)	2.54 ± 0.86 (1.00 – 3.80)
S.Ed(±)	0.35	0.32	0.36
CD(0.05)	0.70	0.65	0.72

*Mean of five replications from five fields; in parentheses given range water sources were 8.52 ± 0.97, 7.56 ± 0.59 and 8.72 ± 0.91/m^3 during 2015, 2016 and 2017, respectively. The mean grub population recorded in open grassland were 4.96 ± 0.75, 5.06 ± 0.82, 4.60 ± 0.89/m^{3}during 2015, 2016 and 2017 respectively, while the mean grub population recorded from cultivated field near water sources were 2.74 ± 0.83, 2.38 ± 0.92 and 2.54 ± 0.86/ m^3 during 2015, 2016 and 2017, respectively. There is no significant difference of grub population found in open cultivated field (2.12 ± 0.73, 2.22 ± 0.68 and 2.20 ± 0.66/m^3) and cultivated field near tree (1.68 ± 0.56, 1.74 ± 0.52 and 1.70 ± 0.59/m^3) during 2015, 2016 and 2017, respectively.

Presence of highest numbers of grubs in grassland near water sources indicates that availability of sufficient soil moisture favours growth and development of different life stages of *L. albistigma*, more specifically the pupal stage. High densities of grubs in grasslands had already been reported by Kuniata and Young (1992), according to whom, *L. reuleauxi* grubs survived on some secondary weedy host plants viz., *Saccharum officinarum*, *S. spontaneum*, *Imperata cylindrical*, *Panicum maximum*, *Pennisetum purpureum* grown abundantly on Ramu River Velley, Papua New Guinea. Pujari and Bhattacharyya (2015) has found similar result that presence of more numbers of *L. mansueta* grubs in grassland near stream habitat indicates that availability of sufficient soil moisture favoured eggs laying, hatching, growth and development of different life stages and more specifically the pupal stage.

Bhattacharyya et al. (2011) also reported that among the weed hosts surveyed in Majuli river island, *Eleusine indica* (a dominant grassy weed) supported the grubs of *L. mansueta*. During survey, lowest numbers of grubs were recovered from cultivated fields and this may be due to the facts that cultivated fields were often disturbed by ploughing which subsequently exposed the grubs to predatory birds as well as natural death of grubs due to desiccation. Based on above information, it is realized that *L. albistigma* may pose a potential problem in low grass lands of nearby areas of Sorbhog, which were brought into cultivation for the first time and hence need special grub management approaches.

Abundance of grubs vs. soil depth

Two habitats viz., grassland and cultivated fields were sampled for abundance of *L.albistigma* grubs at different soil depths during April, 2015 to March, 2016. Grub population were recorded up to 40 cm soil depths in both the habitats. In grassland, *L. albistigma* grubs showed preference for the soil depths of 0-10 and 11-20 cm as compared to 21-30 cm and 31-40 cm. Yubak Dhoj (2006) reported that soil depth up to 20 cm was most preferable depth for larval activity. The present finding confirms the earlier report of Litsinger et al. (2002), they also observed that grubs of *Anomala humeralis* were more abundant from 11-20 cm but can found up to 30 cm soil depth.

The grub population recorded in 0 – 10 cm and 11-20 cm soil depths varied from 0.00 - 7.80 (3.79 ± 3.34) and 0.00 - 5.41 (2.31 ± 2.09)/m^3 soil. Lower number of grubs recovered from 21-30 cm (0.92 ± 0.77) and 31- 40 cm (0.68 ± 0.62) (Table 2). In cultivated land, the highest grub population recorded at the depth of 11 - 20 cm (2.78 ± 1.54) which is significantly differed with other depth. There is no significant difference in abundance of grubs at 0- 10 cm (1.40± 1.22), 21- 30 (0.51± 0.45) and 31 - 40 cm (0.57 ± 0.51) (Table 2).

Table 2. Abundance of *L. albistigma* grubs (April, 2015 to March, 2016)

Soil depth (cm)	Grassland*	Cultivated field*
	Mean ± SD	Mean ± SD
0-10	3.79 ± 3.34	1.40 ± 1.22
	(0.00-7.80)	(0.00 - 3.90)
11- 20	2.31 ± 2.09	2.78 ± 1.54
	(0.00-5.41)	(0.00 - 3.69)
21-30	0.92 ± 0.77	0.51 ± 0.45
	(0.00-2.04)	(0.00-1.22)
31-40	0.68 ± 0.62	0.57 ± 0.51
	(0.00 - 1.70)	(0.00 - 1.32)
S.Ed(±)	1.28	0.66
CD(0.05)	2.59	1.34

*Ten endemic fields each; with 5 replications; in parentheses given range

Some weedy grass supports the grub population in grasslands and hence they were mostly confined below the root zone (about 10 cm). Moreover, these weedy grasses were not available in the cultivated fields due to frequent ploughing. From the results of the present investigations, it is vivid that abundance of grubs of *L.albistigma* was mostly confined upto 20 cm depths of soil in both the situations. Similar results were obtained by Pujari and Bhattacharyya (2015) on *L. mansueta* in Majuli river island, Assam. Farmers' generally used to plough and harrow allowing the digging of soil upto 15-20 cm depths which exposed the grubs to predators (Litsinger et al., 2002). Moreover, high rainfall during the summer season in the month of August cause grubs to rise even higher in the soil profile. Therefore, summer deep ploughing will definitely reduce the grub population which were confined in the upper soil layer.

Population dynamics of life stages

The white grub population in soil was estimated by digging five pits of 1 m^3, sampling were carried out from March, 2016 to February, 2017. The number of grubs, pupae and adults were recorded in each pit (Table 3). The adults were recorded in soil samples from March (0.4 A) to May (0.6 A), 2016 with highest number recorded in the month of April (1.6 A). Population of grubs were recorded from May (1.6 G) to January (0.6 G). Similar population (1.6 G) of grubs were recorded in July and September, 2016 and the peak population was observed in August, 2016 (3 G). The reasons for maximum grub incidence in August may be due to high rainfall. Bouts of high rainfall caused the white grubs to move to the upper layer of soil was also observed by Litsiger et al. (2002) and Pujari and Bhattacharyya (2015). Population of pupae were observed at the sampling sites during March (1.2 P) and April (0.8 P) and February (1.4 P). Pupal population was less may be due to the fact that the third instar grubs moved to the deeper layers of soil for pupation during winter. These observations corroborate with the findings of Yubak Dhoj (2006).

Correlation coefficients

To study the different physical and chemical properties of soil, samples were collected from 10 numbers of *L. albistigma* endemic villages along with mean grub population recovered in soil samples during 2016 (Table 4). Correlation studies between grub population and soil physical and chemical parameters are presented in Table 5. Among soil physical parameters, sand (r = -0.693*) and silt content (r = -0.845*) had significant negative correlations on grub population. Clay content (r = 0.839*) had significant positive relationship with grub population.Cherry and Alsopp (1991) also observed distinct soil preferences exhibited among the cane grubs from Australia and according to them, *Antritrogus parvulus* abundance was positively correlated with clay and silt content and negatively correlated with sand content. While another white grub, *L. crinita* showed no significant correlations with sand, silt and clay content. They also found that none of the two species showed any significant correlation with soil pH.

Among the soil chemical parameters, soil organic matter content (r = 0.901*) and available nitrogen (r = 0.963*) had significant positive correlations. A similar study conducted by Oyafusu et al. (2002)reported that younger grubs of *D. ishigakiensis* feed not only sugarcane roots but also on the organic matter in the soil. Veeresh (1977) reported that higher oviposition by phytophagous scarab beetles was observed near the flight trees and organic matter, and these conditions are important for the survival of first instar grubs. The association of grubs with the presence of organic matter in soil was also reported by Diagne (2004) and King (1985).

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Table 3. Population dynamics of lifestages of *L.albistigma* (2016-17)

Months	Number of stages of white grubs/pit					Total population	Average population	Ave. soil moisture %)
	1	2	3	4	5			
				2014				
March	-	3P	2P	1A	1A,1P	6P, 2A	1.2P, 0.4 A	24.23
April	2P	2A	3A,1P	1P	3A	4P, 8A	0.8P , 1.6A	27.63
May	2A	-	2G	3G,1A	3G	8G, 3A	1.6G, 0.6A,	21.70
June	-	2 G	3G	1 G	-	6G	1.2 G	24.25
July	-	3G	-	4 G	1 G	8G,	1.6 G	24.38
August	3 G	4G	2 G	4 G	2G	15G	3 G	22.98
September	1 G	-	4 G	1 G	2 G	8 G	1.6 G	24.04
October	2 G	1 G	1G	-	1G	6 G	1.2 G	24.32
November	-	1G	-	3 G	-	4 G	0.8 G	23.41
December	1 G	-	1G	-	1G	3 G	0.6 G	21.09
				2015				
January	-	1G	1G	1G	-	3G	0.6 G	19.79
February	1P	-	2 P		4P	7P	1.4P	22.87

A: Adult, G: Grub and P: Pupa

Table 4. Abundance of *L. albistigma* grubs vs. physico-chemical properties of soils

Sampled villages	pH (1:2.5)	OM (%)	CEC cmol (p^+) Kg^{-1}	Available nutrients (kg/ha)			BD (g/cc)	Sand (%)	Silt (%)	Clay (%)	Soil texture	Grub/sq.m
				N	P_2O_5	K_2O						
Kamar Goan	4.17	1.18	24.23	247.05	16	128.6	1.44	42.7	29.1	28	clay loam	1.2
Kayastha Goan	4.61	2.39	20.1	352.1	25.62	460.65	1.12	32.1	24	43	clay	4.2
Sukanjani Goan	5.35	1.89	24.02	248.75	47.79	481.73	1.37	33	29	37	clay loam	1.9
Buri Khamar	5.27	2.3	21.4	349.12	42.48	478.72	1.32	31	28	35	clay loam	3.6
Puthimari	4.62	2.43	21.32	379.35	26.39	463.23	1.11	32.23	23	44	clay	5.3
Duramari	4.18	1.19	21	247.47	20	130.43	1.49	42.9	29.5	29	clay loam	1.7
Ahom Pathar	4.62	2.41	21.56	378.56	26.64	464.23	1.1	31.1	23	44	clay	4.3
Kumuriya Goan	5.4	2.1	22.01	250.53	49.45	484.34	1.39	33.67	30.21	29	clay loam	2.2
Palank Bari	5.32	1.39	23.43	248.48	42.58	479.56	1.36	32.34	29.65	36.45	clay loam	1.5
Noontula	4.14	1.06	19.56	243.03	15.89	125.34	1.49	44.23	27.53	30.34	clay loam	0.9

Table 5. Correlation coefficients- grubs population vs. physico-chemical properties of soil (2016)

Properties	r	Y
pH	0.106 NS	-
OM	0.901*	2.425x + 1.7691
Avl.N	0.963*	0.024x - 4.417
Avl. P	0.042 NS	-
Avl. K	0.603 NS	-
CEC	-0.329 NS	-
BD	-0.929 NS	-
SAND	-0.693*	-0.196x+9.656
SILT	-0.845*	-0.454x+15.080
CLAY	0.839*	0.200x - 4.452

*Significant at p= 0.05; NS =Non significant

OM:Organicmatter, Avl. N: Available Nitrogen, Avl. P: Available P_2O_5, Avl. K: Available K_2O, CEC: Cation Exchange Capacity, BD: Bulk Density

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