DISTRIBUTION OF WHITE GRUBS IN THREE ECOLOGICAL DOMAINS OF NEPAL

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ABSTRACT

A survey was conducted to study the abundance and distribution of white grubs in three districts representing different ecological domines in the country during June-July 2010. Two light traps were installed for two nights in two locations each of Makawanpur, Tanahu and Chitwan districts, and a season long light trap was installed at Mangalpur of Chitwan district from April to September 2010 for assessing scarab beetles flight activity. The 'simple matching coefficient' revealed high similarity >70% between two sites in each of the districts, while a similarity of 29-50% was observed between sites of different districts. The Jaccard coefficient revealed the same trend. However, coefficients were much lower, above 40% when comparing sites within a district, and below 20% when compared sites among the districts. The dominant species in Chitwan were Anomala dimidiata Hope (24%) followed by Maladera affinis Blanchard (23.75%), Anomala varicolor (Gyllenhal) Rutelinae (23%), Heteronychus lioderus Redtenbacher (14%) and Holotrichia sp (7%). The flight activity and species composition of scarab beetles in the three districts appeared to be different.

Key words: Abundance, distribution, dominant species, white grub

INTRODUCTION

White grubs (Coleoptera: Scarabaeidae) are the soil-living and root feeding immature stages of scarab beetles, of which both adult and larval stages are destructive in nature. The white grub family is the second largest omnipresent family, which includes over 30,000 species (Mittal, 2000). The larvae of these beetles are associated with numbers of crops and sometimes cause economic losses (GC et al., 2009). The damage caused by scarab larvae is estimated to reduce the crop yield by about 40-80% (Prasad and Thakur, 1959; Raodeo, 1974), and in a more recent study by about 12-60% (Pokhrel, 2004). Until recently, three main genera, i.e. *Phylophaga sp.*, *Holotricha sp.* and *Anomala sp.* were reported to be major pests in Nepal (Joshi, 1994; Neupane, 1995). Several species of white grubs, including *Phyllophaga crinita* Burmeister, *Phyllophaga congrua* (LeConte), *Phyllophaga crassissima* (Blanchard), and *Cyclocephala lurida* (Bland), are root-feeding pests of turfgrass, forage grass, corn, small grains, sugarcane, strawberry, potato tubers, and young nursery trees (Crocker et al., 1996). The grubs feed on roots of almost all the crops, like potato, maize, wheat, barley, jowar, bajra, groundnut, sesame, sunflower, chilies, cotton, sugarcane, tobacco, brinjal, cucurbit, and lady's finger including turf, meadows, lawns and forest trees (Oya, 1995; Fujiie and Yokoyama, 1996: Arita et al., 1993; Potter et al., 1992). The larvae prefer corn, groundnut, potatoes and strawberries but dislike legumes (Matheson, 1985), sweet clover (Metcalf and Flint, 1975) and lucerne (Keller et al., 2000). Therefore, monitoring of the white grub in three agro-climatic domains Makawanpur, Tananhu and Chitwan districts of Nepal were done for their distribution and identification and effective management.

OBJECTIVE

The objective of this study was to identify the different species of white grubs and their densities present in three ecological domains represented by two locations in each of the Makawanpur, Tananhu and Chitwan districts.

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MATERIALS AND METHODS

White grubs and their adults were collected from two locations in each of the districts using light traps to assess their prevalence in field crops.

ADULT MONITORING

Adults monitoring was done to determine the species occurrence and relative densities during June-July, 2010. For collection of adults scarab beetles, two light traps were installed for 2 nights in two different locations of each district; Daman (27°60'555 N, 85°09'095 E and 2303±10m altitude amsl) and Lamatar (27°50'101 N, 85°06'859 E and 2260±6m altitude amsl) of Makawanpur district representing high altitude, Ghasikuwa (27°96'792 N, 84°41'011 E and 542±8m altidute amsl) and Bhanu (28°08'195 N, 84°41'041 E and 486±6m altitude amsl) of Tanahu district representing middle altitude and Bachuli (27°58'126 N, 84°51'336 E and 184±7m altitude amsl) and Patiyani (27°57'880 N, 84°35'040 E and 180±5m altitude amsl) of Chitwan district representing lower altitude. During monitoring activities of scarab beetles, light trap with 18 watt CFL electric bulb was operated in farmer's field. Insects attracted to the light traps were collected into a nylon mess through a funnel trap fitted just beneath the electric light. Trapped insects were separated into scarab beetles and others; scarab beetles only were counted and preserved for taxonomical identification. Scarab beetles were kept in a vial of 15 cm height x 7 cm diameter size. A cotton swab with ethyl acetate moistened placed inside the vial was used as a killing agent. Collected beetles were pinned properly, stored in an insect collection box and brought to the Entomology Division (NARC) in Khumaltar and Plant Protection Directorate in Harihar Bhawan for identification based on reference insects maintained there.

SEASON LONG MONITORING OF SCARAB BEETLE AT MANGALPUR, CHITWAN

Long-season monitoring of white grub adults using light traps was conducted from 24 April to 5 September, 2010 at Mangalpur VDC of Chitwan district. The light trap was installed in farmer's field. The trap was AC-powered, had a 125 watt tungsten bulb, and was operated each alternate night over the study period. A nylon mesh was fixed for the collection of the trapped insects. Light trapped insects in the nylon mesh were collected each alternate day (i.e. in 2-days intervals), pinned in the insect collection box and then transported to Entomology Division of NARC. Identification was confirmed through Plant Protection Directorate.

Simple matching coefficient and Jaccard coefficient were used to analyze similarities between the sites and Chi-Square distance for dissimilarities of scarab beetles.

RESULTS

The highest numbers of scarab beetles were caught in Daman (32 adults), followed by Lamatar (21 adults) VDCs of Makawanpur district and the lowest numbers were caught in Bachuli (6 adults) VDC of Chitwan district. The highest numbers of beetle genera (6) were attracted in light trap I of Makawanpur and light trap II of Tanahu, while the lowest (4) were trapped in light trap II of Makawanpur and light trap I of Chitwan district. Anomala dimidiata Hope, A. varicolor (Gyllenhal) Rutellenhal, and Heteronychus lioderus Redtenbacher were the dominant species in high hills, mid-hill and terai, respectively. The beetle species and their numbers trapped in each location are presented in Table 1. A total number of 13 species were collected from the light traps in 3 districts.

The Jaccard coefficient revealed the same trend, however, coefficients were much lower, i.e. above 40% when comparing sites of the same district and between 0-20% only when sites of different districts were compared (Table 3). This indicated that the insect species prevailing in the study sites, especially in the different agro-ecological zones (districts) were quite variable. Relative high 'simple matching' coefficient for sites from different districts of about 40% were mainly due to the absences of white grub species in both sites;

however, presence of the same species between sites from different agro-ecologies (districts) was limited. Nevertheless, some species appeared in all three ecological zones i.e. Mimela inscripta (Nonfried).

Table 1. Species and numbers of of white grubs trapped in three locations

Scarab beetle species	Makawanpur		Tanahu		Chitwan	
	I	II	I	II	I	II
Anomala dimidiata Hope	11	17				2
Allisonotum simile (Dynastinae)	1			2		
Anomala varicolor (Gyllenhal)			7	5		
Coprius indicus (Blanchard)	6	1				
Heteronychus lioderus Redtenbacher					2	3
Holotrichia nigricollis Brenske					1	2
Holotrichia sp.			1	2		1
Lepidiota albistigma Burmeister					2	1
Maladera affinis (Blanchard)			2	2		
Mimela inscripta (Nonfried)	3			1	1	
Pentodon algerinum indicum Endroedi	4	1	1			
Sophrops spp.			3	1		
Xylotrupes Gideon Linnaeus	7	2				
Dung beetle						21
Total	32	21	14	13	6	30

The 'simple matching' coefficient revealed relative high similarity of above 70% when comparing the two sites in each district, while similarities between sites from different districts were low, i.e. between 29-50% (Table 2).

Table 2. Simple matching coefficient for the six different sites in three locations

		Proximity matrix (Simple matching measure)					
Districts		Makwanpur		Tanahu		Chitwan	
		I	II	I	II	I	II
Makwanpur	I	1.00	0.86	0.36	0.43	0.43	0.29
	II		1.00	0.50	0.29	0.43	0.43
Tanahu	I			1.00	0.79	0.36	0.36
	II				1.00	0.43	0.29
Chitwan	I					1.00	0.71
	II						1.00
	N	27°60'550	27°50'101	27°96'792	28°08'195	27°58'126	27°57'880
	E	85°09'095	85°06'859	84°41'011	84°41'041	84°51'336	84°35'040
	Altitude (masl)	2303	2260	542	486	184	180

I and II= Replication sites, N=North latitude, E= East longitude

Table 3. Jaccard coefficient for the six different sites

Districts	Proximity Matrix (Jaccard Measure)					
	Makwanpur		Tanahu		Chitwan	
	I	II	I	II	I	II
Makwanpur I	1.00	0.67	0.10	0.20	0.11	0.09
Makwanpur II		1.00	0.13	0.00	0.00	0.11
Tanahu I			1.00	0.57	0.00	0.10
Tanahu II				1.00	0.11	0.09
Chitwan I					1.00	0.43
Chitwan II						1.00

I and II= replication site

For accounting for differences in insect species present and their difference in abundance, the Chi-square distance between all sites was calculated (Table 4). The Chi-square distance almost revealed the same results as the similarity indices (that consider presence and absence of species only but not their number). The six different

sites observed by comparing the frequencies of white grubs showed highly significant difference between Makawanpur I and Chitwan II.

Table 4. Proximity matrix showing the Chi-square between frequencies of insects

Proximity Matrix (Chi-square between Sets of Frequencies)

Districts	Makwanpur		Tanahu		Chitwan		Dung beetle (excluded)
	I	II	I	II	I	II	
Makwanpur I	0.00	3.41	6.50*	6.17*	5.69*	7.43**	(5.58*)
Makwanpur II		0.00	5.74*	5.83*	5.20*	6.60*	(4.63*)
Tanahu I			0.00	2.37	4.47	6.46*	(4.57*)
Tanahu II				0.00	4.08*	6.31*	(4.39*)
Chitwan I					0.00	4.21*	(2.11)
Chitwan II						0.00	

Numbers that are marked with asterisk indicate significant differences between the two compared sites (* P < 0.05, ** P < 0.01, *** P < 0.001). Numbers in parenthesis indicate Chi-square distance between Chitwan II and other sites. The Chi-square distance was also calculated by excluding the dung beetles recorded in Chitwan II.

Dung beetles were observed in high number at one site of Chitwan II. Because these numbers changed considerably. The Chi-square distance when comparing these sites with others the dung beetles were removed from the analysis. Then Chitwan II showed almost similar distances (differences) when comparing with other sites (Table 4).

SEASON LONG MONITORING OF SCARAB BEETLE AT MANGALPUR, CHITWAN

The species *Anomala dimidiata* Hope were caught more or less throughout the experiment period while the highest numbers with peak activity were observed from early June to late July (Fig.1). The dominant species in Mangalpur, Chitwan were *Anomala dimidiata* Hope (24%) followed by *Maladera affinis* (Blanchard) (23.75%), *A. varicolor* (Gyllenhal) (23%), *Heteronychus lioderus* Redtenbacher (14%) *Holotrichia sp.* (7%) and minor species were *Sophrops sp.*, *Chiloloba acuta* Wiedemann, *Mimela inscripta* (Nonfried), *Xylotrupes gideon* Linnaeus, *Lepidiota albistigma* Burmeister, *Pentodone algerinum* Endroedi, *Holotrichia nigricolis* Brenske, *Allisonotum simile* (Dynastinae) and *Coprius indicus* Arrow. *A. varicolor* (Gyllenhal) and *M. affinis* (Blanchard), which showed peak activity from late April to late May, while *H. lioderus* Redtenbacher and *Holotrichia sp.* showed peak activity from the date of light trap installment to early May.

DISCUSSIONS

All total thirteen species of scarab beetle were collected using two light traps in each district at two spots during two nights consecutively (Annex 1). This might be due to the short study period capturing time of two nights only. However, this period is considered the peak time for adult scarab beetles activity. This study showed that *Anomala dimidiata* Hope and *A. varicolor* (Gyllenhal) were found to be the dominant species in high-hill and mid-hill of Nepal. Similar species were found dominant by GC et.al, (2009) who mentioned that *Anomala* groups were cosmopolite

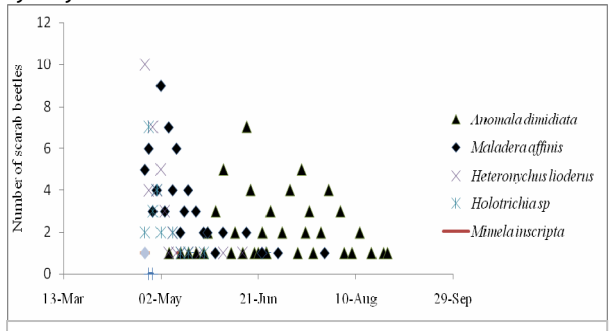

Fig.1: Number of major five scarab beetle species caught in light trap, installed at Mangalpur, Chitwan (24 April to 7 September, 2010)

species found in Gaindakot, Rampur, Gunganagar, Pang and Rising Patan of Nepal. Other species observed at the study site were *Allissonotum simile* (Dynastinae), *Coprius indicus* Arrow, *Holotrichia nigricolis* Brenske, *Holotrichia sp., Maladera affinis* (Blanchard), *Mimela inscripta* (Nonfried), *Pentodone algerinum* Endroedi, *Heteronychus lioderus* Redtenbacher, *Sophrops spp., Xylotrupes gideon* Linnaeus *and Lepidiota albistigma* Burmeister.

The results of regular monitoring of scarab beetles through light trap for the time of 4 months from 24 April to 7 September, 2010 at Mangalpur, Chitwan showed that *Anomala dimidiata* Hope appeared frequently throughout the monitoring period and the peak period was observed from early June to late July. The dominant species in Mangalpur, Chiwan, were *Anomala dimidiata* Hope (24%) followed by *Maladera affinis* (Blanchard) (23.75%), *A. varicolor* (Gyllenhal) (23%), *Heteronychus lioderus* Redtenbacher (14%), *Holotrichia sp* (7%) and minor species were Sophrops spp., Chiloloba acuta Wiedemann, *Mimela inscripta* (Nonfried), *Xylotrupes gideon Linnaeus, Lepidiota albistigma* Burmeister, *Pentodone algerinum* Endroedi, and *Holotrichia nigricolis* Brenske, *Allisonotum simile* (Dynastinae) and *Coprius indicus* Arrow. The two species *A. varicolor* (Gyllenhal) and *M. affinis* (Blanchard) showed the peak activity from late April to late May, while *H. lioderus* Redtenbacher and *Holotrichia sp.* showed peak activity from the date of light trap installment to early May. Similar results were observed by GC et al. (2009), where large numbers of beetles caught at premises of IAAS were *Maladera sp., Adoretus sp., Heteronychus sp., Anomala sp.* and he also observed the peak period of early June to late July for *A. dimidiata* Hope, 2nd week of April to early May for Holotrichia spp., late April to late May for *A. varicolor* (Gyllenhal) and late April to late May for *M. affinis* (Blanchard), respectively.

CONCLUSIONS

The highest number (32 adults) of beetles was observed at Daman of Makawanpur district, and the lowest number (6 adults) at Bachuli. The result showed that *A. dimidiata* Hope and *A. varicolor* (Gyllenhal) were found to be the dominant species in high-hill and mid-hill of Nepal. Season long monitoring light trap installed at Mangalpur of Chitwan district showed that the dominant species there was *A. dimidiata* followed by *Maladera affinis*, *A. varicolor*, *Heteronychus lioderus* and *Holotrichia sp* in order. This study attempted to explore the species present in three districts of Nepal. However, a comprehensive study covering the entire country still remains to be completed. The study reveals that several species of white grubs prevail in Nepalese agro-ecological domain requiring effective management approaches.

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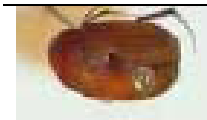
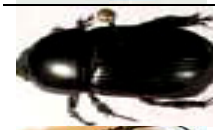
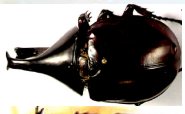
Annex 1: Identified scarab beetles in the study

Insect image	Scientific name	Distribution (trapped area)	Description
	*Anomala dimidiata* Hope	Makawanpur (2303 masl and 2260 masl) and Chitwan (180 masl)	Apple green, body shape broadly oval, clypeus densely punctured pygidium moderately transverse.
	*Chiloloba acuta* Wiedemann	Absent	Green rose chaffer, larvae move ventrally and sometimes dorsoventrally and have well developed hairs on the body.
	*Allisonotum simile* Arrow	Makawanpur (2303 masl) Tanahu (486 masl)	Black smooth and shinning, convex and elongate-oval. Beetle is smaller in size.
	*Anomala varicolor* (Gyllenhal) Rutelinae	Tanahu (486 masl and 542 masl)	The extremities of the tibia and the tersi dark. The elytra are deeply and finely punctuate striate with the subsutural interval broad and closely punctured.

Insect image	Scientific name	Distribution (trapped area)	Description
	*Maladera affinis* (Blanchard)	Tanahu (486 masl and 542 masl)	Common species of sandy soil, typical segment on lateral part of larval head, red color smaller in size, closed pygidium with the wings.
	*Heteronychus lioderes* Redtenbacher	Chitwan (184 masl and 180 masl)	Black above, deep reddish brown beneath and very smooth and shining elongate-oval in shape and not very convex, shinning scutellum
	*Holotrichia* sp.	Tanahu (486 masl and 542 masl)	Raster with irregular setae or with two longitudinal rows of setae.
	*Holotrichia nigricollis* Brenske	Chitwan (184 masl and 180 masl)	Robust, oval and brownish and resemble June beetle (though most are smaller)
	*Xylotrupes gideon* Linnaeus	Makawanpur (2303 masl &and2260 masl)	Black to dark brown beetles, chiefly nocturnal, the male is a shiny black with forked horns on head, female is a matt black and lacks the horns.
	*Sophrops* sp.	Tanahu (486 masl and 542 masl)	Brownish, robust and oval. Beetles feeds on plant foliage and larvae damage the roots of crops.
	*Lepidiota albistigma* Burmeister	Chitwan (184 masl & 180 masl)	Brown in color, robust and oval beetles that feeds on the flowers and foliage of plants, larvae are white do serious damage to roots..
	*Pentodon algerinum indicum* Endroedi	Makawanpur (2303 masl and 2260 masl) and Tanahu (486 masl)	Dorsal surface of body is rounded and convex, male with horn on head or pronotum, female lack horn
	*Mimela inscripta* (Nonfried)	Makawanpur (2303 masl, Tanahu (542 masl) chitwan (184 masl)	Beetles brightly colored, commonly yellowish color both adults and grubs are destructive,
	*Coprius indicus* Arrow	Makawanpur (2303 masl and 2260 masl)	Black, body compact, convex or a little depressed, abdomen very short, femora very thick, the elytra are very strongly sulcate.