Formosan Entomologist
Journal Homepage: entsocjournal.yabee.com.tw

Abundance and Diversity of Scarabaeid Beetles (Coleoptera: Scarabaeidae) in Different Farming Areas in Nepal 【Scientific note】

金龜子 (Coleoptera: Scarabaeidae) 豐富度於尼泊爾不同農業生產區之研究【科學短訊】

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Received: 2009/02/12 Accepted: 2009/04/20 Available online: 2009/08/01

Abstract

The abundance and diversity of scarabaeid beetles was examined at five different farming areas in Nepal. Light traps were used to monitor the beetles for 12 months. A total of 4708 scarabaeid beetles of 29 genera and 77 species were trapped during the one year duration of this study. The five most common scarabaeid species in the study areas were Adoretus coronatus Burmeister, Maladera thomsoni (Brenske), Anomola bilobata Arrow, Holotrichia nigricollis Brenske and Anomola dimidiata (Hope). They accounted for 58.81% of all individuals collected. An inventory of scarabaeid beetles associated with the five different farming areas in Nepal was developed. This data creates a base for further studies of beetles and for the developement of conservation and management strategies in Nepal.

摘要

在尼泊爾，於五個不同的農業生產區，研究金龜子的豐富度與多樣性。利用昆蟲誘捕燈偵測 12 個月。在一年研究期間，總共誘捕到 4708 隻金龜子，分別隸屬於 29 屬及 77 種。其中最普遍的五種金龜子為 Adoretus cornonatus Burmeister、Maladera thomsoni (Brenske)、Anomola bilobata Arrow、Holotrichia nigricollis Brenske 與 Anomola dimidiate (Hope)，佔總數的 58.81%。因此研究而開發了尼泊爾這五個農業生產區金龜子的資料庫。以這些資料為根基，可進一步研究甲蟲，並發展尼泊爾的保育與管理對策。

Key words: scarabaeid beetles, diversity, abundance, species

關鍵詞: 金龜子、多樣性、豐富度、物種。

台灣昆蟲 29: 103-112 (2009)
Formosan Entomol. 29: 103-112 (2009)

Abundance and Diversity of Scarabaeid Beetles (Coleoptera: Scarabaeidae) in Different Farming Areas in Nepal

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ABSTRACT

The abundance and diversity of scarabaeid beetles was examined at five different farming areas in Nepal. Light traps were used to monitor the beetles for 12 months. A total of 4708 scarabaeid beetles of 29 genera and 77 species were trapped during the one year duration of this study. The five most common scarabaeid species in the study areas were *Adoretus coronatus* Burmeister, *Maladera thomsoni* (Brenske), *Anomola bilobata* Arrow, *Holotrichia nigricollis* Brenske and *Anomola dimidiata* (Hope). They accounted for 58.81% of all individuals collected. An inventory of scarabaeid beetles associated with the five different farming areas in Nepal was developed. This data creates a base for further studies of beetles and for the developement of conservation and management strategies in Nepal.

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Introduction

The adult beetles of white grubs, the scarabaeid beetles, are distributed throughout the farming areas in Nepal. The larvae of these beetles are associated with numbers of crops and sometimes cause economic losses (GhartyChetry *et al*., 2008). In Nepal, some crop or fruit research stations have had light traps in place for many years to forecast the occurrence of pest species. These traps are operated only during certain periods of the year and focus only on a limited number of target species. Scarabaeid beetles studied in these trapping programs have rarely been reported on in detail. As a result, relatively little information is available on species diversity, richness and dominance of the scarabaeid beetles in Nepal.

A recent study reported only 23 scarabaeid beetle species from different parts in Nepal and some of species were economically important (GhartyChetry,

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Table 1. Characteristics of the study sites

Site	District/Region	Geographical coordination	Cropping pattern	Soil type
Gunjanagar	Chitwan Central region	27:39N, 84:19E 230 m asl	Maize-maize-vegetables	Sandy
Rampur	Chitwan Central region	27:39N, 84:21E 230 m asl	Maize-maize-vegetables	Sandy
Gaindakot	Nawalparasi Central region	27:42.5N, 84:25E 150 m asl	Maize-maize-vegetables	Sandy loam
Rishing Patan	Tanahun Western region	27:46N, 85:37E 350 m asl	Maize-legumes-tomato	Sandy loam
Pang	Parbat Western region	28:15N, 83:37E 1155 m asl	Maize-millet-fallow	Red clay

2006; GhartyChetry *et al*., 2008). The *Phyllophaga rugosa*, *Holotrichia* spp., *Anomala* spp. and *Popillia* spp. were reported as major pest scarabaeid beetles species in Nepal (Neupane, 1993; Pandey *et al.*, 1993). However, a detailed study of scarabaeid beetles in Nepal remains to be carried out. In the present study, the scarabaeid beetles caught by light traps during 12 months in five different farming areas (Gunjanagar, Rampur, Gaindakot, Rishing Patan and Pang) in Nepal were analyzed to determine their species diversity and richness. This attempt to explore scarabaeid beetles in more detail will support the pest management and species conservation programs for those areas.

Materials and Methods

Field sites

Scarabaeid beetles were monitored at five sites, Gunjanagar, Rampur (Chitwan District), Gaindakot (Nawalparasi District), Rishing Patan (Tanahun District) and Pang (Parbat District) from November 2004 to October 2005. All the study areas were farmland with different soil types and cropping patterns. The details of the study sites are given in Table 1.

Collection of beetles

Light traps were used in this study to monitor adult beetles for 12 months at the 5 above mentioned areas in Nepal. Beetles were monitored once a week. A light trap (a 125-watt incandescent light bulb) was used for 14 h (from dusk till dawn) to monitor adult beetles. Beetles and other insects attracted towards the light traps were collected in a plastic container attached with a funnel fixed beneath the light bulb. They were then exposed to a cotton swab soaked with ethyl acetate that killed the beetles. The trappings were grouped into beetles and non-beetles. The beetle species were counted and preserved in a vial containing 95% ethanol. All vials were returned to the laboratory where the beetles were morphologically identified and confirmed with identified individuals available at the Basel Museum, Switzerland.

Determination of diversity indices

Richness (number of species), abundance (number of individuals) and four diversity measures were used in this study. The diversity indices assume that individuals are randomly sampled from an infinitely large population. The Shannon index (H') explains the evenness of the abundance of species, while the Simpson index (D) is less sensitive to species richness but more sensitive to the most abundant species (Price, 2004). Pielou's evenness index (*J'*) explains the evenness of allotment of individuals among the species. Diversity indices were determined from all the information gathered during the 12 months on each site by using the following equations, (Krebs, 2001).

Shannon diversity index

$$H' = -\sum_{i=1}^{S} (p_i)(\log_2 p_i)$$

Simpson's index of diversity

$$D = 1 - \sum_{i=1}^{S} (p_i)^2$$

Simpson's Reciprocal Index = 1/D

Pielou's evenness index

$$J' = \frac{H'}{H_{max}}$$

Where
H' = Shannon diversity index
p_i = Proportion of total sample belonging to the i th species
S = Numbers of species
$\sum$ = Sum from species 1 to species S
D = Simpson's index of diversity
N = Total percentage cover or total number of organisms
n = Percentage cover of a species or number of organisms of a species
J' = Evenness of allotment of individuals among the species
H_{max} = maximum species diversity (H') = $\log_2 S$

Results

A detailed list of the collected scarabaeid beetles (Coleoptera: Scarabaeidae) from five different farming areas in Nepal is summarized in Table 2. A total of 4708 scarabaeid beetles, representing 29 genera and 77 species, were collected by light traps during a 12 month monitoring period, i.e., an average of 78.47 individuals/trap/week. The five most common scarabaeid species in the study areas were *Adoretus coronatus* Burmeister, *Maladera thomsoni* (Brenske), *Anomola bilobata* Arrow, *Holotrichia nigricollis* Brenske and *Anomola dimidiata* (Hope). They accounted for 58.81% of all individuals collected. All the beetles collected belong to four subfamilies, Rutelinae (53.72%), Melolonthinae (40.55%), Dynastinae (5.44%) and Cetoniinae (0.3%) with 38, 26, 9 and 4 species from 8, 12, 6 and 3 genera, respectively (Fig. 1, Table 2).

Among the five study areas, the highest number of scarabaeid beetles were observed in the Gunjanagar farming area, with 2127 beetles from 11 genera and 27 species, amounting to 45.18% of the total number of scarabaeid beetles collected. The highest number of beetles collected were from the subfamily Rutelinae and the lowest number collected came from the Cetoniinae subfamily (Table 2).

In the Pang area, 1920 beetles from 17 genera and 47 species were observed, amounting to 40.78% of the total number of scarabaeid beetles collected. In the Rampur area, 298 beetles from 9 genera and 19 species, or 6.33% of the total number of scarabaeid beetles were collected. In the Gaindakot area, 196 beetles from 12 genera and 31 species, or 4.16% of the total number of scarabaeid beetles were collected. In the Rishing Patan area, only 167 beetles from 8 genera and 21 species, or 3.55% of the total number of scarabaeid beetles were collected. The highest number of beetles collected in the Gaindakot, Gunjanagar and Rampur areas were from the subfamily Rutelinae, and for the Pang and Rishing Patan areas they were from the subfamily Melolonthinae. Similarly, the least numbers of beetle individuals collected in the Gaindakot, Gunjanagar and Pang areas were from the subfamily Cetoniinae. No beetles were collected from the subfamily Cetoniinae in the Rampur and Rishing Patan farming areas (Table 2).

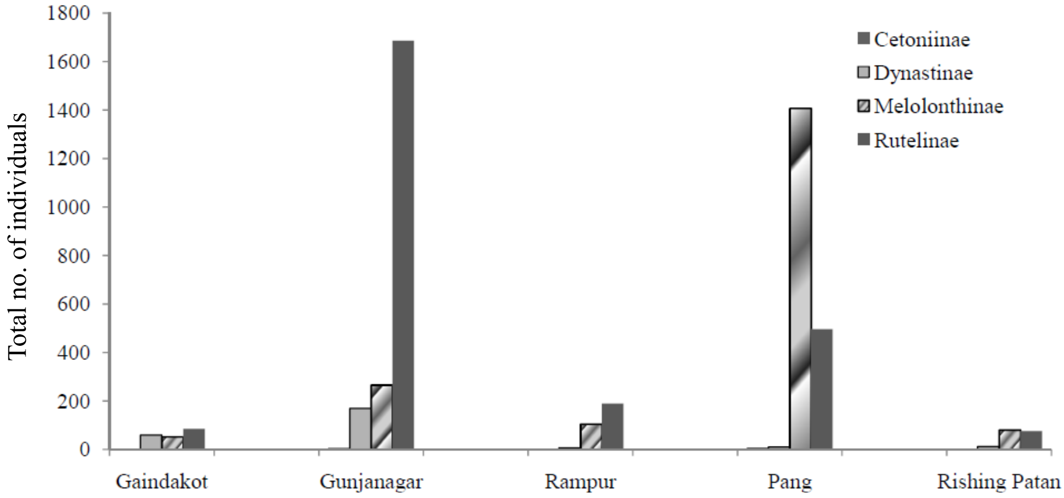

Fig. 1. Abundance of different beetle subfamilies at five farming areas in Nepal.

The general diversity of each site is shown in Figure 2. Among the diversity indices estimated, the Gaindakot and Gunjanagar areas had a relatively higher diversity than the other areas. The number of species monitered was the highest in the Gunjanagar area and lowest in the Rampur area. The total number of beetles was highest in the Gunjanagar area and lowest in the Rishing Patan area. Among the 5 study areas, Gaindakot had the highest Shannon index (H'), Simpson Reciprocal Index (1/D) and evenness (J'), while Gunjanagar had the highest Simpson index (D). In addition, Gaindakot and Rampur had the lowest Simpson index (D) and Shannon index (H'), respectively, and Gunjanagar had the lowest Simpson's Reciprocal Index (1/D) and evenness (J') (Fig. 2).

Discussion

This study found that the richness of the scarabaeid beetle species was higher in the Gunjanagar and Pang areas compared to the other areas, based on the higher number of individuals collected. However, the evenness and the abundance of species, Shannon index (H') and eveness (J') were higher in the Gaindakot area, and was followed by the Rishing Patan area, which was mainly due to a higher species to specimen ratio. Our results showed that in the scarabaeid beetle population the relative abundance of the different species was more even in the Gaindakot area followed by the Rishing Patan, Rampur, Pang and Gunjanagar areas, respectively (Fig. 2). From a diversity point of view, a community dominated by few species is considered to be less diverse than one with a high species richeness and eveness. The highest Simpson index (D) was observed in the Gujanagar area followed by the Rampur, Pang, Rishing Patan and Gaindakot areas, respectively. The species richness was highest in the Gunjanagar area with less species eveness (J'), therefore, D was highest in the Gunjanagar area. However, if we only consider the level of species diversity in relation to the samples collected, the Gaindakot area still had a higher diverisity level compared to the rest of the areas because Simpson's reciprocal index 1/D was highest at the Gaindakot area (Fig 2). It was observed

Table 2. Scarabaeid beetles collected in light traps at five study sites in Nepal (2004-2005)

	Gaindakot		Gunjanagar		Rampur		Pang		Rishing Patan	
Species	No.	%	No.	%	No.	%	No.	%	No.	%
Subfamily: Cetoniinae										
Chiloloba acuta Wiedemann			2	0.09			7	0.36		
Dicranocephalus wallichi wallichi Hope	1	0.51								
Oxycetonia histro (Oliver)			3	0.14						
Oxycetonia variicolor (F.)			1	0.05						
Subfamily: Dynastinae										
Alissonotum binodulum Fairmaire	5	2.55	45	2.12						
Alissonotum simile Arrow*	37	18.88	39	1.83	5	1.68				
Eophileurus forsteri Endroedi									1	0.60
*Heteronychus liodere*s Redtenbacher*	8	4.08	79	3.71						
Heteronychus sp. 2	7	3.57	3	0.14						
Peltonotus morio Burmeister			1	0.05	1	0.34				
Pentodon algerinum indicum Endroedi			2	0.09						
Phyllognathus dionysius F.							10	0.52	10	5.99
Xylotrupes gideon L.	2	1.02							1	0.60
Subfamily: Melolonthinae										
Apogonia sp. 1							1	0.05		
Asactopholis dehradunensis Mittal							6	0.31		
Cyphochilus pygidialis Nonfried										
Hemiserica nasutella Ahrens			3	0.14						
Holotrichia anthracina Brenske									1	0.60
Holotrichia nigricollis Brenske							311	16.20	9	5.39
Holotrichia pruinosa Wied.							1	0.05	2	1.20
Holotrichia seticollis Moser	1	0.51	6	0.28	1	0.34	5	0.26	6	3.59
Holotrichia sikkimensis Brenske							35	1.82	4	2.40
Holotrichia sp. 2							153	7.97	25	14.97
Idionychus excisa Arrow			61	2.87	41	13.76				
Lepidiota albistigma Burmeister							1	0.05		
Maladera affinis (Blanchard)*	41	20.92	105	4.94	13	4.36				
Maladera cardoni (Brenske)	3	1.53	69	3.24						
Maladera iridescens (Blanchard)							1	0.05		
Maladera pokharae Ahrens							1	0.05		
Maladera quinquidens (Brenske)							14	0.73	1	0.60
Maladera schenklingi (Moser)	1	0.51								
Maladera thomsoni (Brenske)*					1	0.34	725	37.76	26	15.57
Schizonychia fuscescens Blanchard	2	1.02	12	0.56	1	0.34			2	1.20
Sophrops cardoni Brenske							1	0.05		

* Economic pests

Table 2. continued

Species	Gaindakot No.	Gaindakot %	Gunjanagar No.	Gunjanagar %	Rampur No.	Rampur %	Pang No.	Pang %	Rishing Patan No.	Rishing Patan %
Sophrops sp. 1	4	2.04	8	0.38	46	15.44	18	0.94		
Sophrops sp. 2									4	2.40
Sophrops sp. 3							130	6.77		
Sophrops sp. 5			2	0.09	1	0.34	3	0.16		
Tetraserica ferrugata (Blanchard)							1	0.05		
Subfamily: Rutelinae										
Adoretosoma bruschii Sabatinelli									1	0.60
Adoretus coronatus Burmeister			1	0.05						
Adoretus lasiopygus Burmeister*	9	4.59	1087	51.10	2	0.67	6	0.31		
Adoretus serripes Arrow			16	0.75	1	0.34				
Adoretus simplex Sharp	1	0.51	7	0.33						
Adoretus sp. 10			1	0.05						
Adoretus sp. 11			1	0.05						
Adoretus sp. 2			21	0.99			1	0.05		
Adoretus sp. 9			1	0.05						
Adoretus versutus Harold	3	1.53	27	1.27	1	0.34				
Adorrhinyptia dorsalis Burm.			2	0.09						
Anomala bengalensis Blanchard	1	0.51	6	0.28					1	0.60
Anomala bilobata Arrow	7	3.57	53	2.49	2	0.67	246	12.81	52	31.14
Anomala cantori (Hope)	16	8.16	62	2.91	7	2.35	4	0.21		
Anomala cf. *biharensis* Arrow			1	0.05						
Anomala chlorosoma Arrow			1	0.05						
Anomala comma Arrow	1	0.51	1	0.05			11	0.57		
Anomala dimidiata (Hope)	25	12.76	133	6.25	42	14.09	32	1.67	1	0.60
Anomala euops Arrow			2	0.09						
Anomala marginipennis Arrow							78	4.06	2	1.20
Anomala perplexa Hope	2	1.02								
Anomala sp. 1			1	0.05						
Anomala sp. 2	1	0.51	106	4.98	4	1.34				
Anomala sp. 3	1	0.51								
Anomala testacea Hope							1	0.05	1	0.60
Anomala varicolor (Gyllenhal)	1	0.51	11	0.52	2	0.67	89	4.64	13	7.78
Anomala variegata Hope	8	4.08	13	0.61	7	2.35	25	1.30	4	2.40
Anomala xanthoptera Blanchard	3	1.53	105	4.94	120	40.27				
Mimela bicolor Hope							1	0.05		
Mimela cf. *fulgidivittata* Blanchard			2	0.09			2	0.10		
Mimela horsfieldii Hope										
Mimela inscripta (Nonfried)			1	0.05						
Mimela sericea Ohaus										
Mimela siliguria Arrow	5	2.55	9	0.42						
Mimela sp. (close to *M. decipiens*)			6	0.28						

* Economic pests

Table 2. continued

	Gaindakot		Gunjanagar		Rampur		Pang		Rishing Patan	
Species	No.	%	No.	%	No.	%	No.	%	No.	%
Parastasia rufopicta Westwood			1	0.05						
Popillia birmanica Arrow			4	0.19						
Rhamphadoretus suillus Arrow			4	0.19						
Total	196	100	2127	100	298	100	1920	100	167	100

* Economic pests

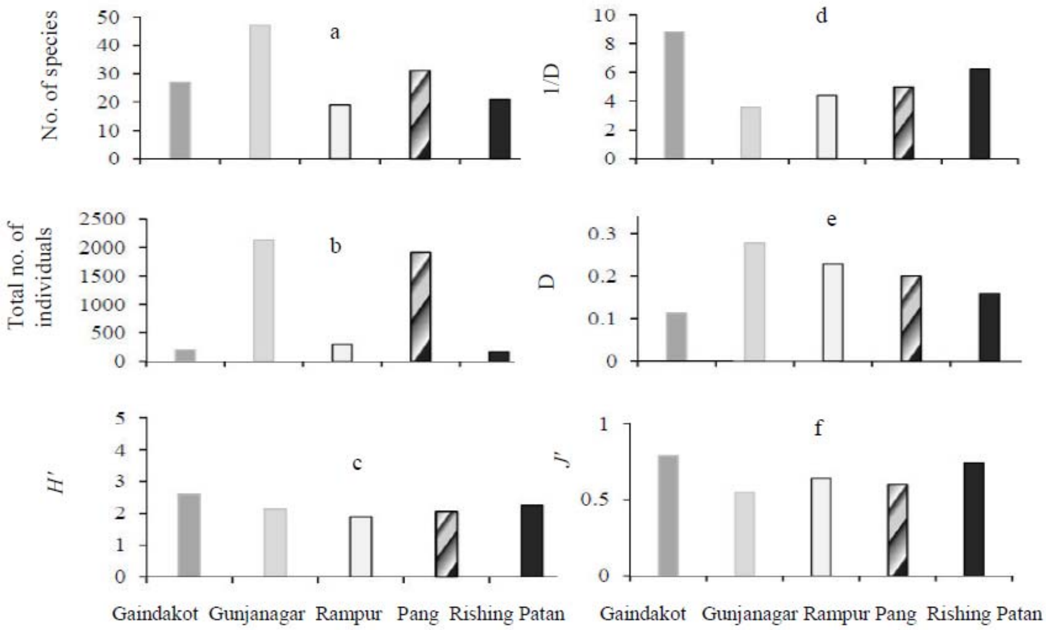

Fig. 2. Scarabaeid beetles diversity parameters of five study sites in Nepal. a) number of species, b) number of beetle specimens, c) Shannon Index (*H'*), d) Simpson's reciprocal index (1/D), e) Simpson's Index (D), and f) Pielou's evenness index (*J'*).

that there is a variation in the scarabaeid beetle species diversity depending on the area. GhartyChetry *et al.* (2008) also observed that in Nepal the scarabaeid beetle species diversity and abundance varied highly with location and with the seasons. The variation in the beetle species might be due to the variation of hosts, vegetations, crops grown and soil types. In addition, the variation of other competing species or natural enemies might also have caused variation in the species diversity of the scarabaeid beetle.

In this study, beetles with a relatively larger body size were observed more often during the months with warm and clear weather (from February to June) and the body size decreased in the months with rainy or cooler weather (from July to January). However, the size of the beetles was not recorded during this study. The emergence of beetles at the end of February might be due to the start of warm weather right after the cool winter. Such behaviour is common with beetles, because beetles lay eggs in the soil and grubs emerge and are active from early summer on until the start of the winter, and then they disappear (Hodgson, 2007). In the present study the number of beetles collected decreased during the monsoon period and with the increase in temperature. This might be due to the effects of high temperature and rain on the beetles' normal activities. In this study we also observed a correlation between the body size of the beetles and the seasons. Specially, the beetles seemed to have a larger body size during the low rainfall period and fewer beetles were observed during the heavy rainfall period. The details of the economic and ecological importance of all species are yet to be determined. Nevertheless, based upon the existing literature, among the collected scarabaeid beetles, five species (*Alissonotum simile* Arrow, *Heteronychus lioderes* Redtenbacher, *Maladera affinis* (Blanchard), *Maladera affinis* (Blanchard) and *Adoretus lasiopygus* Burmeister) were reported to be agricultural pests with a significant economic importance (Table 2).

This study has attempted to explore the species diversity and richness of scarabaeid beetles from five farming sites in central Nepal. However, a detailed study covering the entire country still remains to be done. The present study revealed at least five species that were economic pests in the study areas. Therefore, it is suggested to that suitable management approaches be designed and adopted against them. The remaining 72 species were not listed as pests but might play a crucial role in the local biodiversity. Their biological study could explain what roles they play in the local ecology. The information presented in this study lays the ground work for further studies and for the developement of conservation and management strategies for beetles in Nepal.

Acknowledgments

We would like to express our appreciation to Helvetas-Switzerland and Helvetas Nepal for the financial support through the Sustainable Soil Management Program for this study. We also would like to express our sincere gratitude to all the support staff of the Institute of Agriculture and Animal Sciences, Rampur, Chitwan, Nepal.

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Received: February 12, 2009
Accepted: April 20, 2009

金龜子（Coleoptera: Scarabaeidae）豐富度於尼泊爾不同農業生產區之研究

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摘　　要

在尼泊爾，於五個不同的農業生產區，研究金龜子的豐富度與多樣性。利用昆蟲誘捕燈偵測 12 個月。在一年研究期間，總共誘捕到 4708 隻金龜子，分別隸屬於 29 屬及 77 種。其中最普遍的五種金龜子為 *Adoretus cornonatus* Burmeister、*Maladera thomsoni* (Brenske)、*Anomola bilobata* Arrow、*Holotrichia nigricollis* Brenske 與 *Anomola dimidiate* (Hope)，佔總數的 58.81%。因此研究而開發了尼泊爾這五個農業生產區金龜子的資料庫。以這些資料為根基，可進一步研究甲蟲，並發展尼泊爾的保育與管理對策。

關鍵詞：金龜子、多樣性、豐富度、物種。

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