

インドネシア共和国東カリマンタン州バリクパパン近郊の 低地で採集された糞虫(鞘翅目: コガネムシ上科食糞群)のリスト

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研究資料 (Research record)

List of dung beetles (Coleoptera : Coprophagous group of Scarabaeoidea) collected in lowland near Balikpapan, East Kalimantan, Indonesia

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Abstract

Dung beetles (coprophagous group of Scarabaeoidea) are useful indicators of habitat quality in tropical regions. In December of 2006 through 2008, we carried out surveys of the beetles using pitfall traps baited with human excrement and fish meat at 30 sites, 10–40 km north of Balikpapan, lowland of East Kalimantan, Indonesia. From these surveys we collected a total of 65 species and 8,073 individual dung beetles, and listed in the table. To provide a useful reference for future studies evaluating forest environments using assemblages of dung beetles, we estimated diet and habitat preferences of 44 species with collections of more than 5 individuals. Forty-one of the 44 species were collected with traps baited with both human excrement and fish meat. For 8 species the total of catch did not exceed 70% in either of the two bait types, and 5 of the 8 species were endemic to Borneo. Regarding habitat, 36 species abundant in natural forests were rarely collected in anthropogenic-destroyed forests, plantation forests, and open-lands, except for 7 species that were also abundant in such habitats. *Catharsius renaudpauliani* was only one species that was expected to reside mainly in destroyed forests and plantation forests. Seven species abundant in open-lands were rarely collected in natural forests. Species abundant in natural forests tend to have narrow distribution ranges, while species abundant in open-lands tend to have wide distribution ranges.

Key words: bait, Borneo Island, forest, grassland, habitat, Scarabaeidae

Introduction

Dung beetles (coprophagous group of Scarabaeoidea: Bolboceratidae, Hybosoridae, and parts of Scarabaeidae (Scarabaeinae and Aphodiinae) in the present study) are known to be an indicator of habitat quality and environmental change in tropical regions (McGeoch et al. 2002, Aguilar-Amuchastegui and Henebry 2007, Gardner et al. 2008a, Nichols and Gardner 2011). This beetle group is also known to be relatively easy to sample and identify compared with the vast majority of other insect groups (Spector 2006). For example, in a study carried out in an area of primary rainforest in Brazilian Amazonia, the sampling cost for these beetles was cheapest compared to the costs for 14 other taxa sampled and was second only to birds in terms of indicator performance (Gardner et al. 2008b, Nichols and Gardner 2011). As a result, at least 19 studies concerning the response of these beetles

to tropical forest modification and fragmentation have been performed throughout the world (Nichols et al. 2007). These beetles also serve important ecological functions, such as promoting the rapid decomposition of dung and carcasses, as well as influencing nutrient cycling, bioturbation, plant growth enhancement, secondary seed dispersal, pollination of carrion-scented plants, and parasite control (Davis 1996, Andressen 2002, 2003, Larsen et al. 2005, Slade et al. 2007, 2011, Nichols et al. 2008, Kryger 2009, Ridsdill-Smith and Edwards 2011, Enari and Enari-Sakamaki 2014, Enari et al. 2016).

Because of their value as indicators of habitat quality, the low cost for sampling, and the variety of ecosystem functions they provide, we chose the dung beetles as the material to study the influences of afforestation on grasslands and how both natural and anthropogenic disturbances on forests influence insect diversities in lowland of East Kalimantan,

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Indonesia (Ueda et al. 2015b, c, d). Through these studies we accumulated the large collection of dung beetles that indicated both diet and habitat preferences for a range of species. Except for these studies we also collected the beetles with using the same method as preliminary or verificative studies. Our large collection may provide a useful reference for future studies aiming to better understand habitat quality of forests using dung beetles as indicators, particularly in lowland of East Kalimantan where our studies were carried out. Thus, here we have listed the dung beetles collected in our studies, and showed the numbers of beetles collected by the traps with different baits and the numbers in each vegetation type.

Methods

Study sites

We collected dung beetles at 30 sites (Table 1 and Fig. 1), located 10–40 km north of Balikpapan, lowland of East Kalimantan, Indonesia. The study area included two large intact natural forests: one was the Sungai Wain Protection Forest (SWPF) and the other was the Bukit Bangkirai Forest (BBF) (Fig. 1). These areas have not been logged in the last 50 years but SWPF was burned in 1993 and 1998 but left some adjacent remnants on the north-eastern area (Taylor et al. 1999, Yamaguchi and Tsuyuki 2001) (Fig. 1). We selected three sites inside the intact forests (vegetation type: CNF) and two sites

near the edges (ENF) in the two forest reserves (Table 1 and Fig. 1). We also selected two sites at the lightly burned area including remnants (BNF) in SWPF (Table 1 and Fig. 1).

Outside of the two forest reserves, we selected four anthropogenic-destroyed forests (secondary forests) near villages (SCF) as study sites (Table 1 and Fig. 1). We also selected ten *Acacia mangium* plantations (PLF) as study sites to examine the habitat preference of the beetle (Table 1 and Fig. 1) because *A. mangium* is one of the most popular fast-growing tree species used for plantations in anthropogenic areas of tropical Asia and has been planted widely in the study area. Each plantation except for P12 and P38 was paired with another study site in the *Imperata cylindrica* (local name 'rumput alang-alang') grassland next to the plantation, and each grassland site (GRS) was 100–300 m away from the edge of the plantation. *Imperata cylindrica* grassland is widespread in post slash-burn agriculture areas (post-deforested, burned areas) of tropical Asia. Surveys were also conducted in one cattle pasture (CPS) beside the *A. mangium* plantation of site P12 to compare with the grassland sites (GRS) (Table 1 and Fig. 1).

Collection of dung beetles

Baited and flight intercepting pitfall traps that catch a larger number of species of dung beetles than normal baited pitfall traps (Ueda et al. 2015a) were used to collect the beetles.

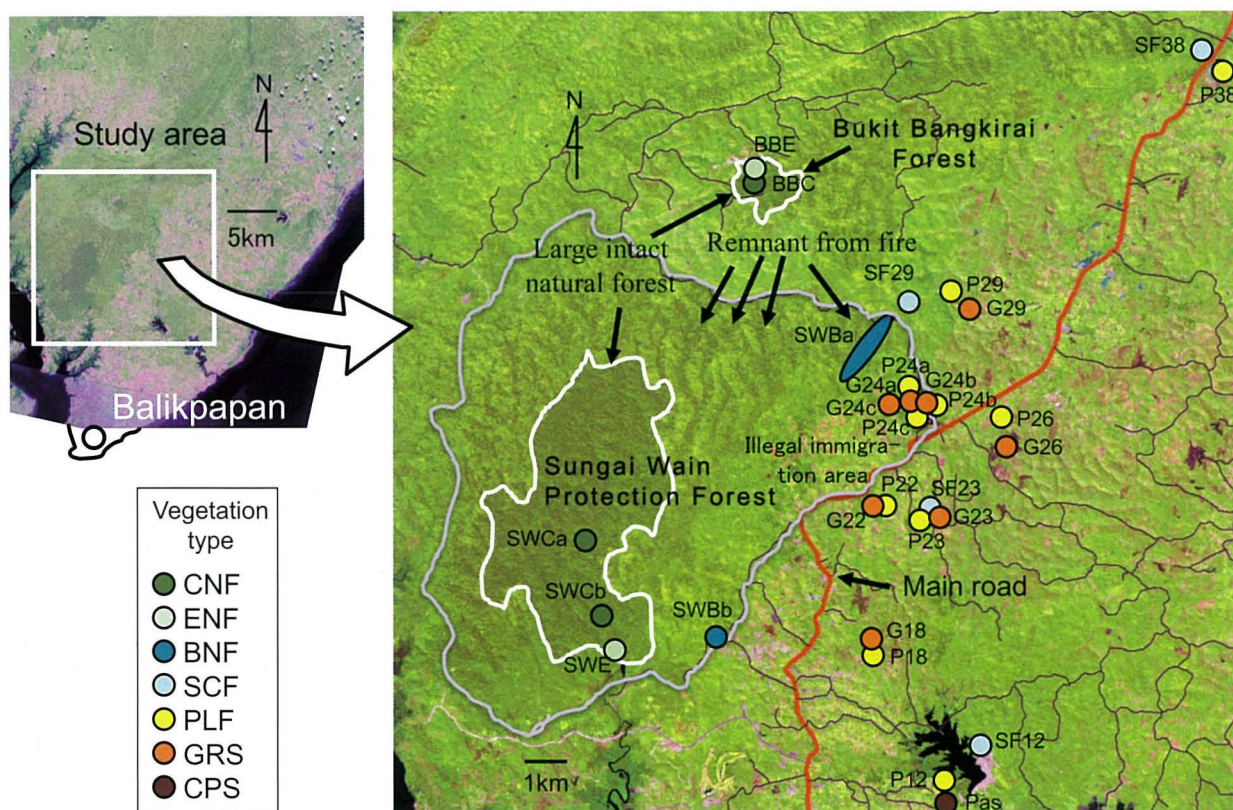


Fig. 1 Location of study sites.

Refer Table 1 for site names and categories of vegetation. The 'SPOTSS' satellite took this picture at 2:27:04 (GMT) on 19 June, 2005.

Table 1. Vegetation type, location, collection period, and number of installed trap-transsects in each site in each year

Site ^a	Vegetation type ^b	Latitude	Longitude	Asl. (m)	Collection period	No. trap-transsects ^c	Note
SWCa	CNF	S 1° 06' 50	E 116° 49' 40	32	15-20 Dec. 2007	1	Near Camp 2 of SWPF. Data from Ueda et al. (2015b)
SWCb	CNF	S 1° 07' 52	E 116° 49' 53	50	16-21 Dec. 2006 20-25 Dec. 2007 9-14 Dec. 2008	1 1 1	Near Camp 1 of SWPF. Data in 2006 and 2007 from Ueda et al. (2015b)
BBC	CNF	S 1° 01' 47	E 116° 51' 58	88	13-18 Dec. 2007	1	Center of BBF. Data from Ueda et al. (2015b)
SWE	ENF	S 1° 08' 21	E 116° 50' 06	40	16-21 Dec. 2006 14-19 and 20-25 Dec. 2007 5-10 and 10-15 Dec. 2008	1 2 2	Near entrance of a trail of SWPF. Data in 2006 and on 20-25 Dec. 2007 from Ueda et al. (2015b)
BBE	ENF	S 1° 01' 35	E 116° 51' 59	55	13-18 Dec. 2007	1	Near entrance of a trail of BBF. Data from Ueda et al. (2015b)
SWBa	BNF	S 1° 03' 43 ~ S 1° 04' 32	E 116° 53' 19 ~ E 116° 53' 56	30 ~ 80	17-22 and 22-27 Dec. 2006 19-24 Dec. 2007 5-10 and 6-11 Dec. 2008	5 6 7	Near POS 2 of SWPF. Data on 22-27 Dec. 2006 from Ueda et al. (2015b) and in 2007 from Ueda et al. (2015d) in part.
SWBb	BNF	S 1° 08' 09	E 116° 51' 29	40	4-9 Dec. 2008	1	In the Sungai Wain Botanical Garden
SF12	SCF	S 1° 09' 44	E 116° 55' 09	29	15-20 Dec. 2007	1	Forest with heavy anthropogenic disturbance near villages
SF23	SCF	S 1° 06' 29	E 116° 54' 20	37	17-22 Dec. 2007	1	Forest along a stream in a village. Data from Ueda et al. (2015c)
SF29	SCF	S 1° 03' 34	E 116° 54' 10	42	18-23 Dec. 2006	1	Heavily burned forest near a village. Data from Ueda et al. (2015d)
SF38	SCF	S 1° 00' 03	E 116° 58' 20	21	16-21 Dec. 2007	1	Forest along a stream in a village
P12	PLF	S 1° 10' 10	E 116° 54' 41	26	23-28 Dec. 2006 15-20 Dec. 2007	1 1	Beside SF12. Data from Ueda et al. (2015b)
P18	PLF	S 1° 08' 21	E 116° 53' 39	36	19-24 Dec. 2006	1	Data from Ueda et al. (2015b)
P22	PLF	S 1° 06' 21	E 116° 53' 47	56	19-24 Dec. 2006	1	Data from Ueda et al. (2015b)
P23	PLF	S 1° 06' 30	E 116° 54' 20	35	19-24 Dec. 2006 17-22 Dec. 2007 6-11 Dec. 2008	1 1 1	Beside SF23. Data in 2006 and 2007 from Ueda et al. (2015b, c)
P24a	PLF	S 1° 04' 46	E 116° 54' 11	48	17-22 Dec. 2006	1	Data from Ueda et al. (2015b)
P24b	PLF	S 1° 05' 09	E 116° 54' 27	73	17-22 Dec. 2006	1	
P24c	PLF	S 1° 05' 04	E 116° 54' 30	77	7-12 Dec. 2008	1	
P26	PLF	S 1° 05' 05	E 116° 55' 28	46	23-28 Dec. 2006	1	Data from Ueda et al. (2015b)
P29	PLF	S 1° 03' 20	E 116° 54' 45	60	18-23 Dec. 2006	1	Beside SF29. Data from Ueda et al. (2015b)
P38	PLF	S 1° 00' 11	E 116° 58' 30	20	16-21 Dec. 2007	1	Beside SF38
G18	GRS	S 1° 08' 13	E 116° 53' 39	36	19-24 Dec. 2006	1	Beside P18. Data from Ueda et al. (2015b)
G22	GRS	S 1° 06' 23	E 116° 53' 37	67	19-24 Dec. 2006	1	Beside P22. Data from Ueda et al. (2015b)
G23	GRS	S 1° 06' 28	E 116° 54' 28	53	19-24 Dec. 2006 17-22 Dec. 2007 6-11 Dec. 2008	1 3 1	Beside SF23 and P23. Data in 2006 and 2007 from Ueda et al. (2015b, c)
G24a	GRS	S 1° 04' 56	E 116° 54' 14	40	17-22 Dec. 2006	1	Beside P24a. Data from Ueda et al. (2015b)
G24b	GRS	S 1° 05' 01	E 116° 54' 28	69	17-22 Dec. 2006	1	Beside P24b
G24c	GRS	S 1° 04' 52	E 116° 53' 50	59	7-12 Dec. 2008	1	Beside P24c
G26	GRS	S 1° 05' 34	E 116° 55' 33	46	23-28 Dec. 2006	1	Beside P26. Data from Ueda et al. (2015b)
G29	GRS	S 1° 03' 34	E 116° 55' 01	60	18-23 Dec. 2006	1	Beside P29. Data from Ueda et al. (2015b)
Pas	CPS	S 1° 10' 29	E 116° 54' 39	26	23-28 Dec. 2006 21-26 Dec. 2007 7-12 Dec. 2008	1 1 1	Beside P12. Data in 2006 and 2007 from Ueda et al. (2015b)

^aSW: Site in the Sungai Wain Forest Reserve (SWPF). C: More than 0.5 km inside from edge of unburnt area of the forest reserves. BB: Site in the Bukit Bangkilai Forest (BBF). E: Near edge of unburnt area of the forest reserves. B: Burned area of the forest reserve. SF: Anthropogenic-destroyed forest (secondary forest) near a village. P: *Acacia mangium* forest plantation estimated 5-11 years old. G: *Imperata cylindrica* grassland. Pas: Cattle pasture. The number of each site indicates the approximate km point of the junction on the main road used to access the site from Balikpapan to Samarinda.

^bCNF: Center of natural forest, ENF: Edge of natural forest, BNF: Burned natural forest, SCF: Secondary forest, PLF: Plantation forest, GRS: Grassland, CPS: Cattle pasture.

^cOne trap-transsect contained 5 human excrement baited traps and 5 fish meat baited traps set alternately with 10 m intervals on the 90 m line.

A plastic cup (8.4 cm in open diameter, 5.6 cm in minimum diameter, and 12.2-cm high) was driven into the ground with its opening level with the ground surface. Two B5-size transparent plastic sheets that crossed each other were then placed over the cup, upon which a plastic bowl (ceiling: 20 cm in diameter and 5-cm high) was placed upside down. Each trap contained a 50-ml glass bottle (4.3 cm in diameter and 8.0-cm high) with a perforated lid (having six holes, each 5 mm in diameter), and was baited to attract beetles. Fresh human excrement (10 g) and raw jack fish (30 g) were used as bait because these baits attract large numbers of species and individuals of dung beetles (Ueda et al. 2015a). A cut nylon net (with a 0.5-mm mesh) was placed between the lid and bottle to prevent small beetles from entering. The traps also contained a 30% solution of propylene glycol to kill and preserve the beetles collected. At all sites ten traps distributed along a 90-m transect at intervals of 10 m, alternating human excrement and raw fish as the attractant were set in the morning during the month of December 2006, 2007 and/or 2008 (Table 1). The captured insects were collected five days after trap installation (Table 1).

Identification and storage of specimen

All beetles captured in the present study were dried on absorbent cotton and identified with using a binocular microscope (Nikon Nature Scope). Some beetles were pinned and sent to Japan for identification. All beetles are stored in the insect specimen room of the Research Center for Biology, the Indonesian Institute of Science (LIPI), Cibinong, Indonesia.

Data analysis

Since females of two *Catharsius* species, *C. dayacus* and *C. renaudpauliani*, were difficult to distinguish each other, data of *Catharsius* female was treated as *Catharsius* spp.

To indicate the relationships between diet or habitat preference and the distribution ranges of the beetles, we categorized their distributions into 5 ranges; Bornean endemic, Sundaland (Borneo + Malay Peninsula, Sumatra, Java, and/or Palawan), Sundaland and Indochina ('Sundaland' + Thailand, Laos, Cambodia, and/or Vietnam), Southeast Asia ('Sundaland and Indochina' + Myanmar, Philippines and/or Sulawesi), and large area ('Southeast Asia' + India, Taiwan, China, Japan, New Guinea, and/or Australia). For the distribution ranges, we referred Balthasar (1963a, b), Zunino (1976), Krikken (1977), Ochi and Kon (1995, 1996, 2006a, b, 2014), Ochi (2006), Ochi et al. (2006, 2008, 2009), Masumoto et al. (2008a, b), Zidek and Pokorný (2010), Hosaka et al. (2013), and Li et al. (2013).

Results and discussion

A total of 65 species and 8,073 individuals of dung beetles were collected (Table 2 and 3). In 44 species that were collected

more than 5 individuals, all species were collected by the traps baited with both human excrement and fish meat at least one individual, with the exception of three species (*Catharsius renaudpauliani*, *Caccobius binodulus*, and *Onthophagus (Pseudophanaeomorphus) chandrai*) (Table 3). In 8 of the 44 species, total catches did not exceed 70% in either of the two bait types (Table 3). This result suggests that most of dung beetles in lowland of East Kalimantan are lured by odor from both dung and carrion. This sort of wide diet preference is also seen on the dung beetles on Sulawesi Island and Madagascar Island (Hanski and Krikken, 1991, Roslin and Viljanen 2011).

The number of beetles collected by human excrement baited traps was three times larger than that by fish baited traps (Table 4). This difference largely depended on the data from grassland (GRS) and cattle pasture (CPS) where rates of beetles collected by fish baited traps were very low (Table 4). This result suggests that dung beetles in open environments mainly feed on dung but those in forests utilize both dung and carrion. Regarding the relationships between the distribution ranges and the diet preferences, five of 8 species that did not exceed 70% in either of the two bait types in their total catches were Bornean endemic species, while species that exceeded 70% did not tend to skew towards any particular distribution range (Table 5). This suggests that some Bornean endemic species have a wide host ranges whereas most species with wider distributions have narrow host ranges.

With respect to vegetation type, in the 44 species, 36 species were abundant in the forest reserves (CNF, ENF, and/or BNF). Two of the 36 species, *Microcopris fujiokai* and *Caccobius binodulus*, were collected only at CNF sites (Table 3) and it is expected that their main habitats are deep inside of intact natural forests. The species abundant in the unburned natural forests (CNF and/or ENF) were mostly seen in the lightly burned natural forests (BNF) but were rarely collected outside of the forest reserves (SCF, PLF, GRS, and CPS), with the exception of 7 species (*Bolbochromus catenatus*, *Panelus kalimantanicus*, *Parascatonomus semiaureus*, *Parascatonomus semicupreus*, *Proagoderus schwaneri*, *Onthophagus (Gibbonthophagus) obscurior*, and *Onthophagus (Onthophagus) waterstradti*). Five of the 7 species (*B. catenatus*, *P. semiaureus*, *P. semicupreus*, *P. schwaneri*, and *O. (O.) waterstradti*) were abundant in both destroyed forests (SCF) and/or plantation forests (PLF) (Table 3). These five species are likely to have wide habitat preferences in variety of forest types. *P. kalimantanicus*, one of the another 2 species that were seen in both forest and open environments, was relatively abundant in disturbed areas (i.e., SCF, PLF, GRS, and CPS), whereas *O. (G.) obscurior* was mainly abundant in forest environments (Table 3). Whatever happens, these two species may have only a weak habitat preference.

Table 3. Distribution range, number of beetles collected at each bait in 3 years, and number of beetles collected per trap transect at each vegetation type

Species name	Distri- -bution range ^a	Number of beetles collected at each bait in 3 years				Number of beetles collected per trap transect at each vege- -tation type in 3 years						
		Human excre.	Fish meat	Total	% fish	CNF	ENF	BNF	SCF	PLF	GRS	CPS
<i>Bolbochromus catenatus</i>	Sunda.	5	1	6	16.7	-	0.2	0.2	0.3	-	-	-
<i>Phaeocrous emarginatus</i>	Large A.	4	10	14	71.4	0.4	1.3	0.1	0.5	-	-	-
<i>Phaeocroops</i> sp.	-	2	40	42	95.2	6.0	0.8	0.4	-	-	-	-
<i>Ochicanton simboroni</i>	Borneo	0	1	1	100	-	-	0.1	-	-	-	-
<i>Ochicanton uedai</i>	Borneo	6	1	7	14.3	0.2	-	0.3	-	-	-	-
<i>Ochicanton woroae</i>	Borneo	13	2	15	13.3	0.2	1.8	0.2	-	-	-	-
<i>Panelus kalimantanicus</i>	Borneo	29	15	44	34.1	0.4	0.3	0.1	1.5	0.7	1.6	0.7
<i>Panelus</i> sp.	-	1	0	1	0	0.2	-	-	-	-	-	-
<i>Haroldius sumatranus</i>	Sunda.	0	1	1	100	0.2	-	-	-	-	-	-
<i>Paragymnopleurus maurus</i>	Sunda.	595	23	618	3.7	35.6	10.0	19.8	-	0.3	-	-
<i>Paragymnopleurus striatus</i>	Sunda.	2	0	2	0	0.4	-	-	-	-	-	-
<i>Sisyphus thoracicus</i>	Indoch.	310	26	336	7.7	18.8	6.8	10.6	-	-	-	-
<i>Synapsis ritsemæ</i>	Sunda.	4	0	4	0	0.6	0.2	-	-	-	-	-
<i>Catharsius dayacus</i> (male)	Borneo	53	6	59	10.2	2.6	2.8	1.5	-	-	-	-
<i>Catharsius renaudpauliani</i> (male)	Sunda.	59	0	59	0	-	-	0.1	3.5	2.5	0.3	0.7
<i>Catharsius</i> spp. (female)	-	108	12	120	10.0	3.0	2.2	0.9	3.8	3.2	0.7	1.0
<i>Copris agnus</i>	Indoch.	1	0	1	0	-	0.2	-	-	-	-	-
<i>Copris gibbulus</i>	Sunda.	0	1	1	100	0.2	-	-	-	-	-	-
<i>Microcopris fujiokai</i>	Borneo	8	3	11	27.3	2.2	-	-	-	-	-	-
<i>Oniticellus cinctus</i>	Large A.	0	1	1	100	-	-	-	-	-	-	0.3
<i>Oniticellus tessellatus</i>	Sunda.	1	1	2	50.0	-	-	-	-	-	-	0.7
<i>Caccobius binodulus</i>	Borneo	6	0	6	0	1.2	-	-	-	-	-	-
<i>Caccobius unicornis</i>	Large A.	599	70	669	10.5	-	-	0.2	4.5	13.0	27.3	41.7
<i>Parascatonomus aurifex</i>	Borneo	10	18	28	64.3	0.8	2.0	0.5	-	0.1	0.1	-
<i>Parascatonomus dux</i>	Borneo	22	177	199	88.9	12.8	7.2	4.7	0.5	0.1	-	-
<i>Parascatonomus rudis</i>	Large A.	2	23	25	92.0	-	0.5	1.1	0.3	-	-	-
<i>Parascatonomus semiaureus</i>	Sunda.	15	61	76	80.3	1.4	4.5	1.4	0.8	0.7	0.3	-
<i>Parascatonomus semicupreus</i>	Sunda.	62	263	325	80.9	5.4	14.2	7.1	2.0	4.4	0.3	0.3
<i>Parascatonomus</i> sp.	-	1	0	1	100	-	-	-	-	-	0.1	-
<i>Proagoderus schwaneri</i>	Sunda.	542	289	831	34.8	15.4	13.3	18.3	19.3	14.5	2.4	0.7
<i>Onthophagus (Gibbonthophagus) cervicapra</i>	Sunda.	77	18	95	18.9	8.4	1.7	1.8	-	0.6	-	-
<i>Onthophagus (Gibbonthophagus) fuji</i>	Borneo	24	20	44	45.5	0.6	2.2	1.1	0.5	0.3	-	-
<i>Onthophagus (Gibbonthophagus) limbatus</i>	Large A.	1199	157	1356	11.6	-	-	-	0.5	8.4	13.5	355.3
<i>Onthophagus (Gibbonthophagus) obscurior</i>	Indoch.	40	31	71	43.7	0.6	2.5	1.3	1.8	0.9	-	2.3
<i>Onthophagus (Serrophorus) laevis</i>	Large A.	40	5	45	11.1	2.6	0.8	1.4	-	-	-	-
<i>Onthophagus (Serrophorus) mulleri</i>	Sunda.	3	1	4	25.0	-	0.5	-	0.3	-	-	-
<i>Onthophagus (Serrophorus) sagittarius</i>	Large A.	1	1	2	50.0	-	-	0.1	-	-	-	0.3
<i>Onthophagus (Indachorius) uedai</i>	Borneo	62	37	99	37.4	-	-	0.3	-	0.6	6.8	1.0
<i>Onthophagus (Indachorius) woroae</i>	Borneo	6	10	16	62.5	1.0	0.3	0.5	-	-	-	-
<i>Onthophagus (Indachorius) sp.</i>	-	0	1	1	100	-	-	0.1	-	-	-	-
<i>Onthophagus (Pseudophanaeomorphus) chandrai</i>	Borneo	0	16	16	100	1.4	1.0	0.2	-	-	-	-
<i>Onthophagus (Pseudophanaeomorphus) sugihartoi</i>	Borneo	1	0	1	0	-	0.2	-	-	-	-	-
<i>Onthophagus (Furconthophagus) lilliputanus</i>	SE. A.	440	58	498	11.6	-	-	-	4.0	0.8	38.1	4.3
<i>Onthophagus (Furconthophagus) papulatus</i>	Indoch.	526	50	576	8.7	-	-	-	0.3	-	5.8	168.3
<i>Onthophagus (Onthophagiellus) crassicollis</i>	Large A.	2	1	3	33.3	-	-	0.2	-	-	-	-
<i>Onthophagus (Onthophagiellus) hidakai</i>	Indoch.	4	1	5	20.0	0.2	0.2	0.2	-	-	-	-
<i>Onthophagus (Colobonthophagus) armatus</i>	SE. A.	1	0	1	0	-	-	-	-	-	0.1	-
<i>Onthophagus (Paraphanaeomorphus) trituber</i>	Large A.	853	133	986	13.5	-	-	-	3.5	4.8	29.0	184.0
<i>Onthophagus (Hikidaeus) pastillatus</i>	SE. A.	28	21	49	42.9	5.8	2.5	0.3	-	-	-	-
<i>Onthophagus (Hikidaeus) simboroni</i>	Borneo	18	2	20	10.0	1.0	1.0	0.4	-	0.1	0.1	-
<i>Onthophagus (Onthophagus) aphodioides</i>	SE. A.	15	2	17	11.8	1.6	0.5	0.3	-	-	-	-
<i>Onthophagus (Onthophagus) batillifer</i>	Indoch.	1	1	2	50.0	0.2	-	0.1	-	-	-	-
<i>Onthophagus (Onthophagus) bonorae</i>	Indoch.	3	68	71	95.8	1.2	8.5	0.7	-	-	-	-
<i>Onthophagus (Onthophagus) borneensis</i>	Sunda.	31	1	32	3.1	1.8	2.5	0.1	0.3	0.4	-	-
<i>Onthophagus (Onthophagus) incisus</i>	Sunda.	51	4	55	7.3	0.8	4.0	1.3	0.3	0.1	-	-
<i>Onthophagus (Onthophagus) infucatus</i>	Indoch.	11	1	12	8.3	1.0	0.7	0.2	-	-	-	-
<i>Onthophagus (Onthophagus) keikooe</i>	Borneo	0	1	1	100	0.2	-	-	-	-	-	-
<i>Onthophagus (Onthophagus) ochromerus</i>	Borneo	0	1	1	100	-	0.2	-	-	-	-	-
<i>Onthophagus (Onthophagus) pacificus</i>	SE. A.	15	2	17	11.8	0.8	0.3	0.6	-	-	-	-
<i>Onthophagus (Onthophagus) pavidus</i>	Sunda.	1	0	1	0	-	0.2	-	-	-	-	-
<i>Onthophagus (Onthophagus) rutilans</i>	Large A.	16	2	18	11.1	2.8	0.5	-	-	0.1	-	-
<i>Onthophagus (Onthophagus) semipacificus</i>	Borneo	23	1	24	4.2	2.4	1.5	0.2	-	-	-	-
<i>Onthophagus (Onthophagus) vulpes</i>	SE. A.	126	4	130	3.1	8.2	7.7	2.3	-	-	-	-
<i>Onthophagus (Onthophagus) waterstradii</i>	Borneo	167	61	228	26.8	6.0	5.7	3.5	8.0	3.8	0.8	-
<i>Aphodius marginellus</i>	Large A.	1	68	69	98.6	-	-	-	-	-	-	23.0
<i>Aphodius</i> sp.	-	0	2	2	100	-	-	-	-	-	-	0.7

^aBoeneo: Bornean endemic, Sunda.: Sundaland (Borneo + Malay Peninsula, Sumatra, Java, Borneo, and/or Palawan), Indoch.: Sundaland and Indochina (Sunda. + Thailand, Laos, Cambodia, and/or Vietnam), SE. A.: Southeast Asia (Indoch. + Myanmar, Philippines and/or Sulawesi), Large A.: Large area (SE. A. + India, Taiwan, China, Japan, New Guinea, and/or Australia)

Table 4. Total number of beetles collected by each bait at each vegetation type

Vegetation type	Number of trap-transects in 3 years	Bait		% collected by fish bait
		Human excrement	Fish meat	
CNF	5	587	196	25.0
ENF	6	395	285	41.9
BNF	19	1,124	476	29.8
SCF	4	133	91	40.6
PLF	15	664	241	26.6
GRS	12	1,272	253	16.6
CPS	3	2,071	285	12.1
Total	64	6,246	1,827	22.6

Table 5. Number of species that was collected more than 5 individuals in each range of collection rates by fish meat baited traps in their total catches

Distribution range	% of beetles collected by fish meat baited traps			Total
	< 30	30 - 70	> 70	
Bornean endemic	8	5	2	15
Sundaland	6	1	2	9
Sundaland and Indochina	4	1	1	6
Southeast Asia	4	1		5
Large area	5		3	8

Catharsius renaudpauliani was only one species that was expected to reside mainly in destroyed forests and plantation forests because the males of the species was largely collected in both SCF and PLF but rare in the forest reserves and open environments (Table 3). Males of another species of the genus *Catharsius*, that is *C. dayacus*, had only ever been seen in the forest reserves (CNF, ENF, and BNF) (Table 3). This result suggests that these two species segregate their habitats with level of disturbance although their females are difficult to distinguish each other with their morphologies.

Seven of the 44 species were abundant in open environments (GRS and/or CPS), and rarely collected in forests (Table 3). Two of the 7 species, *Onthophagus (Furconthophagus) lilliputanus* and *Onthophagus (Indachorius) uedai*, were abundant in the grassland (GRS) but few were found in the cattle pasture (CPS) (Table 3). Conversely, 3 species, *Onthophagus (Furconthophagus) papulatus*, *Onthophagus (Gibbonthophagus) limbatus*, and *Aphodius marginellus* were quite abundant in the cattle pasture (CPS) (Table 3).

Regarding the relationships between the distribution

range and habitat preferences, many Bornean endemic species inhabit only natural forests, while many of Sundaland species inhabit a variety of forests including destroyed forests (SCF) and plantation forests (PLF) (Table 3). This suggests that the Sundaland species might have obtained their relatively wide distributions due to having plasticity in their habitat preferences. Many of open-land species (species abundant in GRS and/or CPS) are distributed outside Sundaland (Table 3). Some of these open-land species may enlarge their distributions artificially through introductions of livestock.

Abundance on each vegetation type and collection rates from fish meat baited traps of each species are summarized in Appendix table.

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Appendix Abundant vegetation type and range of collection rates by fish meat baited traps in total catches for each beetle that was collected more than 5 individuals

Abundant vegetation type in the main	% of beetles collected by fish meat baited traps		
	< 30	30 - 70	> 70
Deep inside of natural forest (CNF)	<i>Microcopris fujiokai</i>		
	<i>Caccobius binodulus</i>		
Natural forest (CNF - BNF)	<i>Ochicanton uedai</i>	<i>Parascatonomus aurifex</i>	<i>Phaeocrous emarginatus</i>
	<i>Ochicanton woroae</i>	<i>Onthophagus (Gibbonthophagus) fujiii</i>	<i>Phaeocroops sp.</i>
	<i>Paragymnopleurus maurus</i>	<i>Onthophagus (Indachorius) woroae</i>	<i>Parascatonomus dux</i>
	<i>Sisyphus thoracicus</i>	<i>Onthophagus (Hikidaeus) pastillatus</i>	<i>Parascatonomus rudis</i>
	<i>Catharsius dayacus</i> (male)		<i>Onthophagus (Pseudophanaeomorphus) chandrai</i>
	<i>Onthophagus (Gibbonthophagus) cervicapra</i>		<i>Onthophagus (Onthophagus) bonorae</i>
	<i>Onthophagus (Serrophorus) laevis</i>		
	<i>Onthophagus (Onthophagiellus) hidakai</i>		
	<i>Onthophagus (Hikidaeus) simboroni</i>		
	<i>Onthophagus (Onthophagus) aphodioides</i>		
	<i>Onthophagus (Onthophagus) borneensis</i>		
	<i>Onthophagus (Onthophagus) incisus</i>		
	<i>Onthophagus (Onthophagus) infucatus</i>		
	<i>Onthophagus (Onthophagus) pacificus</i>		
	<i>Onthophagus (Onthophagus) rutilans</i>		
	<i>Onthophagus (Onthophagus) semipacificus</i>		
<i>Onthophagus (Onthophagus) vulpes</i>			
Variety of forest types (CNF - PLF)	<i>Bolbochromus catenatus</i>	<i>Proagoderus schwaneri</i>	<i>Parascatonomus semiaureus</i>
	<i>Onthophagus (Onthophagus) waterstradti</i>		<i>Parascatonomus semicupreus</i>
Secondary forest and plantation forest (SCF -PLF)	<i>Catharsius renaudpauliani</i> (male)		
Grassland (GRS)	<i>Onthophagus (Furconthophagus) lilliputanus</i>	<i>Onthophagus (Indachorius) uedai</i>	
Grassland and pasture (GRS - CPS)	<i>Caccobius unicornis</i>		
	<i>Onthophagus (Paraphanaeomorphus) trituber</i>		
Pasture (CPS)	<i>Onthophagus (Furconthophagus) papulatus</i>		<i>Aphodius marginellus</i>
	<i>Onthophagus (Gibbonthophagus) limbatus</i>		
All vegetation types?		<i>Panelus kalimantanicus</i>	
		<i>Onthophagus (Gibbonthophagus) obscurior</i>	

インドネシア共和国東カリマンタン州バリクパパン近郊の低地で 採集された糞虫（鞘翅目：コガネムシ上科食糞群）のリスト

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要旨

糞虫（コガネムシ上科食糞群）は熱帯において生息地の質の有用な指標者である。インドネシア共和国東カリマンタン州の低地、バリクパパンの北 10～40km の地域において、2006 年から 2008 年の 12 月に、人糞と魚肉を誘引餌としたピットフォールトラップによる糞虫採集を 30 カ所で行った。65 種 8,073 個体の糞虫が捕獲され、そのリストを表に示した。糞虫群集を用いて森林環境を評価する今後の研究への有用な資料を提供するために、5 個体以上捕獲された 44 種の食性と生息地選好性を評価した。44 種のうち、41 種は人糞と魚肉の両方で採集された。8 種はどちらかの誘引餌へ偏りが 70% を超えず、そのうちの 5 種はボルネオ島固有種であった。生息地については、36 種が天然林に多く、人為的荒廃林、植林地と開放地でほとんど捕獲されなかったが、例外の 7 種はそういった生息地にも多かった。*Catharsius renaudpauliani* は荒廃林と植林地を主な生息地とする唯一の種と考えられた。開放地に多い 7 種は、天然林でほとんど捕獲されなかった。天然林に多い種は分布域が狭い傾向があったのに対し、開放地に多い種は分布域が広い傾向があった。

キーワード：誘引餌、ボルネオ島、森林、草地、生息地、コガネムシ科

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