

Exploitation of Flagship Species of Scarabaeid Beetles with Application of Analyzed Results on Cultural Entomology

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Abstract For successful conservation of diverse insects, it is important to study the current attitude and interest of the general public toward diverse insects from the aspect of cultural entomology. The popularity of different scarabaeid species in Japanese society was therefore investigated. Popularity was assessed by the Google search volume for scarabaeid species names in katakana script, using the Keyword Tool of Google AdWords. As a whole, a relatively small number of scarabaeid species was represented by an extraordinarily high search volume, while an abundance of other species was represented by a low search volume, indicating the biased attention of Japanese to only a small number of scarabaeid species. It appears that most of the popular scarabaeids have characteristics of (1) apparent morphological and ecological traits, (2) association with human survival, (3) occurrence of the species around human habitation, and/or (4) their widespread distribution in Japan. In particular, the search volume for “*Kabuto-mushi*” *Trypoxylus dichotomus*, a species with a distinctive horn and large body and occur in traditional rural landscapes in a wide range of Japan, was extraordinarily high relative to other species examined. This demonstrates, as also shown in earlier publications, that these beetles strongly fascinate the Japanese general public. Such a distinct preference for Japanese rhinoceros beetles suggests their high potential as a flagship species, which by definition are charismatic species and can become symbols and leading elements in any conservation campaign.

Keywords: *flagship species, conservation, cultural entomology, scarabaeids, Japanese culture, popularity, Japanese rhinoceros beetles*

1. Introduction

The current global large scale loss of biological diversity, especially insect diversity, has become important problem in conservation biology [1,2]. In Japan, current evidence of widespread abuse of the environment and abandonment of the traditional agricultural landscape, which contains a mosaic of habitats, is thought to have caused an enormous loss of insect biodiversity and thus many entomologists have assessed the diversity of insects and explored methods for their conservation [3,4,5,6,7]. However, for the successful conservation of diverse insects, it is important to study not only the taxonomy, ecology and biology of these insects, but also the current attitude of the general public toward these insects from the aspect of the humanities (e.g. cultural entomology) [1]. Based on such information, it becomes easier to make the general public understand the importance of conserving insect biodiversity and to enable the general public to participate in conservation programs [8] like the National Biodiversity Strategy 2012-2020 published by the Ministry of the Environment, Government of Japan [9]. Initially, we need to examine which and how different insect species are popular in Japanese societies. Attitude like these will contribute to conservation biology, such as

the exploitation of flagship species, which are popular charismatic species that serve as symbols and rallying points to stimulate conservation awareness and action [8,10,11].

The present study on the popularity of different insect groups in the society mentions the biased attention to a small number of insect groups and the ignorance of a large number of other insect groups [12,13,14], especially in Japan [15,16,17,18]. For example, Yuma [15] demonstrated that only a small number of insect groups, such as dipterans, hemipterans, lepidopterans and orthoptereans, appear frequently in haiku poetry. In addition, Takada [16] revealed that “*Hotaru*” (lampyrids) and “*Kabuto-mushi*” (dynastines or Japanese rhinoceros beetles) are extraordinarily popular coleopteran groups in Japanese culture and suggested that the high popularity of some coleopteran groups is due to their apparent characteristics and occurrence around human habitation. Moreover, Takada [17,18] showed that only a small number of lampyrid species and imported exotic dynastine species fascinate the Japanese general public due to their bioluminescence (for lampyrids) and distinctive horn and large bodies (for dynastines). However, these previous studies by Yuma [15] and Takada [16,17,18] focused on the popularity of different insect orders and families or different species which belong to a small taxonomic group. Thus, the question remains as to which and how diverse

species of large insect orders or families are represented in Japanese culture. It would seem preferable to examine the popularity of such diverse taxa, which should be potentially spotlighted in the field of conservation biology in Japan, if interest of general public in insects is to be considered in association with conservation biology.

Scarabaeid beetles are a species-rich taxon that consists of 371 species recorded in Japan [19]. Scarabaeids have diverse morphological, ecological and biological traits and have been found in a wide range of habitats due to their functional diversity [20]. Their species richness and functional diversity in various environments possibly contributes to yielding much ecological service and/or is surrogate for whole of biodiversity, indicating that scarabaeids need to be spotlighted in the field of conservation biology. In addition to their diverse functions in the ecosystem, scarabaeids include many threatened and endangered species, and 18 species and 1 subspecies (but a subspecies, *Mimela ignicauda sakishimana*, Nomura, 1973 is dealt with as a species, *Mimela sakishimana* Nomura, 1973, according to Fujioka [19]) of scarabaeid beetles are listed as significant species on the *Red List*, which is a report of the threatened status of species within Japan, published by the Ministry of the Environment, Government of Japan [21]. However, in spite of their diversity and their importance to study from the aspect of conservation biology, little is known about the current attitude of the general public toward scarabaeids from the aspect of cultural entomology, except for some taxonomic groups such as dynastines [18,22,23,24,25]. In particular, the popularity of different scarabaeid species has not been sufficiently explored in Japanese culture because their popularity has never been assessed quantitatively. It has been predicted that the popularity of scarabaeid species is biased to a greater or lesser extent due to attributes like morphology, ecology and biology, and that perhaps Japanese rhinoceros beetles are extraordinarily popular scarabaeids due to their apparent biological traits [16], [18,26,27], and thus it seems that they have high potential as a flagship species.

The popularity of different scarabaeid species was therefore investigated and it was examined which and how such species are represented in Japanese society and it was tried to determine which species are flagships. The popularity of different scarabaeid species was assessed by the Google search volume of group names. The search volume is used as a yardstick to measure a term's intention, interest or popularity, and thus can be applied to investigate the popularity of insects [16,17,18,22,24], as well as the public response to social issues [28], internet marketing and search engine optimization [29,30,31]. This statistic breaks out of methodological constraints, which have limited the cultural entomologist's attempt to investigate the popularity of different insect groups [17].

2. Material and Methods

A survey was conducted on the popularity of scarabaeid species on 27th November, 2012, assessing the local monthly search volume in Japan using the Keyword Tool in Google AdWords (https://adwords.google.com/o/Targeting/Explorer?__c=1000000000&__u=1000000000&ideaRequestType=KEYWORD_IDEAS). The local monthly

search volume (called "search volume"), which applies to searches performed on Google and the search network over the past 12-month period, show the approximate average monthly number of search queries matching each keyword result searched for in the country selected. When Google AdWords has insufficient data on a particular keyword, it returns "--" (not enough data). Such a case is regarded as having no search volume (0) for the keyword. This statistic is considered a reliable indicator of the insect popularity in Japanese society because of because of the high abundance of Internet users (78.2% of individuals using the Internet in 2010 [32]) and the high popularity of Google as search engine (39% of the market share in 2008 [33]) in Japan, although Internet use is somewhat biased in favor of younger and well-educated people [29]. In fact, Takada [16,17,18] assessed the popularity of different coleopteran groups, different lampyrid species and different exotic dynastine species in Japanese culture with the search volumes of these names retrieved by the Keyword Tool in Google AdWords. In addition, Chay & Sasaki [28] assessed public responses to climate mitigation policies in Japan using these methods.

Overall, 371 species names of scarabaeid beetles were used as keywords to evaluate the search volume of scarabaeid species (Table 1), referring to the Japanese names of these scarabaeid species listed in FUJIOKA [19]. The search volume of the Japanese names of these scarabaeid species was assessed in katakana, a Japanese syllabic script used in the Japanese writing system (Figure 1). Katakana is more suitable than other Japanese scripts such as hiragana and kanji, to examine which and how insects are used and perceived in Japanese culture, because Katakana is most often used for scientific terms, such as the names of animal and plant species and minerals [16,17,18,22,24].

To evaluate the search volume, the browser Firefox 12.0 was used. The operating system was Windows 7 Home Premium Service Pack 1 (64 bit) installed on a Lenovo G570 4334CSJ (CPU: Intel Core i5 2410M (2.3 GHz)).

3. Results

The search volume for "*Kabuto-mushi*", which is the Japanese rhinoceros beetle [*Trypoxylus dichotomus* (Y. Kurosawa, 1985)] in Japanese, was 165,000 searches, the highest of the species names of scarabaeid in katakana (Table 1). The search volume for "*Kogane-mushi*" [*Mimela splendens* (Gyllenhal, 1817)] was the second highest in katakana (14,800 searches), and the search volume for "*Kanabun*" [*Pseudotorynorhina japonica* (Hope, 1841)] was the third highest in katakana (12,100 searches). For species names in katakana, a search volume frequency of 1,000 to < 10,000 searches, 100 to < 1,000 searches, and of 10 to < 100 searches occurred for 1, 15 and 29 species, respectively. On the other hand, no search volume was obtained for 323 species names in katakana, due to the lack of data on these keywords in Google AdWords.

4. Discussions

4.1 Methodological Problems

These results indicated a trend in the popularity of different scarabaeid species in Japanese culture, but the search volume might be an over-estimation as the popularity to some extent because of the popularity of scarabaeid species, whose names refer not only to species,

but also to the higher taxonomic level, e.g. “*Kogane-mushi*” is the species name of *Mimela splendens*, but also refers to the scarabaeid familial and common name. Thus many Internet users will tend to search for “*Kogane-mushi*” as the term for the scarabaeid familial and common names.

Table 1. Search Volume For The Terms Of The Top 48 Scarabaeid Species In Japanese

Rank	Subfamily	Species	Japanese	Search volume
1	Dynastinae	<i>Trypoxylus dichotomus</i> (Y. Kurosawa, 1985)	Kabuto-mushi	165,000
2	Rutelinae	<i>Mimela splendens</i> (Gyllenhal, 1817)	Kogane-mushi	14,800
3	Cetoniinae	<i>Pseudotorynorhina japonica</i> (Hope, 1841)	Kanabun	12,100
4	Rutelinae	<i>Anomala cuprea</i> (Hope, 1839)	Dougane-buibui	1,900
5	Rutelinae	<i>Anomala albopilosa</i> (Hope, 1839)	Ao-dugane	590
6	Scarabaeinae	<i>Copris ochus</i> (Motschulsky, 1860)	Daikoku-kogane	480
6	Euchirinae	<i>Cheirotonus jambar</i> Y. Kurosawa, 1984	Yanbaru-tenaga-kogane	480
8	Rutelinae	<i>Popillia japonica</i> Newman, 1841	Mame-kogane	390
9	Melolonthinae	<i>Melolontha japonica</i> Burmeister, 1855	Kofuki-kogane	320
9	Cetoniinae	<i>Rhomborhina unicolor</i> Motschulsky, 1861	Ao-kanabun	320
11	Rutelinae	<i>Exomala orientalis</i> (Waterhouse, 1875)	Semadara-kogane	260
12	Dynastinae	<i>Eophileus chinensis</i> (Faldernann, 1835)	Ko-kabuto-mushi	210
12	Cetoniinae	<i>Protaetia orientalis</i> H. Kobayashi, 1994	Shiroten-hanamuguri	210
14	Rutelinae	<i>Anomala rufocuprea</i> Motschulsky, 1860	Hime-kogane	140
14	Cetoniinae	<i>Rhomborhina polita</i> Waterhouse, 1875	Kuro-kanabun	140
14	Cetoniinae	<i>Gametis jucunda</i> (Faldernann, 1835)	Ko-ao-hanamuguri	140
17	Melolonthinae	<i>Polyphylla laticollis</i> Lewis, 1887	Hige-kogane	110
17	Cetoniinae	<i>Anthrachophora nusicola</i> Burmeister, 1842	Akamadara-hanamuguri	110
17	Cetoniinae	<i>Protaetia brevitarsis</i> (Lewis, 1879)	Shirahoshi-hanamuguri	110
20	Melolonthinae	<i>Heptophylla picea</i> Motschulsky, 1857	Nagacha-kogane	91
20	Melolonthinae	<i>Polyphylla albolineata</i> (Motschulsky, 1861)	Shirosuji-kogane	91
22	Melolonthinae	<i>Holotrichia kiotonensis</i> Brenske, 1894	Kuro-kogane	73
22	Trichiinae	<i>Osmodema opicum</i> Lewis, 1887	Oo-chairo-hanamuguri	73
24	Scarabaeinae	<i>Copris acutidens</i> Motschulsky, 1860	Gohon-daikoku-kogane	58
24	Melolonthinae	<i>Maladera japonica</i> (Motschulsky, 1860)	Biroudo-kogane	58
26	Cetoniinae	<i>Cetonia roelofsi</i> Harold, 1880	Ao-hanamuguri	48
27	Aphodiinae	<i>Aphodius rectus</i> (Motschulsky, 1866)	Maguso-kogane	46
27	Melolonthinae	<i>Hoplia communis</i> Waterhouse, 1875	Ashinaga-kogane	46
29	Melolonthinae	<i>Holotrichia parallela</i> (Motschulsky, 1854)	Oo-kuro-kogane	36
29	Melolonthinae	<i>Melolontha frater</i> Arrow, 1913	Oo-kohuki-kogane	36
29	Rutelinae	<i>Adoretus tenuimaculatus</i> Waterhouse, 1875	Koicha-kogane	36
32	Scarabaeinae	<i>Panelus parvulus</i> (Waterhouse, 1874)	Mame-daruma-kogane	28
32	Glaphyrinae	<i>Amphicoma pectinata</i> (Lewis, 1895)	Higebuto-hanamuguri	28
32	Rutelinae	<i>Anomala dainiana</i> Harold, 1877	Sakura-kogane	28
32	Cetoniinae	<i>Glycyphana fulvitemma</i> Motschulsky, 1860	Kuro-hanamuguri	28
32	Trichiinae	<i>Trichius japonicus</i> Janson, 1885	Tora-hanamuguri	28
37	Scarabaeinae	<i>Copris brachypterus</i> Nomura, 1964	Maru-daikoku-kogane	22
37	Scarabaeinae	<i>Liatongus minutus</i> (Motschulsky, 1860)	Tsuno-kogane	22
37	Scarabaeinae	<i>Onthophagus viduus</i> Harold, 1874	Maru-enma-kogane	22
37	Glaphyrinae	<i>Amphicoma splendens</i> (Yawata, 1942)	Oo-higebuto-hanamuguri	22
37	Melolonthinae	<i>Maladera castanea</i> (Arrow, 1913)	Aka-biroudo-kogane	22
37	Cetoniinae	<i>Protaetia pryeri</i> (Janson, 1888)	Ryukyu-tsuya-hanamuguri	22
43	Melolonthinae	<i>Maladera orientalis</i> (Motschulsky, 1857)	Hime-biroudo-kogane	16
43	Dynastinae	<i>Alissonotum pauper</i> (Burmeister, 1847)	Kuro-maru-kogane	16
43	Cetoniinae	<i>Protaetia lugubris</i> (Lewis, 1879)	Miyama-oo-hanamuguri	16
43	Cetoniinae	<i>Protaetia lenzi</i> (Harold, 1878)	Kyouto-ao-hanamuguri	16
43	Trichiinae	<i>Gnorimus subopacus</i> Motschulsky, 1860	Ao-ashinaga-hanamuguri	16
48	Dynastinae	<i>Oryctes rhinoceros</i> (Linnaeus, 1758)	Sai-kabutomushi	10
49	Other 323 species			0

4.2 Biased Attention of Japanese to Only a Small Number of Scarabaeid Species

As a whole, a relatively small number of scarabaeid species was represented by an extraordinarily high search volume, while an abundance of other species was represented by a low search volume, indicating the biased attention of Japanese to only a small number of scarabaeid species (Table 1). It appears that most popular scarabaeids have characteristics of (1) apparent morphological and

ecological traits (e.g. distinctive horns and large body), (2) association with human survival (especially beneficial insects facilitate positive image), (3) occurrence of the species around human habitation, and/or (4) their widespread distribution in Japan, as suggested by several case studies on the popularity of coleopteran insects [16,17,18,22,24]. On the other hand, most scarabaeid species have characteristics of (1) obscure morphological and ecological traits (e.g., a small body, cryptic or subdued coloration and dwelling in closed and compact habitats) and (2) occurrence far from human habitation

and thus are perhaps not found and perceived by casual observers [16]. In passing, Zmihorski *et al.* [8], who examined the effect of some characteristics of butterflies on their popularity in the UK, as measured by their Google hit count, also showed that greater familiarity with butterflies occurs with people who live near the species and can distinguish them. The popularity of butterfly species in the UK was readily explained by appearance (colour) and commonness (distribution), but was negatively explained by body size (wingspan), using a quantitative method. It is possible that the effect of body size on popularity differs between scarabaeids and butterflies because all sizes of butterfly species are easy to detect compared with the small scarabaeid species, which are thought to be invisible and indiscriminate. In this connection, it seems that commonness is not necessarily always to positively affect the popularity of insects. For example, European lucanid species, *Lucanus cervus* is very rare species and rarely seen by general public, but the popularity of this species goes back hundreds of year to an oil painting made by Albrecht Dürer [34]. In this case, it seems that the species is popular due to their traditional

fascination to general public and rather their scarcity may fascinate curiosity or conservation awareness of general public.

The biased attention of Japanese to only a small number of species was shown by the scarabaeid species listed on the *Red List*, which is a report of the threatened status of species within Japan (Table 2). Of the 18 species listed, search volume frequency of 100 to less than 1,000 searches and of 10 to less than 100 searches occurred for only 3 and 2 species, respectively, and no search volume was obtained for 13 species names. The most threatened species (here this word is used to mean species listed on the *Red List*) perhaps tend to be ignored due to their obscure morphological and ecological traits, occurrence far from human habitation or narrow distribution in Japan. For successful conservation of the obscure species, we will need to make the general public pay more attention to these species using appropriate methods, because the success of conservation programs seems to depend on the diffusion of the importance of their conservation, as mentioned by Zmihorski *et al.* [8].

Table 2. Search volume for the terms of scarabaeid species listed in the *Red List* which is a report of the threatened status of species within Japan, published by the Japanese Ministry of Environment

Category	Species	Japanese	Search volume
Endangered (EN)	<i>Cheirotonus jambar</i> Y. Kurosawa, 1984	Yanbaru-tenaga-kogane	480
Vulnerable (VU)	<i>Copris brachypterus</i> Nomura, 1964	Maru-daikoku-kogane	22
	<i>Copris ochus</i> (Motschulsky, 1860)	Daikoku-kogane	480
	<i>Onthophagus gibbulus</i> (Pallas, 1781)	Chabane-enma-kogane	0
	<i>Onthophagus yakuinsulanus</i> Nakane, 1984	Yakushima-enma-kogane	0
	<i>Aphodius gotoi</i> Nomura <i>et</i> Nakane, 1951	Tsuyakeshi-maguso-kogane	0
Near Threatened (NT)	<i>Onthophagus japonicus</i> Harold, 1874	Yamato-enma-kogane	0
	<i>Onthophagus ocellatopunctatus</i> Waterhouse, 1875	Arame-enma-kogane	0
	<i>Aphodius stumi</i> Harold, 1870	Hime-kiro-maguso-kogane	0
	<i>Aphodius küchii</i> Masumoto, 1984	Daisetsu-maguso-kogane	0
	<i>Aphodius languidulus</i> Schmidt, 1916	Kibane-maguso-kogane	0
	<i>Aphodius variabilis</i> Waterhouse, 1875	Kuromon-maguso-kogane	0
	<i>Osmodema opicum</i> Lewis, 1887	Oo-chairo-hanamuguri	73
Data Deficient (DD)	<i>Copris tripartitus</i> Waterhouse, 1875	Hime-daikoku-kogane	0
	<i>Aphodius brachysomus</i> Solsky, 1874	Semaru-oo-maguso-kogane	0
	<i>Mozartius testaceus</i> Nomura <i>et</i> Nakane, 1951	Daruma-maguso-kogane	0
	<i>Anthracophora nasticola</i> Burmeister, 1842	Akamadara-hanamuguri	110
	<i>Mimela sakishimana</i> Nomura, 1973	Sakishima-chibi-kogane	0

4.3 Charismatic Favor of Japanese Rhinoceros Beetles and Their Suitability as Flagship Species

In particular, the search volume for “*Kabuto-mushi*” *Trypoxylus dichotomus* was extraordinarily high relative to other scarabaeid species examined. In contemporary Japan, Japanese rhinoceros beetles, *Trypoxylus dichotoma*, have strongly fascinated the general public with their attractive and cool image due to their distinctive horn and large body, with the result that they are popular as pets [16,18,23,24,35,37] and they have been frequently represented in such Japanese popular cultural media as movies, animations, cartoons, computer games and music with a positive image [25,27,37,38]. Some researches have compared the popularity among insect groups or species, including the Japanese rhinoceros beetles with quantitative methods and shown that Japanese rhinoceros beetles are popular coleopteran insects [16] of a common insect group [39,40]. In addition, if the search volumes of

scarabaeid species are compared with those of lampyrid species as shown by Takada [17], the search volume of Japanese rhinoceros beetles (165,000 searches) is 68.8 times that of the genji firefly, *Luciola cruciata* Motschulsky, 1854 (2,400 searches), which is the most popular species of the Japanese lampyrids, although lampyrids, especially the genji firefly, are one of the most important insects strongly linked with Japanese culture and attract many Japanese to the subject of conservation of the traditional rural landscape in Japan [17].

Such strong preference for Japanese rhinoceros beetles suggests their high potential as a flagship species, which is defined as a popular charismatic species that has become a symbol and leading element of an entire conservation campaign [8,10,11]. In particular, using the Japanese rhinoceros beetle as a flagship species will be useful to conservation programs of the biodiversity of the Japanese traditional rural landscape, called *satoyama*, which contains a mosaic of habitats such as secondary forest and farmland, maintained by sustainable use for human life in rural area but being devastated due to abandonment and

abuse of the landscape. Indeed, Japanese rhinoceros beetles are strongly linked with the environment of *satoyama* landscapes, and adults of this species feed on the sap of broad-leaved trees in the secondary forest and their larvae grow with the humus around farmlands. In addition, Japanese rhinoceros beetles seem to be an important resource for some mammals and birds, such as wild pigs, raccoons, moles and crows, and small insects such as ants, indicating that Japanese rhinoceros beetles sustain diverse organisms living in the *satoyama* landscape.

Japanese rhinoceros beetles also provide an opportunity for the general public to be attracted to other scarabaeid beetles due to their potential suitability as a flagship species. Diverse scarabaeid beetles should be spotlighted as an important subject for the conservation of biodiversity because scarabaeids have functional diversity, which indicates the necessity of a widespread environment to maintain the scarabaeid fauna, and includes many threatened species which will need to be conserved with management practices. Japanese rhinoceros beetles could possibly also become a trigger for the Japanese general public to become interested in the environment, in which other scarabaeid species occur and to conserve the most threatened but ignored species of scarabaeids.

5. Conclusion

This study showed the biased attention of Japanese to only a small number of scarabaeid species and the charismatic favor of Japanese rhinoceros beetles of scarabaeid beetles in Japanese society, suggesting the potential suitability of the Japanese rhinoceros beetle as a flagship species. This study showed that analyzing results of cultural entomology could be applied for conservation biology, especially the exploitation of flagship species, by measuring the popularity of different species in human society quantitatively.

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