

Scarabaeid Dung Beetle Fauna of Kodakara-jima Island, the Tokara Islands, the Ryukyu Archipelago, with Special Reference to Establishment of an Exotic Dung Beetle, *Ataenius picinus* HAROLD (Coleoptera, Scarabaeidae, Aphodiinae)

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Abstract The fauna of scarabaeid dung beetles in Kodakara-jima Island in the Tokara Islands, the Ryukyu Archipelago, southwestern Japan, was studied by light trap. A total of 325 individuals comprising nine species of four genera belonging to two subfamilies were collected. Of these, *Aphodius sublimbatus*, *Ap. postpilosus*, *Rhyparus helophoroides*, *R. kitanoi kitanoi* and *R. azumai azumai* belonging to the subfamily Aphodiinae were first collected from Kodakara-jima Island. This is the first record that three species of the genus *Rhyparus* were collected at the same locality and date. Exotic dung beetle, *Ataenius picinus*, was rapidly increased in number of individuals from 2009 to 2010. *Ataenius picinus* constituted 18.8% of the total number of dung beetles in the fauna. The result shows that *At. picinus* was invaded and established this island in three years, 2008 to 2010.

Introduction

Zoogeographically, the Tokara Islands, the Ryukyu Archipelago, southwestern Japan are a boundary area between the Oriental and Palaearctic Regions. Watase's Line, which is the proposed border between these two zoogeographical regions, is situated at the Tokara Gap (identical with Tokara Tectonic Straits) between the Akuseki-jima and Kodakara-jima Islands of the Tokara Islands (HIKIDA *et al.*, 1992). In the Tokara Islands, Kodakara-jima and Takara-jima Islands on the southern side of WATASE'S Line are located in the Oriental Region, and many oriental species such as Tokara habu, *Protobothrops tokarensis*, are distributed in these islands. Both islands were formed when a coral reef rose, and are different environment from other islands covered by a steep cliff (NARUO, 1995).

Until now, total of 24 dung beetle species of the family Scarabaeidae, eight species belonging to the subfamily Scarabaeinae and 16 species belonging to the subfamily Aphodiinae have been recorded in the Tokara Islands (HOSOYA, 2011, 2014 a). In addition, *Onthophagus nitidus* of the subfamily Scarabaeinae recorded from Nakano-shima and Akuseki-jima Islands and *Aphodius comatus* (Takara-jima Island) in the subfamily Aphodiinae were problematic as possibility of miss identification (HOSOYA, 2011) whereas *Copris acutidens* (Suwanose-jima Island) was accidental record of unintentional introduction (FUKUDA & EHIRA, 1992). Except for these three species, 21 dung beetle species are distributed in the Tokara Islands.

I first researched on the scarabaeid dung beetle fauna in Kodakara-jima Island, the Tokara Islands in 2009, and reported four species, *Onthophagus viduus* of the subfamily Scarabaeinae, and *Aphodius urostigma*, *Aphodius uniformis* and *Ataenius picinus* of Aphodiinae (HOSOYA *et al.*, 2011; HOSOYA, 2014 a). Of these, *At. picinus* is known to have worldwide distribution, but all the populations except

the New World Region are considered to have unintentionally been introduced from the original distribution area (STEBNICKA & HOWDEN, 1997; STEBNICKA, 2004). In Japan, *At. picinus* was first discovered at Yonaguni-jima Island, the southwestern-most island of Japan, in the Yaeyama Islands of the Ryukyu archipelago in April 2000 (KAWAI, 2000). Since its first introduction to Japan, this exotic dung beetle has expanded northward through the Ryukyu archipelago (KAWAHARA *et al.*, 2008; HOSOYA *et al.*, 2009; HOSOYA *et al.*, 2011).

So far, dung beetle fauna in Kodakara-jima Island was researched one time in 2009 (HOSOYA *et al.*, 2011), and has been not clarified. And, the ecological niche, cow dungs in pasture, for scarabaeid beetles exists throughout this island, because cattle breeding is one of the main industries in Kodakara-jima Island. It is possible that new record of dung beetles may be found in the island. In this paper, the author will report the result of the additional survey conducted in 2010, and revise the scarabaeid dung beetle fauna in Kodakara-jima Island, based on light trap, with reference to establishment of an exotic dung beetle, *At. picinus*.

Materials and Methods

Dung beetles were collected by a curtain light-trap (two 18-watt fluorescent lamps and two 20-watt chemical fluorescent lamps using dynamo, and two 8-watt black fluorescent lamps using battery) at 19:45–22:10, August 2, 2010. The trap was set at the entrance of the trail up to the summit of Mt. Takenoyama (N29.2218, E129.3269, alt. 28 m) from where Haebaru pasture was overlooked. Collected dung beetles were preserved in 99.5% ethanol, and were identified by binoculars in the laboratory of Kyushu University. The rate of individuals in each species and the rate of species in each tribe or subfamily were estimated.

Results

A total of 325 scarabaeid dung beetles comprising nine species of four genera, of which one species (11.1%) of the subfamily Scarabaeinae and eight (88.9%) of the subfamily Aphodiinae, were collected in light trap. A list of each species and its abundance were summarized in Table 1. *Aphodius sublimbatus*, *Ap. postpilosus*, *Rhyparus helophoroides*, *R. kitanoi kitanoi* and *R. azumai azumai* of Aphodiinae were first recorded, and *O. viduus* of Scarabaeinae, and *Ap. urostigma*, *Ap. uniformis* and *At. picinus* of Aphodiinae were re-recorded from Kodakara-jima Island. The subfamilies Scarabaeinae and Aphodiinae constituted 13.2% and 86.8% of the total number of dung beetles in the fauna, respectively. In the subfamily Aphodiinae, the tribes Aphodiini, Eupariini and Rhyparini constituted 55.7%, 18.8% and 12.3% of the total number of dung beetles in the fauna, respectively. *Aphodius urostigma* was most high abundance in the fauna (166 individuals, 51.1%). Exotic dung beetle, *At. picinus*, belonging to the tribe Eupariini constituted 18.8% (61 individuals) of the dung beetles fauna.

Discussion

The scarabaeid dung beetle fauna in Kodakara-jima Island is total nine species: *O. viduus* of Scarabaeinae, *Ap. urostigma*, *Ap. uniformis*, *Ap. sublimbatus*, *Ap. postpilosus*, *At. picinus*, *R. helophoroides*, *R. kitanoi kitanoi* and *R. azumai azumai* of Aphodiinae. All five species of new records in Kodakara-jima Island are already recorded in other two to four islands in the Tokara Islands (HOSOYA, 2011, 2014 a). In nine species recorded from Kodakara-jima Island, seven species, *O. viduus*, *Ap. urostigma*, *Ap. uniformis*, *Ap. sublimbatus*, *Ap. postpilosus*, *R. helophoroides* and *R. azumai azumai*,

Table 1. The list of dung beetles collected by light trap in Kodakara-jima Island in the Tokara Islands, August 2, 2010.

Species	% of species in tribe and subfamily	No. of individuals collected	% of individuals collected
Scarabaeinae	11.1		
<i>Onthophagus viduus</i>		20 ♂♂ 23 ♀♀	13.2
Aphodiinae	88.9		
Aphodiini	44.4		
<i>Aphodius urostigma</i>		166	51.1
<i>Aphodius uniformis</i>		12	3.7
<i>Aphodius postpilosus</i>		2	0.6
<i>Aphodius sublimbatus</i>		1	0.3
Eupariini	11.1		
<i>Ataenius picinus</i>		61	18.8
Rhyparini	33.3		
<i>Rhyparus helophoroides</i>		22	6.8
<i>Rhyparus azumai azumai</i>		12	3.7
<i>Rhyparus kitanoi kitanoi</i>		6	1.8

are common in the Tokara Islands and neighboring northward and southward the Islands, one is exotic beetle *At. picinus*, one is the Palaearctic subspecies *R. kitanoi kitanoi* (KAWAI *et al.*, 2005; OCHI, 2012). It is shown that the dung beetle fauna in Kodakara-jima Island is composed of the species distributed wide area.

The dung beetle fauna in Kodakara-jima Island constituted high rate of species (88.9%) and high abundance (86.7%) of Aphodiinae. One of the factors making the dung beetle fauna in Kodakara-jima Island is considered to be the lack of enough dung resource in the narrow pastures in the small island (1 km²). Members of the subfamily Aphodiinae have small body sizes and can thus multiply even if there is little food, compared to the dung beetle in the subfamily Scarabaeinae.

Most dung beetle species recorded in Kodakara-jima Island, except the genus *Rhyparus* which an ecological trait is unknown, is observed mainly in open land (KAWAI *et al.*, 2005). It is thought that this feature is caused by high ratio of open land environment in Kodakara-jima Island.

In this research, dung beetles were collected by a curtain light-trap using two 18-watt fluorescent lamps and two 20-watt chemical fluorescent lamps using dynamo, and two 8-watt black fluorescent lamps using battery, whereas a light-trap using only four 8-watt black fluorescent lamps using battery in 2009 (HOSOYA *et al.*, 2011). By using brighter light in this research, many species and individuals could be collected by the light-trap.

Aphodius postpilosus have been recognized as a synonym of *Ap. urostigma* in Japan, and was treated *Ap. postpilosus* as valid in Japan recently (HOSOYA, 2014 a). The distributional area of these two species in the Tokara Islands needs reexamination. The result showed that these two species, *Ap. urostigma* and *Ap. postpilosus*, were distributed in Kodakara-jima Island. In the result, *Ap. urostigma* was most high abundance in the fauna. Thus, *Ap. urostigma* is the most dominant species in Kodakara-jima Island.

It was not recorded that *R. kitanoi kitanoi* was collected with *R. helophoroides* (KAWAI *et al.*, 2005). MIMURA (2006) reported that *R. kitanoi kitanoi* and *R. helophoroides* were collected the same locality, but different day. In the present study, it is the first record that *R. kitanoi kitanoi* was collect-

ed the same locality and date with *R. helophoroides*, and three species of the genus *Rhyparus* were collected the same time.

The first specimen of the invasive dung beetle, *At. picinus*, in the Tokara Islands was collected at walking on the floor in the guest-house in Takara-jima Island at August 2008 (HOSOYA *et al.*, 2009). In Kodakara-jima Island, *At. picinus* was collected from cow dung in 2009, but was not attracted to the light-trap or to lights in the village (HOSOYA *et al.*, 2011). In 2010, *At. picinus* were attracted to light-trap in large number (61 individuals, 18.8%) in present study. It is thought that *At. picinus* invaded and established in Kodakara-jima Island for the same period as on Takara-jima Island in three years, 2008 to 2010 (HOSOYA, 2014 b). *Ataenius picinus* is an ecologically diverse species that is present in fresh and extremely dry cow dung, sheep and horse dung, decaying fruits and mushrooms, compost heaps, soil and leaf litter, and under carrion and organic matter (WATT, 1984; STEBNICKA & HOWDEN, 1997; KAWAI, 2000; KAWAHARA, 2001; GALANTE *et al.*, 2003; STEBNICKA, 2004; KUSUI & YAMASHITA, 2005; NISHINO, 2005; KAWAHARA *et al.*, 2008; UESATO, 2008; MINATANI, 2009; HOSOYA *et al.*, 2011) and can use various niches. Thus, it is considered that this exotic dung beetle will be established and the population will grow further, impacting the native ecosystems as well as native dung beetles in Japan.

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要 約

細谷忠嗣：トカラ列島小宝島における糞虫相と外来糞虫ヤエヤマニセツツマグソコガネ *Ataenius picinus* HAROLD (コウチュウ目コガネムシ科マグソコガネ亜科) の定着について。——トカラ列島小宝島の糞虫相についてライトトラップを用いて調査した。コガネムシ科の2亜科に属する4属9種の合計325個体が採集された。マグソコガネ亜科に属するウスイロマグソコガネ *Aphodius sublimbatus*、ヒメフチケマグソコガネ *Ap. postpilosus*、ヒメセスジカクマグソコガネ *Rhyparus helophoroides*、キュウシュウカクマグソコガネ *R. kitanoi*、セスジカクマグソコガネ *R. azumai azumai* は同島の初記録であり、カクマグソコガネ属 *Rhyparus* の3種が同時に採集された初の記録でもある。また、外来糞虫であるヤエヤマニセツツマグソコガネ *Ataenius picinus* は前年の2009年に比べて個体数が急増しており、採集された全個体数の18.8%を占めるまでになっており、本種が2008年から2010年の間に同島に侵入し、定着したことが示された。

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