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Ants, Wasps and Bees of Kuro-shima, Northern Ryukyus, Japan (Hymenoptera, Aculeata)

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Abstract Faunal surveys of ants, wasps and bees were conducted on Kuro-shima, Mi-shima group, Northern Ryukyus, Japan, in 2006-2007. In total 52 species belonging to 35 genera were collected. Among them 20 ant, 2 wasp and 18 bee species are new to this island. A revised list of Aculeata from Kuro-shima is presented. Some biological and biogeographical notes are given for the Aculeate fauna of the Mi-shima group.

Key words: Mi-shima group, Ryukyus, Aculeata, fauna, species number, biology, biogeography.

Introduction

In the previous paper (Ikudome and Yamane, 2007) we presented additional information on the Aculeate fauna of Iwo-jima, a volcanic island belonging to the Mi-shima Islands, located in Northern Ryukyus. In 2006 and 2007 we conducted faunal surveys on another island of the Mi-shima group, namely Kuro-shima (Fig. 1), which had no recent volcanic activity and is more extensively covered with thick forests. The most comprehensive list of the Aculeata on this island is given in Yamane *et al.* (1999), where only two species of ant, 22 species of wasp, and seven species of bee are recorded. Our surveys added a lot of ant and bee species to the list.

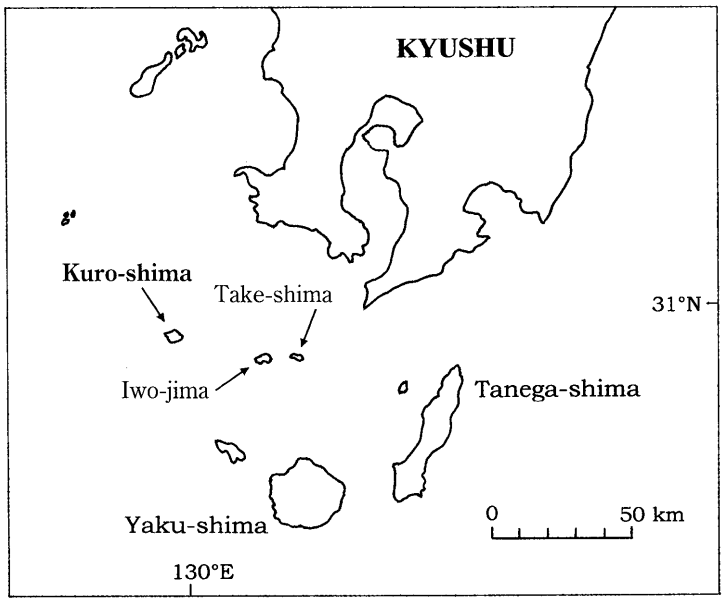

Fig. 1. Map of Kuro-shima and surrounding islands.

Sampling methods

The ants were collected by Yamane on 28-30 March, 2007. Mainly manual collection was made, but colonies were searched for as much as possible to know nesting sites. Foragers attracted to *Mallotus japonicus* (Euphorbiaceae) extrafloral nectarines were also sampled. The wasps and bees were collected by Ikudome on 3-5 May, 3-6 August and 14-17 October, 2006. They were mainly caught with a net on the flower of plants along roads (plant names recorded), but some were collected by random sweeping by a net to cover lower vegetation.

List of collected species in 2006/2007

In total 52 species belonging to 35 genera were collected in 2006-2007. Genera are arranged in alphabetical order in each family or subfamily. A revised list of aculeate Hymenoptera of this island is given in Table 1.

Formicidae

Colony codes are shown as, for example, KG07-10 ('SKY' is omitted from KG07-SKY-01 for convenience). GC: general collection. *MJ* EFN: *Mallotus japonicus* extrafloral nectary. All species are new to Kuro-shima.

Dolichoderinae

1. *Ochetellus glaber* (Mayr)

Katadomari: KG07-01, nest in dead stem of *Pleioblastus linearis*, roadside; workers from *MJ* EFN. Nakasato Line: workers on roadside, GC. Chuo Line: workers from *MJ* EFN.

Formicinae

2. *Camponotus bishamon* Terayama

Katadomari: workers from *MJ* EFN. Chuo Line: workers from *MJ* EFN. Some specimens are intermediate between *C. bishamon* and *C. vitiosus* in the condition of propodeum and petiole.

3. *Camponotus devestivus* Wheeler

Nakasato Line: 2 dealated females from rotting wood.

4. *Lasius japonicus* Santschi

Nakasato Line: KG07-12, nest in soil around tree base in sparse forest; KG07-16, nest under stone and in soil, roadside; KG07-18, nest under stone and in soil, roadside; workers on roadside, GC.

5. *Paratrechina flaviceps* (F. Smith)

Katadomari: KG07-02, nest in shallow soil (with males & a queen); workers from *MJ* EFN. Nakasato Line: KG07-03, nest in rotting wood; KG07-04, nest in shallow soil; KG07-13, nest under stone and in soil in sparse forest (with males & queens). Chuo Line: nest from rotting twig (with males & queens)

6. *Paratrechina sakurae* (Ito)

Nakasato Line: workers from soil, GC.

Myrmicinae

7. *Crematogaster nawai* Ito

Chuo Line: workers from *MJ* EFN.

8. *Crematogaster osakensis* Forel

Nakasato Line: KG07-08, nest in soil in evergreen forest; workers from soil, GC; workers from rotting wood.

Table 1. A revised list of species of the Aculeata on Kuro-shima. (* indicates a new record.)

Ants (22 species)

Formicidae
Dolichoderinae
1. *Ochetellus glaber* *
Formicinae
2. *Camponotus bishamon* *
3. *Camponotus devestivus* *
4. *Lasius japonicus* *
5. *Paratrechina flaviceps* *
6. *Paratrechina sakurae* *
Myrmicinae
7. *Aphaenogaster osimensis*
8. *Aphaenogaster tokarainsula*
9. *Crematogaster nawai* *
10. *Crematogaster osakensis* *
11. *Crematogaster vagula* *
12. *Monomorium chinense* *
13. *Monomorium intrudens* *
14. *Pheidole fervens* *
15. *Pheidole noda* *
16. *Pristomyrmex punctatus* *
17. *Tetramorium nipponense* *
18. *Vollenhovia benzai* *
19. *Vollenhovia emeryi* *
Ponerinae
20. *Hypoponera sauteri* *
21. *Pachycondyla chinensis* *
22. *Ponera tamon* *

Wasps (24 species)

Pompilidae
1. *Cyphononyx dorsalis*
2. *Leptodialepis sugiharai*
3. *Platydialepis ryoheii*
4. *Auplopus takachihoi*
5. *Batozonerus maculifrons*
6. *Parachyphononyx alienus*
Scoliidae
1. *Scolia fascinate* *
2. *Campsomeriella annulata*
3. *Megacampsomeris mojiensis*
Eumenidae
1. *Stenodynerus chinensis*
2. *Euodynerus trilobus*
3. *Anterhynchium flavomarginatum*
4. *Eumenes rubronotatus*
Vespidae
1. *Polistes jokahamae*
2. *Polistes rothneyi*
3. *Parapolybia indica*
4. *Vespa ducalis* *
Sphecidae
1. *Isodontia nigella*
2. *Sceliphron madraspatanum*
Crabronidae
1. *Liris subtessellatus*
2. *Liris festinans*
3. *Trypoxylon petiolatum*
4. *Trypoxylon malaisei*
Philanthidae
1. *Cerceris japonica*

Bees (22 species)

Colletidae
1. *Colletes perforator* *
2. *Hylaeus hirashimai* *
3. *Hylaeus insularum*
Halictidae
1. *Lasioglossum (Evylaeus) japonicum* *
2. *Lasioglossum (E.) smilodon* *
3. *Lasioglossum (E.) sphecodicolor* *
4. *Lasioglossum (Lasioglossum) mutilum* *
5. *Lasioglossum (L.) occidens* *
6. *Nomia punctulata* *
7. *Sphecodes japonicus* *
8. *Sphecodes nipponicus* *
Andrenidae
1. *Andrena (Andrena) aburana* *
2. *Andrena (Chlorandrena) knuthi* *
3. *Andrena (Simandrena) austroinsularis* *
Megachilidae
1. *Megachile pseudomonticola*
2. *Megachile remota sakagamii* *
3. *Megachile sculpturalis* *
Apidae
1. *Amegilla florea florea*
2. *Tetraloniella mitsukurii* *
3. *Thyreus decorus*
4. *Ceratina satoi* *
5. *Xylocopa appendiculata circumvolans*

TOTAL

13 families, 47 genera, 68 species

9. *Crematogaster vagula* Wheeler
   Nakasato Line: KG07-14, foragers on dead tree.
10. *Monomorium chinense* Santschi
   Katadomari: workers on roadside, GC; workers from *MJ* EFN.
11. *Monomorium intrudens* F. Smith
   Nakasato Line: KG07-20, nest in suspended dead twig (polygyny).
12. *Pheidole fervens* F. Smith
   Katadomari: workers on roadside, GC.
13. *Pheidole noda* F. Smith
   Nakasato Line: KG07-05, nest in soil; KG07-17, nest in soil.
14. *Pristomyrmex punctatus* Mayr
   Katadomari: Workers on roadside, GC. Nakasato Line: workers on roadside, GC; workers from rotting wood. Chuo Line: workers from *MJ* EFN
15. *Tetramorium nipponense* Wheeler
   Nakasato Line: KG07-09 & -10, nests in rotting wood in evergreen forest (KG07-10: polygyny); KG07-11, nest in dry bamboo stem; KG07-19, nest in wet rotting wood; workers on roadside, GC.
16. *Vollenhovia benzai* Terayama et Kinomura
   Nakasato Line: workers from soil, GC.
17. *Vollenhovia emeryi* Wheeler
   Katadomari: workers from rotting wood, GC. Nakasato Line: KG07-06, nest in dead stem of *Pleioblastus linearis*.

Ponerinae

18. *Hypoponera sauteri* Onoyama
   Nakasato Line: KG07-07, nest in soil in *Pleioblastus linearis* forest; workers from soil, GC.
19. *Pachycondyla chinensis* (Emery)
   Nakasato Line: KG07-15, nest under bark of dead tree; workers from soil, GC; workers from rotting wood, GC.
20. *Ponera tamon* Terayama
   Katadomari: workers from shallow soil.

Pompilidae

1. *Leptodialepis sugiharai* (Uchida)
   3 females, 4 viii 2006, *Vitis flexuosa.*

Scoliidae

1. *Scolia fascinata Smith*
   1 male, 5 viii 2006, *Lespedeza bicolor.* New to Kuro-shima.
2. *Campsomeriella annulata* (Fabricius)
   5 males & 8 females, 4-6 viii 2006; 1 male, 15 x 2006. *Buddleia curviflora* f. *venenifera* (males), *Lythrum anceps* (males & females), *Crepidiastrum lanceolatum* (male), *Luffa cylindrica* (female), *Mallotus japonicus* (female).
3. *Megacampsomeris mojiensis* (Uchida)
   4 males & 1 female, 4-6 viii 2006; 3 males & 7 females, 15 x 2006. *Mallotus japonicus* (males), *Farfugium japonicum* (males & females), *Buddleja curviflora* f. *venenifera* (male & female), *Crepidiastrum lanceolatum* (female).

Eumenidae

1. *Stenodynerus chinensis simillimus* Yamane et Gusenleitner
   1 male, 4 viii 2006, *Sambucus chinensis*.
2. *Anterhynchium flavomarginatum procera* Yamane
   10 males & 4 females, 3-6 viii 2006. *Luffa cylindrica* (females), *Sambucus chinensis* (males & female), *Aster scaber* (female), *Callicarpa japonica* var. *luxurians* (male), *Zanthoxylum ailanthoides* (male).

Vespidae

1. *Polistes jokahamae* Radoszkowski
   4 queens, 4 v 2006, 5 workers, 4 viii 2006. *Angelica pubescens* (queens), *Rubus hirsutus* (queens), *Vitis flexuosa* (workers), *Sambucus chinensis* (males), *Buddleja curviflora* f. *venenifera* (male).
2. *Polistes rothneyi iwatai* van der Vecht
   1 queen, 4 v 2006. *Angelica pubescens*.
3. *Vespa ducalis* Smith
   1 female, 4 v 2006. *Angelica pubescens*. New to Kuro-shima.

Sphecidae

1. *Isodontia nigella* (Smith)
   15 males & 1 female, 4-5 viii 2006. *Vitis flexuosa* (males & female), *Sambucus chinensis* (males).
2. *Sceliphron madraspatanum kohli* Sickmann
   1 female, 4 viii 2006. *Vitis flexuosa*.

Crabronidae

1. *Liris subtessellatus* (Smith)
   1 male, 6 viii 2006. *Mallotus japonicus*.

Colletidae

1. *Colletes perforator* Smith
   2 males, 15 x 2006, *Farfugium japonicum*; 1 male, 15 x 2006, *Crepidiastrum lanceolatum*. New to Kuro-shima.
2. *Hylaeus hirashimai* Ikudome
   3 males and 2 females, 4 viii 2006, *Sambucus chinensis*; 1 male, 4 viii 2006, *Callicarpa japonica* var. *luxurians*; 1 male, 4 viii 2006, 11 males and 28 females, 15 x 2006, *Peucedanum japonicum*; 6 males and 2 females, 6 viii 2006, *Mallotus japonicus*; 6 males and 6 females, 15 x 2006, *Polygonum cuspidatum*; 1 male and 9 females, 15 x 2006, *Aralia elata*; 8 males, 15 x 2006, *Solidago altissima*; 10 males, 16 x 2006, *Polygonum chinense* var. *thunbergianum*; 1 male, 16 x 2006, *Lactuca indica* var. *laciniata*. New to Kuro-shima.
3. *Hylaeus insularum* Yasumatsu et Hirashima
   66 males and 5 females, 4 viii 2006, 34 males and 2 females, 5 viii 2006, *Sambucus chinensis*; 17 males and 4 females, 4 viii 2006, 2 females, 6 viii 2006, *Callicarpa japonica* var. *luxurians*; 1 male, 4 viii 2006, *Buddleja curviflora* f. *venenifera*; 9 males and 8 females, 6 viii 2006, *Mallotus japonicus*; 5 males and 48 females, 15 x 2006, *Polygonum cuspidatum*; 152 females, 15 x 2006, *Aralia elata*; 2 males, 15 x 2006, *Peucedanum japonicum*; 34 males and 30 females, 15 x 2006, *Solidago altissima*; 4 females, 15-16 x

2006, *Lactuca indica* var. *laciniata*; 4 females, 16 x 2006, *Polygonum chinense* var. *thunbergianum*.

Halictidae

1. *Lasioglossum* (*Evylaeus*) *japonicum* (Dalla Torre)
   1 female, 4 v 2006, *Ixeris stolonifera*; 1 female, 16 x 2006, *Lactuca indica* var. *laciniata*. New to Kuro-shima.
2. *Lasioglossum* (*Evylaeus*) *smilodon* Ebmer et Sakagami
   2 males, 3 viii 2006, *Aster scaber*; 1 male and 1 female, *Lythrum anceps*; 1 female, 4 viii 2006, *Callicarpa japonica* var. *luxurians*; 1 female, 4 viii 2006, *Sambucus chinensis*; 4 males and 18 females, 6 viii 2006, *Mallotus japonicus*; 2 females, 6 viii 2006, *Luffa cylindrica*; 1 female, 15 x 2006, *Aralia elata*; 1 female, 15 x 2006, *Lactuca indica* var. *laciniata*; 1 male, 16 x 2006, *Polygonum chinense* var. *thunbergianum*; 3 males, 16 x 2006, *Crepidiastrum lanceolatum*. New to Kuro-shima.
3. *Lasioglossum* (*Evylaeus*) *sphecodicolor* Sakagami et Tadauchi
   1 female, 16 x 2006, *Lactuca indica* var. *laciniata*.
4. *Lasioglossum* (*Lasioglossum*) *mutilum* (Vachal)
   1 female, 4 v 2006, *Rubus hirsutus*; 1 female, 4 viii 2006, *Callicarpa japonica* var. *luxurians*; 1 male, 4 viii 2006, *Buddleja curviflora* f. *venenifera*; 1 female, 5 viii 2006, *Zanthoxylum ailanthoides*; 17 males and 9 females, 15-16 x 2006, *Crepidiastrum lanceolatum*; 1 female, 15 x 2006, *Farfugium japonicum*; 5 males and 7 females, 16 x 2006, *Lactuca indica* var. *laciniata*; 5 females, 16 x 2006, *Youngia denticulata*; 2 males and 4 females, 16 x 2006, *Polygonum chinense* var. *thunbergianum*. New to Kuro-shima.
5. *Lasioglossum* (*Lasioglossum*) *occidens* (Smith)
   1 female, 4 viii 2006, *Peucedanum japonicum*; 1 male and 1 female, 6 viii 2006, *Callicarpa japonica* var. *luxurians*; 17 males and 1 female, 15 x 2006, *Farfugium japonicum*; 1 male and 2 females, 15 x 2006, *Crepidiastrum lanceolatum*; 15 males and 1 female, 16 x 2006, *Polygonum chinense* var. *thunbergianum*; 3 males and 4 females, 16 x 2006, *Lactuca indica* var. *laciniata*; 1 female, 16 x 2006, *Youngia denticulata*; 1 male 16 x 2006, *Polygonum cuspidatum*. New to Kuro-shima.
6. *Nomia punctulata* Dalla Torre
   3 males, 3 viii 2006, *Lythrum anceps*; 2 males and 11 females, 16 x 2006, *Lespedeza cyrtobotrya*; 2 males and 4 females, 16 x 2006, *Crepidiastrum lanceolatum*. New to Kuro-shima.
7. *Sphecodes japonicus* Cockerell
   1 male, 16 x 2006, *Polygonum chinense* var. *thunbergianum*. New to Kuro-shima.
8. *Sphecodes nipponicus* Yasumatsu et Hirashima
   1 male, 16 x 2006, *Polygonum chinense* var. *thunbergianum*. New to Kuro-shima.

Andrenidae

1. *Andrena* (*Andrena*) *aburana* Hirashima
   10 females, 4 v 2006, *Rubus hirsutus*. New to Kuro-shima.
2. *Andrena* (*Chlorandrena*) *knuthi* Alfken
   8 females, 4 v 2006, *Ixeris stolonifera*. New to Kuro-shima.
3. *Andrena* (*Simandrena*) *austroinsularis* Tadauchi et Hirashima
   2 females, 4 v 2006, *Rubus hirsutus*. New to Kuro-shima.

Megachilidae

1. *Megachile remota sakagamii* Hirashima et Maeta

4 males, 3-4 viii 2006, *Lythrum anceps*; 3 males, 5 viii 2006, *Lespedeza bicolor* f. *acutifolia*; 2 males and 1 female, 16 x 2006, *Crepidiastrum lanceolatum*; 1 female, 16 x 2006, *Lespedeza cyrtobotrya*. New to Kuro-shima.

2. *Megachile sculpturalis* (Smith)

1 female, 3 viii 2006, *Lythrum anceps*. New to Kuro-shima.

Apidae

1. *Amegilla florea florea* (Smith)

3 males and 4 females, 4-5 viii 2006, 2 females, 15 x 2006, *Buddleja curviflora* f. *venenifera*.

2. *Tetraloniella mitsukurii* (Cockerell)

1 male and 1 female, 15 x 2006, *Lactuca indica* var. *laciniata*; 1 female, 15 x 2006, *Farfugium japonicum*; 4 females, 15-16 x 2006, *Crepidiastrum lanceolatum*; 20 males and 18 females, 16 x 2006, *Lespedeza cyrtobotrya*. New to Kuro-shima.

3. *Ceratina satoi* Yasumatsu

1 female, 3 viii 2006, *Aster scaber*. New to Kuro-shima.

4. *Xylocopa appendiculata circumvolans* Smith

2 males and 4 females, 4 v 2006, *Rubus hirtus*; 4 females, 3-4 viii 2006, *Buddleja curviflora* f. *venenifera*; 1 male and 2 females, 4 viii 2006, *Luffa cylindrica*; 3 females, 15 x 2006, *Hibiscus mutabilis*.

Biological and biogeographical notes

Up to now only two species of ant have been recorded from Kuro-shima (Yamane *et al.*, 1999). The present results show that the species number on this island (22) is only slightly higher than on Iwo-jima (18) (Table 1; see also Ikudome and Yamane, 2007). This is somewhat curious since Kuro-shima has much more developed broad-leaved evergreen forests with wet floor. Most species were collected on the roadside and in sparse forests. In the thick forest *Tetramorium nipponense* and *Crematogaster osakensis* were dominant, but forest dwellers commonly found on Yaku-shima and mainland Kagoshima were absent. Important difference between these two islands is the presence of three ponerine species on Kuro-shima, which are not recorded from Iwo-jima. Five species were collected from extrafloral nectary of *Mallotus japonicus* which was mainly seen by the roadside.

Two species of wasp, *Scolia fascinata* and *Vespa ducalis*, are added to the fauna of Kuro-shima. The latter, a specialized predator on *Polistes*, was collected from the Mi-shima group for the first time. The numbers of wasp species found are the same (24) on Iwo-jima and Kuro-shima, though more vespid species exist on Kuro-shima (4 *vs.* 1). Coexistence of two large social species (*Polistes yokahamae* and *P. rothneyi*) has been known on Kuro-shima, and was again confirmed this time (for older records, see, Yamane, 1986). On Iwo-jima and Take-shima of the Mi-shima group, only the former species has been recorded. All this implies that Kuro-shima has more food resource supporting populations of several social species. No stylopized wasps have been collected on any of the three Mi-shima islands.

Seventeen among the 20 bee species collected in 2006 represent first records for this island. Two species previously recorded, *i.e.*, *Megachile pseudomonticola* and *Thyreus decorus*, were not found in the present material. The total species number is currently 22 for

this island. However, more species would be added as the faunal survey has not been conducted from spring to early summer. Unlike the case of ants and wasps, the number of bee species for Kuro-shima is more than three times that for Iwo-jima (Ikudome and Yamane, 2007). One of the reasons for this richness in bee fauna may be the relatively rich vegetation on Kuro-shima. In fact flowering plants are rich in both abundance and species number; abundant flowers were: *Polygonum cuspidatum* and *P. chinense* var. *thunbergianum* (Polygonaceae), *Peucedanum japonicum* (Umbelliferae), *Lespedeza cyrtobotrya* and *L. bicolor* f. *acutifolia* (Leguminosae), *Crepidiastrum lanceolatum* and *Lactuca indica* var. *laciniata* (Compositae), etc. Furthermore, flowering plants that generally fascinate bees were found, for example, *Aralia elata* (Araliaceae), *Mallotus japonicus* (Euphorbiaceae), *Lythrum anceps* (Lythraceae), etc.

Kuro-shima is situated to the north of Watase's Line which separates the Oriental from Palaearctic Region. Most of bees from Kuro-shima are basically Plaearctic element. However, part of them spread their range to the Central Ryukyus beyond Watase's line, for example, *Colletes perforator* which is known from Kikai-jima, Amami-oshima, Tokuno-shima and Okinawa-jima (Yamane, *et al.*, 1999). On the other hand, among the wide-ranging species are *Ceratina satoi* which occurs widely in Japan (including the Ryukyus), the Korean Peninsula and China, and *Megachile sculpturalis* which is known from Hokkaido to Taiwan. The latter is a leaf-cutter bee with a large body size (ca. 25 mm long), and in the Ryukyus the earlier records came from large islands such as Yaku-shima, Amami-oshima, Okinawa-jima and Ishigaki-jima. Thus this species was once supposed to inhabit the islands larger than 220 km^2 in area (Ikudome and Yamane, 1990). Recently it was recorded from Tanega-shima and Kuchinoerabu-jima (Ogata and Nagase, 1987; Yamane *et al.*, 1999). Both Kuchinoerabu-jima (38.04 km^2) and Kuro-shima (15.69 km^2) are much smaller than 220 km^2 in area. However, these two islands have relatively high elevations and are mostly covered with the evergreen forest. This should supply not only foods (pollen and nectar) but also material for nest construction, which seem to support their populations on these small islands.

Although no bee species endemic to Kuro-shima exists, two bee species are known only from the Ryukyus, namely *Lasioglossum sumilodon* and *Andrena austroinsularis*. The former seems to occur in the Central and Northern Ryukyus and hitherto known from Kikai-jima, Akuseki-jima and Suwanose-jima (Ebmer *et al.*, 1994), Yaku-shima (Ebmer *et al.*, 1994; Ikudome, 2005), and Iwo-jima (Ikudome and Yamane, 2007). On the other hand, the latter, often treated as a subspecies of *A. opacifovea* but raised to species rank by Tadauchi and Huan-Li (1995), was known from the Central Ryukyus (Amami-ôshima and Okinawa-jima; Yamane *et al.*, 1999).

Two eusocial bee species, *Apis cerana* and *A. mellifera*, whose colonies reproduce by budding, were not found.

In conclusion, ant and wasp faunas of Kuro-shima are only slightly richer than or almost same as those of Iwo-jima, but bee fauna on the former is much richer than on the latter. The richness in bee fauna on Kuro-shima may be explained at least partly by diversity and abundance of flowering plants. Deteriorated condition of forest floor due to heavy grazing by goats and cattle may explain the relative poorness of ant diversity in the Kuro-shima forest.

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