

## Arthropod Galls Found on Toshima and Shikinejima Islands, the Izu Islands, Japan

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**Abstract** We surveyed arthropod galls on Toshima and Shikinejima Islands, the Izu Islands, Tokyo, Japan in November 2012 and May 2013 and found 31 sorts of gall, consisting of 20 cecidomyiid, four aphid, three psyllid, two eriophyoid, one tephritid, and one thrips galls. Twenty-eight and 14 sorts of gall were newly recorded from Toshima and Shikinejima Islands, respectively. Among them, the following galls were new to the Izu Islands: leaf-vein gall induced by *Trioza machilicola* MIYATAKE (Hemiptera: Psylloidea) on *Machilus thunbergii* (Lauraceae), leaf gall induced by *Tuberocephalus sakurae* (MATSUMURA) (Hemiptera: Aphididae) on *Prunus speciosa* (Rosaceae), leaf gall induced by *Eriophyes* sp. (Acari: Eriophyidae) on *Elaeocarpus sylvestris* var. *ellipticus* (Elaeocarpaceae), leaf gall induced by *Phyllocoptes* sp. (Acari: Eriophyidae) on *Stachyurus praecox* var. *matsuzakii* (Stachyuraceae), flower bud gall induced by *Asphondylia* sp. (Diptera: Cecidomyiidae) on *Hedera rhombea* (Araliaceae), leaf gall induced by *Aphis clerodendri* (MATSUMURA) (Hemiptera: Aphididae) on *Clerodendrum trichotomum* (Lamiaceae), bud gall induced by *Rhopalomyia iwataensis* SHINJI (Diptera: Cecidomyiidae) on *Artemisia indica* var. *maximowiczii* (Asteraceae), and leaf gall induced by *Cryptosiphum artemisiae* BUCKTON (Hemiptera: Aphididae) on *A. indica* var. *maximowiczii*.

### Introduction

The Izu Islands consist of several volcanic islands located south of Honshu, Japan, extending for about 230 km from north to south. The Islands have a unique biota of insects (e.g. KUROSAWA, 1978; INOUE and AMANO, 1986; TAKAOKA and SAITO, 2005), terrestrial reptiles (e.g. HASEGAWA, 2003), and plants (e.g. INOUE, 1988; OIKI *et al.*, 2001; MIYAKE and INOUE, 2003).

In recent years, we have been paying special attention to clarify gall inducer fauna of the Izu Islands, because they are one of the most suitable organisms for biogeographic studies (TOKUDA *et al.*, 2012a, b, 2013). As has been summarized by TOKUDA *et al.* (2012a, b, 2013), several researchers recorded gall midges inhabiting the Izu Islands (ISHIZAWA, 1942; YUKAWA, 1971; SUNOSE, 1981, Hachijojima Interpretation Association, 2007). Among inhabited islands, however, investigations of gall inducers have never been conducted on Toshima and Shikinejima Islands. To accumulate the basic knowledge about the gall inducer fauna of the Izu Islands, we conducted field surveys on Toshima and Shikinejima Islands in November 2012 and May 2013.

Toshima Island is situated about 130 km south of Tokyo, of which land area and circumference are 4.1 km<sup>2</sup> and 7.7 km, respectively. The apex of the island is the peak of Mount Miyatsuka (508 m asl.) Although trees of *Camellia japonica* L. (Theaceae) are widely planted in most lowland areas, the natural vegetation of the island is basically classified into two types: *Castanopsis* – *Persea* (= *Machilus*) type and *Eurya* – *Styrax* type. The former is dominated by *Castanopsis sieboldii* (MAKINO) HATUS. ex

T. YAMAZ. et MASHIBA (Fagaceae) and *Machilus thunbergii* SIEB. et ZUCC. (Lauraceae) at lowland and the latter by *Eurya japonica* THUNB. (Theaceae) and *Styrax japonica* SIEB. et ZUCC. var. *kotoensis* (HAYATA) MASAM. et T. SUZUKI (Styracaceae) at highland (KOJIMA and FUJIWARA, 2008).

Shikinejima Island is situated about 160 km south of Tokyo (3.0 km southwest of Niijima Island). The land area, circumference, and apex of the island are 3.6 km<sup>2</sup>, 12 km, and 109 m asl., respectively. The natural forest vegetation of Shikinejima is mostly dominated by *C. sieboldii*, accompanied by *Carex oshimensis* NAKAI (Cyperaceae) in understory, and partly dominated by *Pittosporum tobira* (THUNB.) W. T. AITON (Pittosporaceae) and *Euonymus japonicus* THUNB. (Celastraceae) especially in coastal areas (OHYAMA, 2001). In addition, scrub stands dominated by *Juniperus taxifolia* HOOK. et ARN. var. *lutchuensis* (KOIDZ.) SATAKE (Cupressaceae) and *Raphiolepis indica* (L.) LINDL. ex KER var. *umbellata* (THUNB.) H. OHASHI (Rosaceae) grow in some parts of the Island (OHYAMA, 2001).

## Methods

Galls induced by insects and mites were surveyed on Toshima Island on 22 November 2012 by MT and KK and on 15–16 May 2013 by MT, and on Shikinejima Island on 15 May 2013 by MT. Detailed methods of field survey and collection are fundamentally the same as those in TOKUDA *et al.* (2012a). Each collecting record of gall consists of latitude, longitude, altitude and collecting date. Galls are listed according to the order in YUKAWA and MASUDA (1996). Gall numbers designated by YUKAWA and MASUDA (1996) are shown in brackets for each gall.

The family name of host plants follows the Angiosperm Phylogeny Group (APG) system of plant classification (STEVENS, 2008). Specimens collected in this study are kept in Laboratory of System Ecology, Faculty of Agriculture, Saga University, Japan.

## Results

### *Arthropod galls found on Toshima and Shikinejima Islands*

#### **FAGACEAE**

1. Inflorescence gall induced by an unidentified cecidomyiid (Diptera) on *Castanopsis sieboldii* [C-163] (**New record from Shikinejima Island**)

**Japanese name:** ‘Sudajii-hanaeda-fukure-fushi’

**[Shikinejima]** N34°20′06″ E139°12′44″, Alt. 24 m, 15 May 2013 (old galls); N34°19′58″ E139°12′37″, Alt. 39 m, 15 May 2013 (old galls); N34°19′29″ E139°12′25″, Alt. 24 m, 15 May 2013 (old galls).

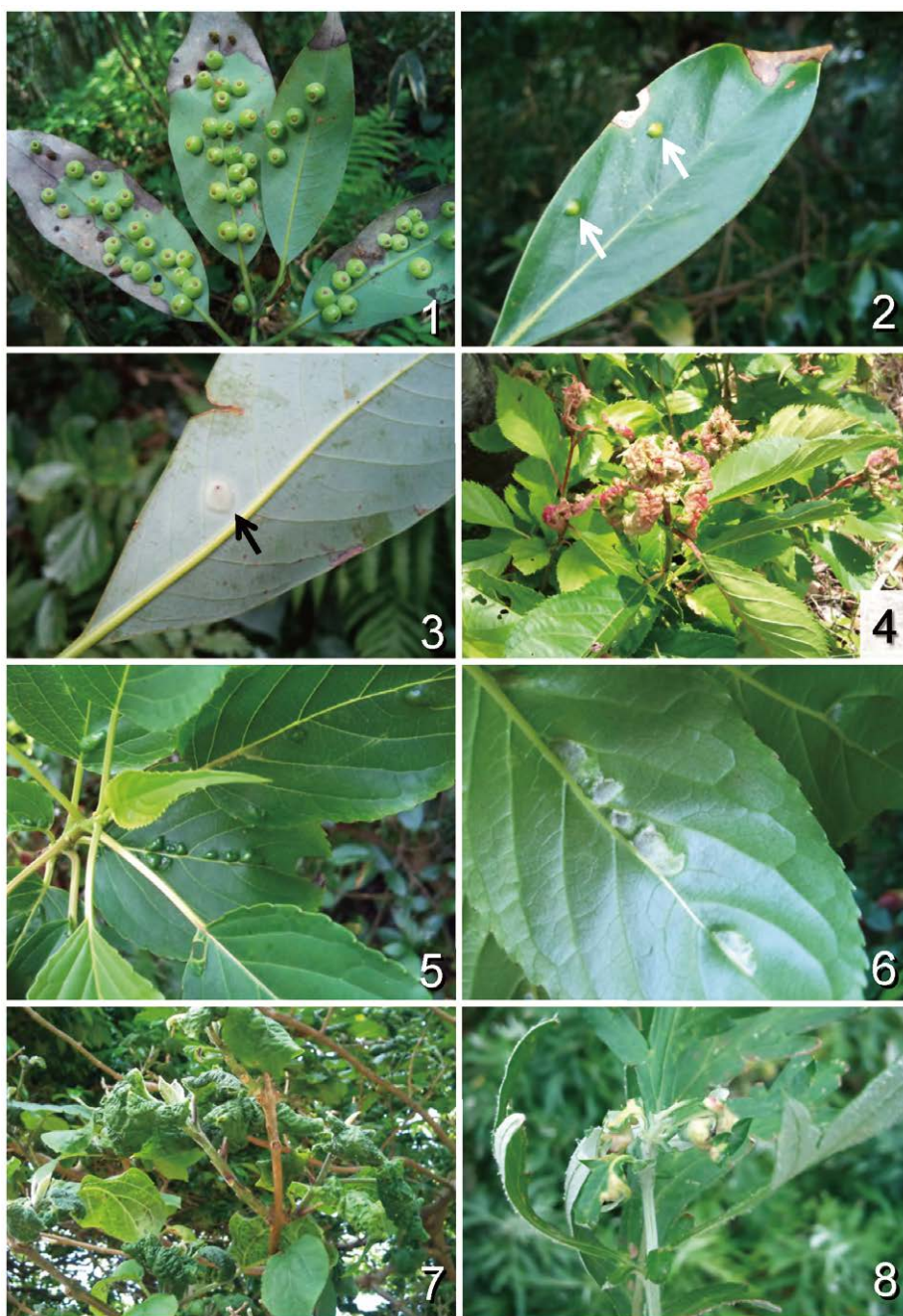
**Remarks:** On the Izu Islands, this gall was previously recorded from Kozushima, Miyakejima, Mikurajima, and Hachijojima Islands (TOKUDA *et al.*, 2012a, 2013).

#### **LAURACEAE**

2. Leaf gall induced by *Pseudasphondylia neolitseae* YUKAWA (Diptera: Cecidomyiidae) on *Neolitsea sericea* (BL.) KOIDZ. [C-254] (**New records from Toshima and Shikinejima Islands**)

**Japanese name:** ‘Shiroadamo-ha-kobu-fushi’

**[Toshima]** N34°31′05″ E139°16′35″, Alt. 365 m, 22 November 2012 & 16 May 2013.



Figs. 1–8. Arthropod galls found on Toshima and Shikinejima Islands. — 1, Barrel-shaped leaf galls induced by *Daphnephila machilicola* on *Machilus thunbergii*; 2, leaf-vein galls (arrows) induced by *Trioza machilicola* on *M. thunbergii*; 3, a leaf gall (arrow) induced by an unidentified cecidomyiid on *M. thunbergii*; 4, leaf galls induced by *Tuberocephalus sakurae* on *Prunus speciosa*; 5–6, leaf galls induced by *Phyllocoptes* sp. on *Stachyurus praecox* var. *matsuzakii* (5: upper side and 6: lower side); 7, leaf galls induced by *Aphis clerodendri* on *Clerodendrum trichotomum*; and 8, leaf galls induced by *Cryptosiphum artemisiae* on *Artemisia indica* var. *maximowiczii*.

[**Shikinejima**] N34°19'58" E139°12'37", Alt. 39 m, 15 May 2013 (first instar); N34°19'45" E139°12'39", Alt. 42 m, 15 May 2013.

**Remarks:** On the Izu Islands, this gall was previously recorded from Ohshima, Nijijima, Kozushima, Miyakejima, Mikurajima and Hachijojima Islands (SUNOSE, 1981; TOKUDA *et al.*, 2012a, b, 2013).

3. Barrel-shaped leaf gall induced by *Daphnephila machilicola* Yukawa (Diptera: Cecidomyiidae) on *Machilus thunbergii* [C-256] (Fig. 1) (**New record from Toshima Island**)

**Japanese name:** 'Tabunoki-haura-usu-fushi'

[**Toshima**] N34°31'35" E139°16'14", Alt. 131 m, 22 November 2012; N34°31'18" E139°16'10", Alt. 152 m, 22 November 2012; N34°31'05" E139°16'35", Alt. 365 m, 22 November 2012 & 16 May 2013 (an emerged female was found on a gall); N34°31'07" E139°16'18", Alt. 266 m, 16 May 2013; N34°31'10" E139°16'36", Alt. 435 m, 16 May 2013; N34°31'21" E139°17'02", Alt. 287 m, 16 May 2013; N34°31'17" E139°17'06", Alt. 248 m, 16 May 2013; N34°31'47" E139°16'52", Alt. 93 m, 15 May 2013; N34°31'33" E139°17'12", Alt. 118 m, 16 May 2013.

**Remarks:** On the Izu Islands, this gall was previously recorded from Ohshima, Nijijima, Kozushima, Miyakejima, Mikurajima, Hachijojima and Aogashima Islands (SUNOSE, 1981; TOKUDA *et al.*, 2012a, b, 2013).

4. Leaf-vein gall induced by *Trioza machilicola* MIYATAKE (Hemiptera: Psylloidea) on *M. thunbergii* [C-257] (Fig. 2) (**New record from the Izu Islands**)

**Japanese name:** 'Tabunoki-ha-kubomi-fushi'

[**Toshima**] N34°31'35" E139°16'14", Alt. 131 m, 22 November 2012.

**Remarks:** This gall was previously recorded from Honshu, Shikoku, and Kyushu (YUKAWA and MASUDA, 1996), but has never been found on the Izu Islands (TOKUDA *et al.*, 2012a, b, 2013).

5. Leaf gall induced by an unidentified cecidomyiid (Diptera) on *M. thunbergii* [C-262] (Fig. 3) (**New records from Toshima and Shikinejima Islands**)

**Japanese name:** 'Tabunoki-ha-fukure-fushi'

[**Toshima**] N34°31'05" E139°16'35", Alt. 365 m, 22 November 2012 (third instar); N34°31'47" E139°16'52", Alt. 93 m, 15 May 2013; N34°31'25" E139°16'27", Alt. 197 m, 16 May 2013.

[**Shikinejima**] N34°20'02" E139°12'45", Alt. 47 m, 15 May 2013.

**Remarks:** On the Izu Islands, the gall was previously recorded from Nijijima, Kozushima, Miyakejima, Mikurajima, Hachijojima and Aogashima Islands (TOKUDA *et al.*, 2012a, b, 2013).

6. Leaf-vein gall induced by *Trioza cinnamomi* (BOSELLI) (Hemiptera: Psylloidea) on *Cinnamomum tenuifolium* (MAKINO) SUGIM. ex. H. HARA [C-263] (**New records from Toshima and Shikinejima Islands**)

**Japanese name:** 'Yabunikkei-hamyaku-ibo-fushi'

[**Toshima**] N34°31'47" E139°16'38", Alt. 74 m, 22 November 2012; N34°31'17" E139°17'06", Alt. 248 m, 22 November 2012.

[**Shikinejima**] N34°20'06" E139°12'44", Alt. 24 m, 15 May 2013; N34°19'28" E139°12'16", Alt. 82 m, 15 May 2013.



**Remarks:** On the Izu Islands, this gall was recorded from Ohshima, Kozushima, Miyakejima, Mikurajima, Hachijojima, and Aogashima Islands (MIYATAKE, 1966; TOKUDA *et al.*, 2012a, b, 2013).

7. Leaf gall or necrosis induced by an unidentified cecidomyiid (Diptera) on *M. thunbergii* (**New records from Toshima and Shikinejima**)

[**Toshima**] N34°31'35" E139°16'14", Alt. 131 m, 16 May 2013; N34°31'16" E139°17'19", Alt. 174 m, 16 May 2013; N34°31'33" E139°17'12", Alt. 118 m, 16 May 2013.

[**Shikinejima**] N34°19'45" E139°12'39", Alt. 42 m, 15 May 2013.

**Remarks:** The leaf gall or necrosis was discovered on Miyakejima Island and has never been reported from other localities (TOKUDA *et al.*, 2012b). Injured parts of extending leaves blackened probably by the necrosis of host tissue surrounding cecidomyiid larvae. Further histological studies are needed to determine whether the leaf parts injured by the gall midge are galls or simple necrosis.

### LARDIZABALACEAE

8. Leaf gall induced by *Psylla coccinea* KUWAYAMA (Hemiptera: Psylloidea) on *Stauntonia hexaphylla* (THUNB.) DECNE. [C-268] (**New record from Toshima Island**)

**Japanese name:** 'Mube-ha-ore-fushi'

[**Toshima**] N34°31'05" E139°16'35", Alt. 365 m, 16 May 2013 (old galls).

**Remarks:** On the Izu Islands, the psyllid was reported from Hachijojima Island (MIYATAKE, 1966).

### PIPERACEAE

9. Leaf gall induced by *Liothrips kuwanai* (MOULTON) (Thysanoptera: Phlaeothripidae) on *Piper kadsura* (CHOISY) OHWI [C-269] (**New records from Toshima and Shikinejima Islands**)

**Japanese name:** 'Fuhtoukazura-ha-chijimi-fushi'

[**Toshima**] N34°31'47" E139°16'38", Alt. 74 m, 22 November 2012 & 16 May 2013; N34°31'18" E139°16'55", Alt. 379 m, 22 November 2012; N34°31'16" E139°17'19", Alt. 174 m, 22 November 2012; N34°31'18" E139°16'10", Alt. 152 m, 16 May 2013; N34°31'18" E139°16'53", Alt. 386 m, 16 May 2013; N34°31'17" E139°17'06", Alt. 248 m, 16 May 2013.

[**Shikinejima**] N34°20'02" E139°12'45", Alt. 47 m, 15 May 2013.

**Remarks:** On the Izu Islands, this gall was recorded from Ohshima, Kozushima, Miyakejima, Mikurajima, Hachijojima, and Aogashima (OKAJIMA, 2006; TOKUDA *et al.*, 2012a, b, 2013).

### THEACEAE

10. Leaf-vein gall induced by *Lasioptera camelliae* OHNO et YUKAWA (Diptera: Cecidomyiidae) on *Camellia japonica* L. [C-280] (**New records from Toshima and Shikinejima Islands**)

**Japanese name:** 'Yabutsubaki-hamyaku-fukure-fushi'

[**Toshima**] N34°31'25" E139°16'27", Alt. 197 m, 22 November 2012; N34°31'17" E139°17'06", Alt. 248 m, 22 November 2012.

[**Shikinejima**] N34°20'06" E139°12'44", Alt. 24 m, 15 May 2013.

**Remarks:** On the Izu Islands, this gall was recorded from Ohshima, Nijijima, Toshima, Miyakejima and Mikurajima Islands (SUNOSE, 1981; TOKUDA *et al.*, 2012a, b, 2013).

## HYDRANGEACEAE

11. Leaf gall induced by *Aphis spiraeicola* PATCH (Hemiptera: Aphididae) on *Deutzia crenata* SIEB. et ZUCC. [C-330; mentioned as *Aphis citricola* VAN DER GOOT] **(New record from Toshima Island)**

**Japanese name:** ‘Utsugi-ha-maki-fushi’

[Toshima] N34°31’17” E139°17’06”, Alt. 248 m, 16 May 2013.

**Remarks:** *Aphis spiraeicola* is a polyphagous species distributed widely in Japan and it induces leaf galls on some of their host plants (YUKAWA and MASUDA, 1996). On the Izu Islands, the aphid was reported from *Rumex japonicus* Houtt. (Polygonaceae) on Hachijojima Island (YOSHITOMI, 2013).

## ROSACEAE

12. Leaf gall induced by *Tuberocephalus sakurae* (MATSUMURA) (Hemiptera: Aphididae) on *Prunus speciosa* (KOIDZ.) NAKAI [C-314] (Fig. 4) **(New record from the Izu Islands)**

**Japanese name:** ‘Ohshimazakura-ha-chijimi-fushi’

[Toshima] N34°31’21” E139°17’02”, Alt. 287 m, 16 May 2013.

[Shikinejima] N34°20’02” E139°12’45”, Alt. 47 m, 15 May 2013.

**Remarks:** This gall was previously recorded from Hokkaido, Honshu, Shikoku, and Kyushu (YUKAWA and MASUDA, 1996), but has never been found on the Izu Islands (TOKUDA *et al.*, 2012a, b, 2013; YOSHITOMI, 2013). Although several species of *Tuberocephalus* are known to induce similar leaf curl galls on *Prunus* in Japan (MATSUMOTO, 2008), we identified the aphid species based on the severe curling of whole host leaf (Fig. 4).

## AQUIFOLIACEAE

13. Bud gall induced by *Asteralobia sasakii* (MONZEN) (Diptera: Cecidomyiidae) on *I. crenata* var. *hachijoensis* [C-373] **(New record from Toshima Island)**

**Japanese name:** ‘Hachijoinutsuge-me-tama-fushi’

[Toshima] N34°30’59” E139°16’35”, Alt. 296 m, 16 May 2013.

**Remarks:** On the Izu Islands, this gall was previously recorded from Ohshima, Kozushima, Miyakejima, Mikurajima and Hachijojima (SUNOSE, 1981; TOKUDA *et al.*, 2012a, b, 2013).

## ELAEocarpaceae

14. Leaf gall induced by *Eriophyes* sp. (Acari: Eriophyidae) on *Elaeocarpus sylvestris* (LOUR.) POIR. var. *ellipticus* (THUNB.) H. HARA [C-396] **(New distribution record from the Izu Islands)**

**Japanese name:** ‘Horutonoki-ha-tsubo-fushi’

[Toshima] N34°31’33” E139°17’12”, Alt. 118 m, 22 November 2012 & 16 May 2013.

**Remarks:** This gall was previously recorded from Honshu and the Southwest Islands of Japan (YUKAWA and MASUDA, 1996).

**STACHYURACEAE**

15. Leaf gall induced by *Phyllocoptes* sp. (Acari: Eriophyidae) on *Stachyurus praecox* SIEB. et ZUCC. var. *matsuzakii* (NAKAI) MAKINO ex H. HARA [C-407] (Figs. 5–6)

**(New record from the Izu Islands)**

**Japanese name:** ‘Hachijokibushi-ha-kobuke-fushi’

**[Toshima]** N34°31’17” E139°16’52”, Alt. 393 m, 16 May 2013.

**Remarks:** This gall was previously recorded from Honshu and Kyushu on *S. praecox* (YUKAWA and MASUDA, 1996).

**AUCUBACEAE**

16. Fruit gall induced by *Asphondylia aucubae* YUKAWA et OHSAKI (Diptera: Cecidomyiidae) on *Aucuba japonica* THUMB. var. *japonica* [C-413] **(New record from Toshima Island)**

**Japanese name:** ‘Aoki-mi-midori-fushi’

**[Toshima]** N34°30’59” E139°16’35”, Alt. 296 m, 16 May 2013; N34°31’10” E139°16’36”, Alt. 435 m, 16 May 2013.

**Remarks:** On the Izu Islands, this gall was previously recorded from Ohshima, Miyakejima, Mikurajima and Hachijojima Islands (SUNOSE, 1981; TOKUDA *et al.*, 2012a, b, 2013).

**ARALIACEAE**

17. Flower bud gall induced by *Asphondylia* sp. (Diptera: Cecidomyiidae) on *Hedera rhombea* (MIQ.) BEAN [C-417] **(New record from the Izu Islands)**

**Japanese name:** ‘Kizuta-tsubomi-fukure-fushi’

**[Toshima]** N34°31’47” E139°16’52”, Alt. 93 m, 15 May 2013; N34°31’35” E139°16’14”, Alt. 131 m, 16 May 2013; N34°31’16” E139°17’19”, Alt. 174 m, 16 May 2013; N34°31’47” E139°16’38”, Alt. 74 m, 16 May 2013.

**Remarks:** Two species of *Asphondylia*, flower-bud galler and fruit galler, are associated with *H. rhombea* (UECHI *et al.*, 2012). Although the fruit gall was recorded from Hachijojima Island (TOKUDA *et al.*, 2012b), the flower bud gall has not yet been recorded from the Izu Islands (TOKUDA *et al.*, 2012a, b, 2013).

**STYRACACEAE**

18. Leaf gall induced by an unidentified cecidomyiid (Diptera) on *Styrax japonica* SIEB. et ZUCC. var. *kotoensis* (HAYATA) MASAM. et T. SUZUKI **(new record from Toshima Island)**

**Japanese name:** ‘Ohbaegonoki-haura-midoritama-fushi’

**[Toshima]** N34°30’59” E139°16’35”, Alt. 296 m, 16 May 2013; N34°31’14” E139°16’44”, Alt. 463 m, 16 May 2013; N34°31’18” E139°16’44”, Alt. 470 m, 16 May 2013; N34°31’18” E139°16’53”, Alt. 386 m, 16 May 2013.

**Remarks:** This gall was discovered by TOKUDA *et al.* (2012b) from Miyakejima Island and was also reported from Niijima and Kozushima Islands (TOKUDA *et al.*, 2013).

**OLEACEAE**

19. Fruit gall induced by *Asphondylia sphaera* MONZEN (Diptera: Cecidomyiidae) on *Ligustrum ovalifolium* HASSK. var. *pacificum* (NAKAI) M. MIZUSH. [D-027] **(New record from Toshima Island)**

**Japanese name:** ‘Hachijoibota-mi-midori-fushi’

**[Toshima]** N34°31′47″ E139°16′52″, Alt. 93 m, 15 May 2013; N34°31′21″ E139°17′02″, Alt. 287 m, 16 May 2013.

**Remarks:** On the Izu Islands, this gall was recorded from Ohshima, Niijima, Miyakejima, Mikurajima, and Hachijojima Islands (TOKUDA *et al.*, 2012a, b, 2013).

#### APOCYNACEAE

20. Root gall induced by *Ametrodiplosis* sp. (Diptera: Cecidomyiidae) on *Trachelospermum asiaticum* (SIEB. et ZUCC.) NAKAI [D-032] (**New record from Toshima Island**)

**Japanese name:** ‘Teikakazura-ne-kobu-fushi’

**[Toshima]** N34°31′05″ E139°16′35″, Alt. 365 m, 22 November 2012.

**Remarks:** On the Izu Islands, this gall was recorded from Niijima and Hachijojima Islands (TOKUDA *et al.*, 2012b, 2013).

21. Fruit gall induced by *Asteralobia* sp. (Diptera: Cecidomyiidae) on *T. asiaticum* [D-033] (**New record from Toshima Island**)

**Japanese name:** ‘Teikakazura-misaki-fukure-fushi’

**[Toshima]** N34°31′35″ E139°16′14″, Alt. 131 m, 22 November 2012; N34°31′17″ E139°17′06″, Alt. 248 m, 22 November 2012.

**Remarks:** On the Izu Islands, this gall was recorded from Ohshima, Niijima, Miyakejima and Hachijojima Islands (TOKUDA *et al.* 2012b; TOKUDA *et al.* 2013).

#### LAMIACEAE

22. Leaf gall induced by *Aphis clerodendri* (MATSUMURA) (Hemiptera: Aphididae) on *Clerodendrum trichotomum* THUNB. (Fig. 7) (**New record from the Izu Islands**)

**Japanese name:** ‘Kusagi-ha-chijimi-fushi’

**[Toshima]** N34°31′19″ E139°16′42″, Alt. 81 m, 15 May 2013; N34°31′47″ E139°16′52″, Alt. 93 m, 15 May 2013.

**[Shikinejima]** N34°19′45″ E139°12′39″, Alt. 42 m, 15 May 2013.

**Remarks:** Although this aphid is distributed widely in Japan (e.g. INAIZUMI, 1974; MORITSU, 1983), it has not yet been recorded from the Izu Islands (YOSHITOMI, 2013).

#### CAPRIFOLIACEAE

23. Bud gall induced by *Asphondylia baca* MONZEN (Diptera: Cecidomyiidae) on *Weigela coraeensis* var. *fragrans* (OHWI) H. HARA [D-061] (**New record from Toshima Island**)

**Japanese name:** ‘Nioiutsugi-me-tama-fushi’

**[Toshima]** N34°31′35″ E139°16′14″, Alt. 131 m, 16 May 2013 (gall midge adults emerged from 22 to 25 May 2013); N34°31′07″ E139°16′18″, Alt. 266 m, 16 May 2013; N34°31′33″ E139°17′12″, Alt. 118 m, 16 May 2013.

**Remarks:** On the Izu Islands, this gall was recorded from Ohshima, Niijima, Mikurajima and Hachijojima Islands (TOKUDA *et al.*, 2012a, b, 2013).

**ASTERACEAE**

24. Leaf gall induced by *Rhopalomyia chrysanthemum* MONZEN (Diptera: Cecidomyiidae) on *Chrysanthemum pacificum* NAKAI [D-075] (**New records from Toshima and Shikinejima Islands**)

**Japanese name:** 'Isogiku-ha-ibo-fushi'

[**Toshima**] N34°31'50" E139°16'42", Alt. 57 m, 15 May 2013.

[**Shikinejima**] N34°19'28" E139°12'16", Alt. 82 m, 15 May 2013.

**Remarks:** On the Izu Islands, this gall was recorded from Ohshima, Nijijima, Kozushima, Miyakejima, Mikurajima and Hachijojima Islands (TOKUDA *et al.*, 2012a, b, 2013).

25. Petiole gall induced by *Paratephritis fukaii* SHIRAKI (Diptera: Tephritidae) on *Farfugium hiberniflorum* (MAKINO) KITAM. [D-085] (**New records from Toshima and Shikinejima Islands**)

**Japanese name:** 'Tsuwabuki-haguki-fukure-fushi'

[**Toshima**] N34°31'18" E139°16'10", Alt. 152 m, 22 November 2012; N34°31'21" E139°17'02", Alt. 287 m, 22 November 2012; N34°31'17" E139°17'06", Alt. 248 m, 22 November 2012.

[**Shikinejima**] N34°19'45" E139°12'39", Alt. 42 m, 15 May 2013 (old galls).

**Remarks:** On the Izu Islands, this gall was recorded from Ohshima, Kozushima, Miyakejima, Mikurajima, Hachijojima and Aogashima Islands (TOKUDA *et al.*, 2012a, b, 2013).

26. Bud gall induced by *Rhopalomyia* sp. (Diptera: Cecidomyiidae) on *C. pacificum* [D-087] (**New records from Toshima and Shikinejima Islands**)

**Japanese name:** 'Isogiku-me-nagatsubo-fushi'

[**Toshima**] N34°31'50" E139°16'42", Alt. 57 m, 15 May 2013.

[**Shikinejima**] N34°19'28" E139°12'16", Alt. 82 m, 15 May 2013.

**Remarks:** On the Izu Islands, this gall was recorded from Ohshima, Nijijima, Miyakejima and Mikurajima, Hachijojima Islands (TOKUDA *et al.*, 2012a, b, 2013).

27. Stem gall induced by *Rhopalomyia giraldii* KIEFFER et TROTTER (Diptera: Cecidomyiidae) on *Artemisia indica* WILLD. var. *maximowiczii* (NAKAI) [D-107] (**New record from Shikinejima Island**)

**Japanese name:** 'Yomogi-kuki-wata-fushi'

[**Shikinejima**] N34°19'45" E139°12'39", Alt. 42 m, 15 May 2013.

**Remarks:** On the Izu Islands, this gall was recorded from Nijijima Island (TOKUDA *et al.*, 2013).

28. Bud gall induced by *Rhopalomyia iwatensis* SHINJI (Diptera: Cecidomyiidae) on *A. indica* var. *maximowiczii* [D-108] (**New record from the Izu Islands**)

**Japanese name:** 'Yomogi-shintome-fushi'

[**Toshima**] N34°31'47" E139°16'47", Alt. 78 m, 15 May 2013; N34°31'07" E139°16'18", Alt. 266 m, 16 May 2013; N34°31'16" E139°17'19", Alt. 174 m, 16 May 2013 (pupa); N34°31'33" E139°17'12", Alt. 118 m, 16 May 2013.

**Remarks:** This gall was previously recorded from Honshu, Kyushu and Tanegashima Island (YUKAWA and MASUDA, 1996).



29. Leaf gall induced by *Rhopalomyia yomogicola* (MATSUMURA) (Diptera: Cecidomyiidae) on *A. indica* var. *maximowiczii* [D-112] (**New record from Shikinejima Island**)

**Japanese name:** ‘Yomogi-ha-eboshi-fushi’

[**Shikinejima**] N34°20′06″ E139°12′44″, Alt. 24 m, 15 May 2013; N34°19′58″ E139°12′37″, Alt. 39 m, 15 May 2013; N34°19′45″ E139°12′39″, Alt. 42 m, 15 May 2013.

**Remarks:** On the Izu Islands, this gall was recorded from Ohshima, Niijima and Kozushima Islands (SUNOSE, 1981; TOKUDA *et al.*, 2013).

30. Leaf gall induced by *Cryptosiphum artemisiae* BUCKTON (Hemiptera: Aphididae) on *A. indica* var. *maximowiczii* [D-111] (Fig. 8) (**New record from the Izu Islands**)

**Japanese name:** ‘Yomogi-haberi-maki-fushi’

[**Toshima**] N34°31′25″ E139°16′27″, Alt. 197 m, 22 November 2012; N34°31′18″ E139°16′10″, Alt. 152 m, 16 May 2013; N34°31′33″ E139°17′12″, Alt. 118 m, 16 May 2013.

**Remarks:** This gall was previously recorded from Honshu, Shikoku and Kyushu (YUKAWA and MASUDA, 1996).

31. Leaf gall induced by *Rhopalomyia cinerarius* Monzen (Diptera: Cecidomyiidae) on *A. indica* var. *maximowiczii* [D-113] (**New record from Toshima Island**)

**Japanese name:** ‘Yomogi-ha-shiroketama-fushi’

[**Toshima**] N34°31′18″ E139°16′10″, Alt. 152 m, 22 November 2012; N34°31′07″ E139°16′18″, Alt. 266 m, 22 November 2012; N34°31′17″ E139°17′06″, Alt. 248 m, 22 November 2012.

**Remarks:** On the Izu Islands, this gall was recorded from Ohshima, Niijima, Miyakejima and Hachijojima Island (TOKUDA *et al.*, 2012a, 2013).

#### *Absence records of galls and gall inducers*

On Toshima Island, we surveyed at least 25 large trees of *C. sieboldii* in November 2012, but did not find the inflorescence gall induced by an unidentified cecidomyiid. The leaf gall induced by *P. neolitseae* on *N. sericea* (Gall no. C-254 in YUKAWA and MASUDA, 1996) is common on neighboring islands such as Ohshima and Niijima (TOKUDA *et al.*, 2013), but it was rather rare on Toshima Island. The gall was found only on one shoot of an *N. sericea* tree (growing at 365 m asl.) among approximately 1,350 current shoots of 55 host trees that we examined on the island in November 2012. In addition, we observed six trees of *Actinodaphne acuminata* (BLUME) MEISN. (Lauraceae) on Toshima Island in November 2012, but stem galls by *Bruggmanniella* sp. (Diptera: Cecidomyiidae) (Gall no. C-258 in YUKAWA and MASUDA, 1996; see also TOKUDA and YUKAWA, 2006), which had been collected from Mikurajima Island in 2010 and 2011 (TOKUDA *et al.*, 2012b), was not found. Galls induced by *Celticosis japonica* YUKAWA et TSUDA and by an unidentified cecidomyiid (Gall nos. C-202 and 200, respectively, in YUKAWA and MASUDA, 1996) were not found on approximately 1,200 shoots (30 trees) of *Celtis sinensis* PERS. (Cannabaceae). Galls induced by *Masakimya pustulae* YUKAWA et SUNOSE (Gall nos. C-380 and C-381 in YUKAWA and MASUDA, 1996) was not found on approximately 100 shoots (three trees) of *E. japonicus* and on 100 shoots (five individuals) of *Euonymus fortunei*

(TURCZ.) HAND.-MAZZ. (Celastraceae) in November 2012, and 300 shoots (ten trees) and 150 shoots (five individuals) of *E. japonicus* and *E. fortunei*, respectively, in May 2013, all of which are different trees and individuals from those surveyed in November 2012. Three communities (ca. 1,200 leaflets) of *Pueraria lobata* (WILLD.) OHWI (Fabaceae) were surveyed but galls induced by *Pitydiplosis puerariae* YUKAWA, IKENAGA et SATO (Yukawa *et al.*, 2012) were not found; and 24 communities of *A. indica* var. *maximowiczii* (ca. 1,400 individuals) but galls induced by cecidomyiids other than *R. cinerarius* and *R. iwatensis* were not found.

On Shikinejima Island, approximately 500 shoots (12 trees) of *M. thunbergii*, 300 shoots (seven trees) of *E. japonicus*, three communities (ca. 1,000 leaflets) of *P. lobata*, six trees of *Ilex integra* THUNB. (Aquifoliaceae), and three trees of *I. crenata* were surveyed, but galls induced by *D. machilicola*, *M. pustulae*, *P. puerariae*, and *Ilex*-associated *Asteralobia* gall midges (see TOKUDA *et al.*, 2004) were not found.

## Discussion

In this study we found on Toshima and Shikinejima Islands in total 31 sorts of gall, consisting of 20 cecidomyiid galls, four aphid galls, three psyllid galls, two eriophyoid galls, one tephritid gall, and one thrips gall. All of 28 sorts (= 17 cecidomyiid, four aphid, three psyllid, two eriophyoid, one tephritid and one thrips galls) found on Toshima Island and 14 sorts (= nine cecidomyiid, two aphid, one psyllid, one tephritid and one thrips galls) on Shikinejima Island were newly recorded from these islands. Among them, leaf-vein gall induced by *T. machilicola* on *M. thunbergii*, leaf gall induced by *T. sakurae* on *P. speciosa*, leaf gall induced by *Eriophyes* sp. on *E. sylvestris* var. *ellipticus*, leaf gall induced by *Phyllocoptes* sp. on *S. praecox* var. *matsuzakii*, flower bud gall induced by *Asphondylia* sp. on *H. rhombea*, leaf gall induced by *A. clerodendri* on *C. trichotomum*, bud gall induced by *R. iwatensis* on *A. indica* var. *maximowiczii*, and leaf gall induced by *C. artemisiae* on *A. indica* var. *maximowiczii* were new to the Izu Islands.

Inflorescence gall induced by an unidentified cecidomyiid on *C. sieboldii* was clarified to exist from Shikinejima to Aogashima Islands but not from Ohshima to Nijijima Islands (TOKUDA *et al.*, 2012a, b, 2013). The cecidomyiid gall was previously reported from Okinawa (YAMAUCHI *et al.*, 1982) and southern Kyushu (NAGAI, 2010) but not yet found on northern Kyushu and Honshu (YUKAWA and MASUDA, 1996). The mechanism determining its northern limit of distribution range on the Izu Islands and in Kyushu is an interesting study subject.

Among Lauraceae-associated gall midges, *D. machilicola*, *P. neolitseae*, and an unidentified cecidomyiid inducing leaf gall on *M. thunbergii* were clarified to exist widely on the Izu Islands (summarized in Tokuda *et al.*, 2013; the present study). Although *D. machilicola* was not found on Shikinejima Island, further intensive surveys may confirm the existence there. The leaf gall or necrosis induced by an unidentified cecidomyiid on *M. thunbergii* was previously known to occur only on Miyakejima Island and newly reported in this study from Toshima and Shikinejima Islands. This species may be widely distributed on the Izu Islands.

As has been mentioned by SUNOSE (1981) and TOKUDA *et al.* (2012a, b, 2013), leaf gall induced by *M. pustulae* has never been collected from the Izu Islands. In this study we also did not find the gall on Toshima and Shikinejima Islands. The present results support the hypothesis proposed by SUNOSE (1981) that *M. pustulae* has not yet

colonized the Izu Islands. In addition, *Pseudasphondylia elaeocarpi* TOKUDA et YUKAWA distributed in Honshu had never been reported from the Izu Islands (YUKAWA and MASUDA, 1996; TOKUDA and YUKAWA, 2005; TOKUDA *et al.*, 2012a, b, 2013) and was not found on Toshima and Shikinejima Islands. This gall midge may also have not yet colonized the Izu Islands.

In this study, we found four *Rhopalomyia* gall midges associated with *A. indica* var. *maximowiczii*: *R. cinerarius* and *R. iwatensis* from Toshima Island and *R. giraldii* and *R. yomogicola* from Shikinejima Island, respectively. It should be noted here that *R. yomogicola*, one of the commonest species in Japan and previously reported from Ohshima, Nijijima, and Kouzushima Islands, was found on Shikinejima Island with very high densities (M. Tokuda, 2013, personal observation) but not found at all on Toshima Island in spite of intensive surveys (ca. 1,400 host individuals as mentioned earlier). In contrast, the leaf gall induced by *R. cinerarius* has been found most frequently on the Izu Islands (TOKUDA *et al.*, 2012a, b, 2013) and also recorded from Toshima Island, but it was not found on Shikinejima Island in this study.

A Lauraceae-associated psyllid *T. machilicola*, which had never been reported previously from the Izu Islands (TOKUDA *et al.*, 2012a, b, 2013), was recorded for the first time in this study from Toshima Island. Contrary to this, another Lauraceae-associated psyllid *T. cinnamomi* was collected from all inhabited islands except for Nijijima. Such differences in the distribution pattern between the two closely related psyllids are also an interesting study subject in future.

Because distributional information on other gall inducers such as aphids and eriophyoids is still limited (YUKAWA and MASUDA, 1996; YOSHITOMI, 2013), further intensive surveys are needed to clarify their faunas of the Izu Islands. In addition, field surveys in autumn season are required to reveal gall midge fauna of Shikinejima Island. Nevertheless, a series of our faunastic studies (TOKUDA *et al.*, 2012a, b, 2013; present study) have been providing distributional information for many gall-inducing insects on all inhabited islands of the Izu Islands. Because these islands are fundamentally volcanic and oceanic islands, gall inducers are considered to have colonized by wind-brown dispersal across the sea (TOKUDA, 2012). Future biogeographic and ecological studies will elucidate the historical aspects of colonization of the islands by gall-inducing arthropods and unique biological interactions on insular arthropod and plant populations.

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