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Can Gallers Expand the Host Range to Alien Plants within a Short Period of Time ? *

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Abstract. Among 607 alien plant species of Angiospermae that have naturalized in Japan since 1850s, only four species were found in the list of 568 host plant species of Japanese galling insects and mites. The rate of alien Angiospermae used by Japanese gallers to the total number was only 0.7%, which was apparently lower than 13.1% for the domestic gall-bearing species of Angiospermae. Although some of the alien plants are congeneric relatives to the domestic hosts and have been utilized by gallers in the original places, most of Japanese gallers could not expand their host range to alien plants within such a short period of time as 150 years. The galling habit is considered to be one of the main reasons to explain this evidence.

Key words: alien plant, host plant, gall, galler, host range, Angiospermae, Japan.

Introduction

There are different criteria in the definition of alien plants, particularly in terms of the time and means of naturalization (Washitani & Morimoto, 1993; Tachikake, 1998). For example, various plant species which were accompanied by the introduction of rice, wheat, bamboo, taro, etc. to Japan are designated as 'prehistoric naturalized plants' (Maekawa, 1973). In contrast, more recent arrivals (simply called as 'alien plants', hereafter) include those that have naturalized in Japan since 1850s when Japanese Government opened the country to foreign intercourse after a long-term isolation for about 250 years. After this event, many alien plants successively arrived and established themselves in Japan (Asai, 1993). According to Washitani & Morimoto (1993), several hundred species of alien plants (Angiospermae) are included in this criterion.

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Yukawa & Masuda (1996) listed 568 plant species of 91 families as known hosts of Japanese galling insects and mites ('gallers', hereafter) and confirmed that at least 1,400 sorts of insect and mite galls are produced on these plants. According to their list, most of the gallers are monophagous or oligophagous within congeneric host plants. Based on their narrow host range, we made an assumption that gallers, unlike other non-galling herbivores, cannot expand their host range readily to alien plants within a relatively short period of time. In contrast, for example, at least 45 species of non-galling domestic herbivores have become pests of mango which has been cultivated extensively in southern Japan since 1990s (Nagamine *et al.*, 1996; Yamaguchi, T., 1997, personal communication). Among the pests, 27 species of Hemiptera and 9 of Lepidoptera are included, but gallers have not yet been found in Japan, although several galling species of Cecidomyiidae (Diptera) are known to be economically important pests of mango in tropical Asia (Prasad, 1971).

In order to confirm our assumption, we intended to show actual data as to how many species of Japanese gallers have been successfully expanding their host plant range to alien species within a certain period of time. For this purpose, we treat the recent arrivals since 1850s as alien plants because the maximum duration after naturalization cannot be overestimated. This estimation would serve for further studies on the adaptation of domestic herbivores to alien plants, since such studies have seldom been attempted from the view points of ecology and evolutionary biology, whilst much more attention has been paid to the effects of alien species (weeds, herbivorous pests, natural enemies, etc.) on domestic ecosystems (Washitani & Morimoto, 1993).

Literature Surveys

This paper is relied almost entirely upon literature surveys. First, we checked the names of alien plants in the list compiled by Washitani & Morimoto (1993) and counted the number of alien species. Then, gall-bearing alien plants were searched for in the list of host plant species of gallers in Japan using the colored illustrated book edited by Yukawa & Masuda (1996). These surveys provided the rate of alien plants used by Japanese gallers to the total number of alien species in Japan. Similarly the rate for domestic plant species was also provided.

In order to know whether or not the alien plants are utilized by gallers in their original places, the following books were surveyed: Buhr (1964, 1965) for European galls; Felt (1965) and Gagné (1989) for North American galls. For this purpose, the families Fabaceae and Asteraceae were surveyed intensively because these families are utilized frequently by gallers in Europe and North America, as well as in Japan. In particular, the species of the genera *Medicago* (Fabaceae), *Aster*, and *Solidago* (Asteraceae) were selected as definite examples of alien plants from Europe and North America, because these genera are relatively dominant among alien plants. However, the alien plants from other areas than Europe and North America could not be surveyed due to the insufficient information of gallers.

The scientific names of plant species were relied upon Iwatsuki *et al.* (1987) and those of gallers upon Yukawa & Masuda (1996).

Results

Alien plants used by gallers

Based on the list compiled by Washitani & Morimoto (1993), we noted that 607 alien plant species of Angiospermae have naturalized in Japan since 1850s (Table 1). We found four of them in the list (Yukawa & Masuda, 1996) of 568 (564 domestic + 4 alien) host plant species of Japanese gallers (Table 1). The rate of alien Angiospermae used by Japanese gallers to the total number of alien species was only 0.7%, which was apparently lower than 13.1% for the domestic gall-bearing species of Angiospermae.

Unfortunately, the species numbers of alien plants belonging to Pteridophyta and Gymnospermae were not given in Washitani & Morimoto (1993). Therefore, some introduced pine species which are galled by the Japanese pine needle gall midge, *Thecodiplosis japonensis* Uchida et Inouye (Furuno & Sone, 1978; Furuno, 1987) were not mentioned in this paper. This omission would not influence on the rate of alien plants (Angiospermae + Gymnospermae) used by Japanese gallers.

Table 1. The number of domestic and alien plant species in Japan, and the rate of plant species used by gallers.

	No. of plant species			
	Pteridophaga	Gymnospermae	Angiospermae	Total
Domestic plant[1)]	751	45	4162	4958
Used by gallers[2)]	1	17	546	564
(%)	(0.1)	(37.8)	(13.1)	(11.4)
Alien plant[3)]	-	-	607	-
Used by gallers[2)]	-	-	4	-
(%)	-	-	(0.7)	-

1) Iwatsuki *et al.* (1987), 607 alien plant species are excluded.
2) Yukawa & Masuda (1996).
3) Washitani & Morimoto (1993), only Angiospermae ia available.

Gallers utilizing alien plants

According to Yukawa & Masuda (1996), five species of Japanese gallers utilize the four alien plant species (Table 2). Among them, *Simicronyx madaranus* Kôno (Coleoptera: Curculionidae) and *Epiblema sugii* Kawabe (Lepidoptera: Tortricidae) produce galls on alien plant species, *Cuscuta pentagona* (Convolvulaceae) and *Ambrosia artemisifolia* var. *elatiol* (Asteraceae), respectively, in addition to the domestic host plants. Since both gallers are endemic in Japan (Yukawa & Masuda, 1996), it is apparent that they expanded their host range to alien plants after 1850s. In particular, *S. madaranus* did so to the alien plant belonging to the genus different from the domestic host.

The host plants of the remaining three species have never been recorded in Japan (Yukawa & Masuda, 1996). There are two possible explanations for the lack of domestic host records: (1) host plant surveys are still insufficient; (2) gallers are also alien. The host plant, *Chenopodium album* var. *centrorubrum* (Chenopodiaceae), of two gallers, *Coleophora sosisperma* (Lepidoptera: Colephoridae) and *Hayahurstia atriplicis* (Hemiptera: Aphididae), is supposed to be introduced from China to Japan a long time ago as an

Table 2. Japanese gallers utilizing alien Angiospermae.

Galler	Original Host	Alien Host
Smicronyx madaranus (Col: Curcurionidae)	*Calystegia japonica* (Convolvulaceae)	*Cuscuta pentagona* (Convolvulaceae)
Epiblema sugii (Lep: Tortricidae)	*Xanthium strumarium* *Ambrosia trifida* (Asteraceae)	*Ambrosia artemisifolia* var. *elatiol* (Asteraceae)
Coleophora sosisperma (Lep: Colephoridae)	unrecorded	*Chenopodium album* var. *centrorubrum* (Chenopodiaceae)
Hayahurstia atriplicis (Hom: Aphididae)	unrecorded	*Ditto*
Myzus polygoniyonai (Hom:Aphididae)	unrecorded	*Persicaria viscosa* (Polygonaceae)

Table 3. The percentage of alien plant species of the families Fabaceae and Asteraceae used by gallers in the original places, Europe and N. America.

Plant family	Origin	No. of plant species		
		examined	unused	used (%)
Fabaceae	Europe	31	14	17 (54.8)
	N.America	7	6	1 (14.3)
Asteraceae	Europe	32	10	22 (68.8)
	N.America	41	13	28 (68.3)

edible plant (Hotta *et al.*, 1989). If so, they may be alien gallers, having been accompanied by the introduction of their host plant to Japan, although the former is not yet found outside Japan.

Myzus polygoniyonai (Hemiptera: Aphididae) is known only from Honshu, Japan and its domestic host plant has never been recorded (Yukawa & Masuda, 1996). In addition, there is no detailed information about the naturalization of its alien host plant, *Persicaria viscosa* (Polygonaceae) in Japan. Therefore, at the moment no satisfactory explanation has yet been discovered for the utilization of *P. viscosa* by *M. polygoniyonai*.

No matter how their host plant and distributional information is partly insufficient, it is clear from the aforementioned data that only a few species of Japanese gallers have expanded their host range to alien plants since 1850s.

Alien plants utilized by gallers in their original places

Tables 3 and 4 are intended to show whether or not alien plants are utilized by gallers

Table 4. Definite examples of alien plants used or unused by gallers in the original places.

Plant species[1)]	Galler		
	Coleoptera	Hymenoptera	Diptera[2)]
Medicago arabica	0	0	0
M. carstiensis	0	0	0
M. luplina	0	2	4
M. minima	0	0	4
M. orbicularis	0	0	0
M. polymorpha	0	0	0
M. sativa	2	0	4
Aster novae-angriae	0	0	2
A. novi-bergii	0	0	0
A. pilosus	0	0	0
A. sublatus var. *sublatus*	0	0	2
Solidago altissima	0	0	2
S. canadensis	0	0	10
S. gigantea var. *leiophylla*	0	0	0
S. sempervirens	0	0	1

1) *Medicago*: a representative of alien genera from Europe.
Solidago: a representative of alien genera from N.America.

2) Most of galls are produced by Cecidomyiidae except two species of Tephritidae on *Solidago altissima*.

in their original places. The percentages of alien plant species of the families Fabaceae and Asteraceae used by European and N. American gallers were surprisingly higher (Table 3) than that of alien Angiospermae used by Japanese gallers (Table 1). Furthermore, some alien plants are preferably utilized by gallers in Europe or N. America (Table 4), but have never been galled in Japan, in spite of the fact that their congeneric domestic relatives are utilized by Japanese gallers in the cases of *Aster* and *Solidago* of Asteraceae (Yukawa & Masuda, 1996). These data indicate that many alien plant species have been suitable hosts for gallers in Europe and N. America.

Discussion

The literature surveys clearly indicate that most of Japanese gallers cannot expand their host range readily to alien plants, in spite of the fact that some of the alien plants are congeneric relatives to the domestic hosts and have been utilized by gallers in the original places. These data for gallers are contrasted to those for other non-galling herbivores like mango pests in Kagoshima and Okinawa Prefectures (Nagamine *et al.*, 1996; Yamaguchi, T., 1997, personal communication). Since gall-formation is a delicate event during the course of cell division, tissue differentiation, shoot growth, etc., the ovipositing seasons of gallers must synchronize well with the host plant phenology, otherwise they cannot produce galls even on their host plant species (Yukawa, 1994). Unlike other non-galling

herbivores, the galling habit is considered to be one of the main reasons to explain why gallers cannot expand their host range to alien plants within such a short period of time as 150 years.

The present data indicate that host-shifting is less frequent in gallers than in other non-galling herbivores. Once it happens, however, the isolation mechanism would act more effectively on gallers to promote speciation, leading to the relatively narrow host plant range as has been noted for many gallers (Yukawa & Masuda, 1996).

The recolonization of the Krakatau Islands, Indonesia, by gallers has been studied by one of us, JY and one of his colleagues, since 1982 almost 100 years after total sterilization by the world-famous large eruption of Krakatau (Yukawa & Tukirin, 1997). In such a study, the present data would be useful for analyzing the recolonization process by gallers in the light of the vegetation succession, since the gallers would not shift to non-host plants and cannot establish themselves on the islands before the arrival of their own hosts.

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References

Asai, Y., 1993. *Green invaders - A Story of Alien Plants.* 294pp. Asahi-sensho, Asahi-shinbunsha, Tokyo. (In Japanese)

Burhr, H., 1964. *Bestimmungstabellen der Gallen (Zoo- und Phytocecidien) an Pflanzen Mittel- und Nordeuropas, Band I.* pp. 1-761. Gustav Fischer, Jena.

Burhr, H., 1965. *Bestimmungstabellen der Gallen (Zoo- und Phytocecidien) an Pflanzen Mittel- und Nordeuropas, Band II.* pp. 762-1572, pls. Gustav Fischer, Jena.

Felt, E. P., 1965. *Plant galls and gall makers.* 364pp. Hafner, New York.

Furuno, T. & K. Sone, 1978. Studies on the insect damage upon the pine-species imported in Japan (No.5). On Japanese pine needle gall midge, *Thecodiplosis japonensis* Uchida et Inouye. *Bull. Kyoto Univ. Forests* , (50): 12-23.

Furuno, T. 1987. Studies on the insect damage upon the exotic pine-species introduced in Japan (No.8). Further report on Japanese pine needle gall midge, *Thecodiplosis japonensis* Uchida et Inouye. *Bull. Kyoto Univ. Forests* , (59): 16-30.

Gagné, R. J., 1989. *The Plant-feeding Gall Midges of North America.* xi+356pp, pls. Cornell Univ. Press, Ithaca, New York.

Hotta, M., K. Ogata, A. Nitta, K. Hishikawa, M. Yanagi & K. Yamazaki, 1989. *Useful Plant of the World.* 1499pp. Heibonsha, Tokyo. (In Japanese)

Iwatsuki, K. *et al.*, 1987. *The List of Japanese Plants.* 740pp. Conservation Bureau. The Environment Agency of Japan, Tokyo. (In Japanese)

Maekawa, F., 1973. Prehistoric naturalized plants. *Plants and Culture* , (8): 41-49. (In Japanese)

Nagamine, M., F. Nakasone & M. Kinjô, 1996. *Mango Pests in Okinawa.* 24pp. Okinawa Pref. Plant Disease and Ins. Contr. St., Naha. (In Japanese)

Prasad, S. N., 1971. *The Mango Midge Pests.* 172pp. Cecidological Society of India, Allahabad, India.

Tachikake, M., 1998. *The Handbook of Naturalized Plants in Japan.* 306pp. Hiba Kagaku Kyôiku Shinkôkai, Hiroshima. (In Japanese)

Washitani, I. & N. Morimoto, 1993. *Alien Plants and Animals Naturalized in Japan.* 191pp. Hoikusha, Tokyo. (In Japanese)

Yukawa, J., 1994. Synchronization between gall midges and their host plant phenology. *Phenology Study*, (23): 1-7. (In Japanese)

Yukawa, J. & H. Masuda, 1996. *Insect and Mite Galls of Japan in Colors.* 826pp. Zenkoku Nôson Kyôiku Kyôkai, Tokyo. (In Japanese)

Yukawa, J. & T. Partomihardjo, 1997. Insect and mite galls collected from Peucang, Panaitan, and the Krakatau Islands, Indonesia. *Tropics* ,7: 141-152.