Oviposition preferences of the Japanese Gypsy moth, *Lymantria dispar japonica* (Motschulsky, 1860) (Insecta: Lepidoptera: Erebidae: Lymantriinae), on evergreen broad-leafed tree leaves in Hiroshima Prefecture, Japan[1]

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Abstract: Female gypsy moths, *Lymantria dispar dispar* (Linnaeus, 1758), commonly deposit their egg masses on tree trunks in Europe and North America. However, in northern Japan (Hokkaido and northern Honshu) females of *L. umbrosa* (Butler, 1881) and *L. dispar japonica* (Motschulsky, 1860) show a strong preference for white birch, *Betula platyphylla* Sukatschev var. *japonica* (Miq.) Hara (Betulaceae), trunks. In those areas of Japan where white birches are absent, it has been unclear where most oviposition occurs. In southern part of Hiroshima Prefecture, southwestern Japan, where evergreen broad-leafed trees exist, a preliminary egg mass survey failed to find egg masses on any tree trunks. Subsequently an intensive survey of 1115 individual trees (of 36 different species) in three broad-leafed forest plots found 126 egg masses of which 125 (99.2%) were on *Quercus glauca* (Thunb.) (Fagaceae), *Camellia japonica* L. (Theaceae), *Eurya japonica* Thunb. (Theaceae), or *Ilex purpurea* Hassk (Aquifoliaceae), and 111 egg masses were positioned on the undersurface of new-growth *Q. glauca* leaves. In southern part of Hiroshima Prefecture, gypsy moth egg mass surveys in the future should focus on the evergreen leaves of broad-leaved trees, especially *Q. glauca*.

Key Words: Evergreen broad-leafed tree, gypsy moth, leaf undersurface, *Lymantria dispar japonica*, oviposition site selection, *Quercus glauca*

The Gypsy moth, *Lymantria dispar dispar* (Linnaeus, 1758) (Lepidoptera: Erebidae: Lymantriinae), is one of the most serious forest pests in its native range (Europe and North Africa) and is a recognized major invasive species in North America (Tobin et al. 2009). Although female gypsy moths native to Europe and North Africa and those established in North America are flightless (Keena et al. 2008), female Asian gypsy moths (AGM), considered to include both *L. dispar japonica* (Motschulsky, 1860) and *L. dispar asiatica* Vnukovskij, 1926 (Pogue and Schaefer 2007), are flight capable and their larvae are more polyphagous than the European strain. *Lymantria dispar japonica* is present in Japan, from Honshu, Shikoku and Kyushu and it is locally established on parts of southwestern Hokkaido (Figure 1). *Lymantria dispar asiatica* is present

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through temperate Asia, east of the Ural Mountains into the Russian Far East, the northern two-thirds of China, and the Korean Peninsula. They are, therefore, considered to pose an even greater risk as invasive pests (USDA, APHIS, Plant Protection and Quarantine 2003, Canadian Food Inspection Agency 2010). The AGM became established in Canada (Vancouver, British Columbia) and the United States (Seattle-Tacoma, Washington and Portland, Oregon) in 1990-1991 and was the subject of large and successful eradication programs in each jurisdiction. As a consequence of these introductions as well as of the ongoing interceptions of AGM's egg masses on vessels and cargo from Japan, China, Korea, and the Russian Far East, the North American Plant Protection Organization approved a Regional Standard for Phytosanitary Measures in 2009 (NAPPO 2009). The RSPM requires vessels and cargo entering North America from abroad with flight-capable gypsy moth females to be free of corresponding egg masses. As long as vessels are free of egg masses, trade is not restricted. Because of this invasive risk, AGM has become a major concern for vessels traveling from Japan to North America.

To avoid confusion in relation to the species being referred to in this paper, I follow the nomenclatural names as in Pogue and Schaefer (2007). Hokkaido Gypsy Moth (HGM) refers to *L. umbrosa* (Butler) known from Hokkaido, Japan, northeast into the Kuril Islands, Russia, and might be on the Siberian mainland and Japanese Gypsy Moth (JGM) refers to the subspecies *L. dispar japonica*. HGM and JGM are mostly allopatric, except for southwestern Hokkaido where they co-occur. Hereafter, the Gypsy moth of Hiroshima Prefecture and throughout Honshu is recognized as JGM.

HGM females preferentially deposit their egg masses on trunks of white birch, *Betula platyphylla* Sukatschev var. *japonica* (Miq.) Hara (Betulaceae), trees in the forests of Hokkaido Prefecture (Schaefer 1978, Higashiura 1987). The oviposition preference for white birch is thought to be common in northern Japan where the HGM or JGM is sympatric with *B. platyphylla* (Schaefer 1978). *Betula platyphylla* is distributed from central Honshu to Hokkaido (Makino 1985). Except for alpine and sub-alpine regions, potential natural forest vegetation in Japan is roughly divided into two categories from north to south (Miyawaki 1977, Miyawaki and Okuda 1990). Some forests consist primarily of deciduous broad-leaf trees found in most areas of Hokkaido and eastern Honshu; and other forests consist primarily of evergreen broad-leafed trees, found from western Honshu, Shikoku, and Kyushu. Because of the distribution of evergreen broad-leafed trees and the absence of *B. platyphylla*, the oviposition behavior of JGM in southwestern Japan is not well understood.

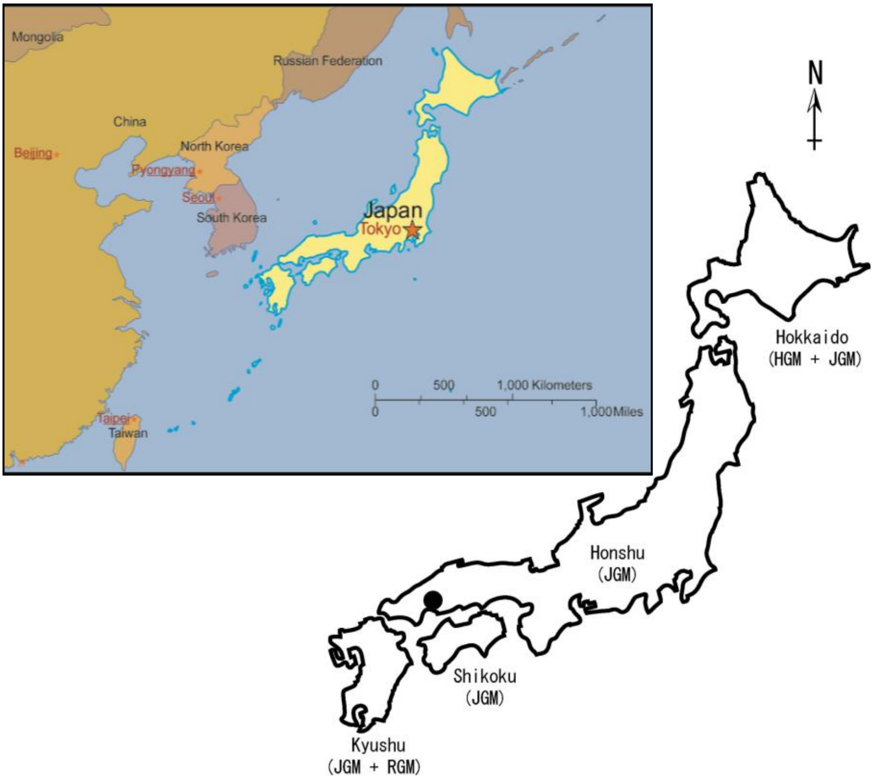


Figure 1. Map of Japan and neighboring countries (inside box, taken from http://www.your-vector-maps.com/countries/-japan/?imagelist=l-jap) and a larger map of Japan with the distribution of the species of *Lymantria* mentioned in this paper and the location of the study site, Hiroshima Prefecture (solid circle). HGM, JGM, and RGM in parentheses show Hokkaido gypsy moth, *L. umbrosa* (Butler, 1881), Japanese gypsy moth, *L. dispar japonica* (Motschulsky, 1860), and the Ryukyu gypsy moth, *L. postalba* Inoue, 1956, respectively. They are main species of *Lymantria* in each island of Japan, as described in Pogue and Schaefer (2007).

In Hiroshima Prefecture, southwestern Honshu, no egg masses were found in broad-leafed forests in Onomichi City in 2000 (Y. Higashiura, personal communication) and Takehara City in 2001 (S. Jikumaru, unpublished data) where later moth outbreaks were recorded (Jikumaru and Sano 2007, Jikumaru 2008). Egg mass surveys conducted by Higashiura (2000) and Jikumaru (2001) were focused on tree boles at ground level. By chance, in June 2009 I observed one female ovipositing on the undersurface of a leaf of an evergreen broad-leafed tree, *Quercus glauca* (Thunb.) (Fagaceae), in the Fruit Tree Research Division, Agricultural Technology Research Center, Hiroshima Prefectural Technology Research Institute (FTRD) (Figure 2). Because no visible signs of egg masses located on lower portions of tree boles were found and an egg mass deposition on the undersurface of a broad leaf was observed, two possibilities existed for oviposition in Hiroshima Prefecture. First, egg masses were laid higher on the tree boles, or second, oviposition occurred on other tree surfaces, such as the underside of the leaf observed in 2009.

My research objective was to determine where of the two potential oviposition sites, eggs masses were deposited. Egg mass counts are an important decision-making tool to determine management objectives that may include suppression or eradication programs (Liebhold et al. 1994) thus, methods to improve the egg mass sampling technique are required. This study was designed to improve survey methodology and to determine oviposition behavior of JGM in evergreen broad-leafed trees found in the southern portion of Hiroshima Prefecture.

Figure 2. *Lymantria dispar japonica* female with her egg mass on the underside of a *Quercus glauca* leaf, Hiroshima Prefecture, Japan (June 25, 2009).

Methods

Survey Sites. At different seasons, egg mass surveys were conducted at Takehara City (34.355N, 132.938E), Mihara City (34.398N, 133.148E), Onomichi City (34.414N, 133.157E), as well as the Grape and Persimmon Research Station, National Institute of Fruit Tree Science, National Agriculture and Food Research Organization (GPRS) (34.330N, 132.822E) and FTRD (34.332N, 132.820E), the last two of which were located in Higashi-Hiroshima City. Surveys occurred in forested sites at 100-200 m elevation, forest composition and survey dates are listed in Tables 1 and 2.

Table 1. Japanese gypsy moth egg mass survey of tree trunks (greater than 5 cm DBH) in broad-leafed forest at listed locations in Hiroshima Prefecture, Japan, conducted January 2009

Tree species[1]	Takehara			Mihara			Onomichi		
	No. of trees[2]	DBH[3]	No. of trees with egg masses[4]	No. of trees[2]	DBH[3]	No. of trees with egg masses[4]	No. of trees[2]	DBH[3]	No. of trees with egg masses[4]
Quercus variabilis Bl.	—	—	—	27	15.8 ± 4.2	0	29	23.7 ± 7.3	0
**Q. glauca* Thunb.	—	—	—	20	9.4 ± 2.5	0	4	5.3 ± 1.6	0
Q. serrata Thunb.	14	18.0 ± 7.7	0	1	6.1	0	3	21.4 ± 10.1	0
Clethra barbinervis Sieb. et Zucc.	27	10.6 ± 2.5	0	—	—	—	—	—	—
Lyonia ovalifolia (Wall.) Drude var. *elliptica* (Sieb. et Zucc.) Hond.-Mazz.	—	—	—	11	7.2 ± 1.4	0	1	10.2	0
**Ilex purpurea* Hassk	—	—	—	5	12.3 ±4.9	0	4	8.9 ± 5.3	1[5]
**I. pedunculosa* Miq.	2	19.9	0	—	—	—	1	5.7	1[5]
Prunus jamasakura Sieb. et Zucc.	—	—	—	6	9.7 ± 2.4	0	1	28.6	0
P. verecunda Koehne	1	18.5	0	—	—	—	—	—	—
Juniperus rigida Sieb. et Zucc.	—	—	—	5	7.0 ± 2.2	0	—	—	—
Cerasus leveilleana (Koidz.) H. Ohba	—	—	—	—	—	—	4	12.4 ± 5.5	0

Table 1. Japanese gypsy moth egg mass survey of tree trunks (greater than 5 cm DBH) in broad-leafed forest at listed locations in Hiroshima Prefecture, Japan, conducted January 2009 (continuation)

Tree species[1]	Takehara			Mihara			Onomichi		
	No. of trees[2]	DBH[3]	No. of trees with egg masses[4]	No. of trees[2]	DBH[3]	No. of trees with egg masses[4]	No. of trees[2]	DBH[3]	No. of trees with egg masses[4]
Pinus densiflora Sieb. et Zucc.	1	35.2	0	3	23.5 ±10.0	0	—	—	—
**Cinnamomum camphora* (L.) Presl	—	—	—	—	—	—	2	22.6	0
**Camellia japonica* L.	2	10.1	0	—	—	—	—	—	—
**Lithocarpus glaber* (Thunb.) Nakai	2	15.7	0	—	—	—	—	—	—
Magnolia salicifolia Maxim.	2	14.0	0	—	—	—	—	—	—
Rhusja vanica L. var. *roxburghii* (DC.) Rehder et Wils.	—	—	—	2	7.5	0	—	—	—
Toxicodendron succedaneum (L.) Kuntze	—	—	—	2	14.6	0	—	—	—
Albizia julibrissin Durazz.	—	—	—	—	—	—	1	14.3	0
Alnus sieboldiana Matsumura	1	17.7	0	—	—	—	—	—	—
**Myrica rubra* Sieb. et Zucc.	—	—	—	—	—	—	1	17.8	0

[1]Asterisks denote evergreen broad-leafed tree species. [2]Individuals in two plots (each plot: 15 x 15 m data pooled) are listed except for Onomichi where one plot (30 x 30 m) is listed. [3]Diameter of breast height in mean ± SD. [4]Outer bark surface up to a height of ca. 12 m for each tree was examined for egg masses using ladders. [5]An egg mass laid before 2008.

Survey Techniques. The initial survey, conducted 16 - 29 January 2009 before hatching of JGM eggs and before tree bud burst, focused on determining if egg masses were present on the upper portions of tree trunks. Sites used were Takehara, Mihara, and Onomichi. In the first two locations, two plots (15 x 15 m) were randomly selected. Tree species and diameter at breast height (DBH) was measured for all trees greater than 5 cm DBH. In Onomichi, a plot (30 x 30 m) was selected and tree species and DBH were measured as above. Trunk surfaces up to top for small trees or a height of ca. 12 m for large trees were examined for egg masses based on the method used by Schaefer (1978) but aided by a 6 m ladder in all sample areas.

A second more intensive survey was designed to examine the entire tree architecture and leaves between 31 July and 14 September 2009, following JGM oviposition and prior to leaf drop. GPRS, FTRD and a second site adjacent to the above mentioned Onomichi site were used for this survey because many JGM larvae were present in May 2009. As before, two quadrants (15 x 15 m) were randomly selected in each forest and tree species, DBH, and numbers of egg masses were recorded on all trees taller than 120 cm. For each tree, more than two persons examined the complete surface of the trunk, branches, and leaves. For each egg mass detected, location (trunk, branches or leaves), the height above ground level, age (egg masses deposited in 2008 or in 2009 differentiated by shape, color and/or hardness), tree species, and tree height was recorded.

Statistical Analyses. Contingency tables were used to test for independence between tree species and egg masses found among 36 tree species (Table 3) in the intensive survey. As mentioned above, egg masses deposited in 2008 were distinguished from them deposited in 2009. First, 36 x 2 contingency tables were analyzed before the contingency table was subdivided following Zar (2010). Finally, 3 x 2 and 2 x 2 contingency tables were analyzed for egg masses in 2008 and 2009, respectively. Contingency table analysis was also used to explore whether there was any relationship between *Q. glauca* trees with or without egg masses in 2008 and oviposition in 2009. Pearson's correlation coefficients between egg mass height and tree height for those *Q. glauca* utilized for oviposition were evaluated for 2008 and 2009 egg masses. Mean egg mass height was calculated for each tree with more than two egg masses.

Results

Survey of higher portion of tree trunks. In both Takehara and Mihara data for the two subplots was pooled prior to analysis. No egg masses were laid on the higher portions of tree trunks in 2008 among 185 trees of 21 different tree species (Table 1) yet a number of wandering larvae during the day and heavy defoliation of trees, typical features of JGM at high population densities, appeared at these sites in May 2009.

Table 2. Intensive survey designed to examine the entire tree architecture and leaves for Japanese gypsy moth egg mass in broad-leaved forest at listed locations in Hiroshima Prefecture, Japan, conducted 31 July to 14 September 2009

Tree species[1]	GPRS[2]			FTRD[3]			Onomichi		
	No. of trees[4]	DBH[5]	No. of trees with egg masses[6]	No. of trees[4]	DBH[5]	No. of trees with egg masses[6]	No. of trees[4]	DBH[5]	No. of trees with egg masses[6]
**Eurya japonica* Thunb.	111	2.8 ± 1.0	0	102	3.0 ± 1.5	1 (1[7])	145	2.7 ± 1.1	1 (1)
**Quercus glauca* Thunb.	32	4.6 ± 5.1	13 (31)	186	5.3 ± 5.3	23 (30)	35	4.2 ± 3.6	15 (50)
Q. variabilis Bl.	47	16.7 ± 6.8	0	9	28.8 ± 7.3	0	30	15.4 ± 10.0	0
Q. serrata Thunb.	20	10.1 ± 5.2	0	8	22.7 ± 9.1	0	7	8.1 ± 5.7	0
Rhododendron reticulatum D. Don ex G. Don	41	1.7 ± 0.5	0	—	—	—	69	1.7 ± 0.6	0
Lyonia ovalifolia (Wall.) Drude var. *elliptica* (Sieb. et Zucc.) Hond.-Mazz.	23	4.4 ± 1.4	0	—	—	—	25	4.4 ± 1.7	0
**Camellia japonica* L.	—	—	—	8	5.1 ± 3.9	1(1)	22	3.2 ± 1.5	8 (11[8])

Table 2. Intensive survey designed to examine the entire tree architecture and leaves for Japanese gypsy moth egg mass in broad-leaved forest at listed locations in Hiroshima Prefecture, Japan, conducted 31 July to 14 September 2009 (continuation)

Tree species[1]	GPRS[2]			FTRD[3]			Onomichi		
	No. of trees[4]	DBH[5]	No. of trees with egg masses[6]	No. of trees[4]	DBH[5]	No. of trees with egg masses[6]	No. of trees[4]	DBH[5]	No. of trees with egg masses[6]
Viburnum dilatatum Thunb. ex Murray	—	—	—	—	—	—	29	1.6 ± 0.5	0
**Elaeagnus pungens* Thunb.	11	3.8 ± 0.9	0	—	—	—	12	2.1 ± 1.1	0
**Symplocos lucida* Sieb. et Zucc.	8	6.5 ± 2.4	0	11	9.7 ± 3.7	0	—	—	—
**Ilex purpurea* Hassk	—	—	—	—	—	—	16	8.9 ± 5.8	1 (1)
Other tree species[9]	17 (10)		0	46 (10)		0	45 (14)		0

[1]Asterisks denote evergreen broad-leafed tree species. [2]Grape and Persimmon Research Station, National Institute of Fruit Tree Science, National Agriculture and Food Research Organization, Higashi-Hiroshima. [3]Fruit Tree Research Division, Agricultural Technology Research Center, Hiroshima Prefectural Technology Research Institute, Higashi-Hiroshima. [4]Data for each of two 15 x 15 m plots were pooled. [5]Diameter at breast height in mean ± SD. [6]Trees with egg masses. Numbers in parentheses show total numbers of egg masses counted for respective species on the undersurfaces of leaves. [7]The egg mass was recorded on a tree trunk. [8]One of the egg masses was recorded on an upper surface of a leaf. [9]Numbers in parentheses show total number of species in the corresponding category.

Oviposition frequency among 36 tree species. Altogether, 1115 trees were surveyed, representing 36 species in 26 genera (Table 3). *Quercus glauca*, *C. japonica*, *E. japonica* and *I. purpurea* were utilized for oviposition in 2008, while in 2009, *Q. glauca* and *C. japonica* were utilized exclusively (Table 3). Presence of egg masses was not independent of tree species, *Q. glauca* and *C. japonica* had more egg masses (χ^2 = 148.7, df = 2, P < 0.0001) in 2008, while in 2009 *Q. glauca* had more egg masses (χ^2 = 57.2, df = 1, P < 0.0001).

Overall, 126 egg masses were counted; 111 (88.1%) were on the undersurface of leaves of *Q. glauca*, a preferred oviposition host (Table 4). Fourteen were on leaves of three other evergreen tree species: *C. japonica*, *E. japonica* and *I. purpurea*, and one on the trunk of *E. japonica* (Tables 2 and 4). The number of egg masses varied between tree species and years (Table 4). In 2008, of 91 egg masses deposited, 84.6% and 12.1% were on *Q. glauca* and *C. japonica*, respectively. Mean number of egg masses per tree was slightly higher for *C. japonica* (0.37) than *Q. glauca* (0.30). In 2009, of 23 egg masses deposited, 95.7% and 4.3% of them were attached to *Q. glauca* and *C. japonica*, respectively. Mean number of egg masses per tree was 0.09 and 0.03 for *Q. glauca* and *C. japonica*, respectively, in 2009. In addition, 12 egg masses were found whose age could not be determined; all were attached to *Q. glauca* (Table 4).

JGM oviposition traits on Quercus glauca. The number of egg masses observed varied between *Q. glauca* trees and years. Total egg masses found on *Q. glauca* trees in 2008 and 2009 was 77 and 22 respectively. Frequency distribution (Figure 3) showed a maximum of 6 and 2 egg masses per tree in the two consecutive years. Eight individual *Q. glauca* trees were utilized for oviposition across both years. Those individual *Q. glauca* trees with 2008 egg masses tended to be re-utilized for oviposition in 2009 (Table 5; χ^2 = 11.9, df = 1, P < 0.01). Most egg masses placed on *Q, glauca* were found on current year new growth. Mean height of all egg masses on *Q. glauca*, regardless of year, was 2.33 m (SD = 1.12, N = 111). For 2008 and 2009, the proportions of egg masses attached to leaves at heights below 4 m were 96.1% and 90.1%, respectively (Figure 4). Egg mass height was correlated with *Q. glauca* tree height for both years (2008: r = 0.618, N = 40, P < 0.0001; 2009: r = 0.478, N = 18, P < 0.05).

Table 3. Number and basal area of tree species surveyed for Japanese gypsy moth egg mass in Hiroshima Prefecture, Japan

Species	Number of trees[1]	Basal area (m^2/ha)[1]	No. of trees with egg masses deposited in respective year[2]	
			2008	2009[3]
Eurya japonica	358 (32.1)	1.9 (4.8)	2	0
Quercus glauca	253 (22.7)	7.5(18.6)	40	18
Rhododendron reticulatum	110 (9.9)	0.2 (0.5)	0	0
Q. variabilis	86 (7.7)	19.3(47.6)	0	0
Lyonia ovalifolia	48 (4.3)	0.6 (1.5)	0	0
Q. serrata	35 (3.1)	4.7 (11.7)	0	0
Camellia japonica	30 (2.7)	0.3 (0.8)	9	1
Viburnum dilatatum	29 (2.6)	0.4 (1.0)	0	0
Elaeagnus pungens	23 (2.1)	0.1 (0.3)	0	0
Symplocos lucida	19 (1.7)	0.9 (2.2)	0	0
Ilex purpurea	16 (1.4)	1.0(2.5)	1	0
Others[4]	108 (9.7)	3.4 (8.4)	0	0

[1]Numbers in parentheses show relative percentages. [2] One *Q. glauca* was not included because oviposition year of egg mass on the tree was unknown. [3]Eight *Q. glauca* and a *C. japonica* utilized for both years are included. [4]Others include 25 species with less than 11 trees.

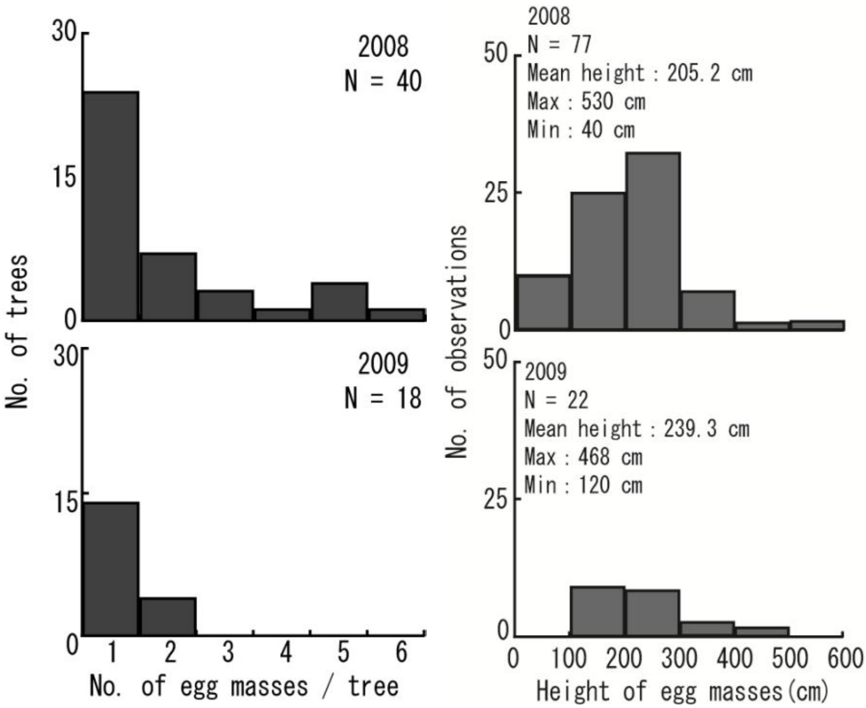
Table 4. Number of Japanese gypsy moth egg masses deposited on four tree species in 2008 and 2009

Species	Number of egg masses deposited in 2008 or 2009			
	2008[1]	**2009[1]**	**Unknown[2]**	**Total[1]**
Eurya japonica	2 (0.01 ± 0.07)	0	0	2 (0.01 ± 0.07)
Quercus glauca	77 (0.30 ± 0.91)	22 (0.09 ± 0.91)	12	111 (0.44 ± 1.27)
Camellia japonica	11 (0.37 ± 0.61)	1 (0.03 ± 0.91)	0	12 (0.40 ± 0.67)
Ilex purpurea	1 (0.06 ± 0.25)	0	0	1 (0.06 ± 0.25)
Total	91	23	12	126

[1]Numbers in parentheses represent mean number of egg mass (±SD) per respective tree species. [2]Egg masses were too high to reach (mostly above 4.0 m), thus the oviposition year was unclear.

Table 5. Effect of previous year oviposition on Japanese gypsy moth egg mass distribution in *Quercus glauca*, Hiroshima Prefecture, Japan

Number of trees in 2008	Number of trees in 2009	
	with egg mass	**without egg mass**
with egg mass	8	32
without egg mass	10	203



Figures 3-4. 3 (left). Frequency distribution of *Lymantria dispar japonica* egg masses on a *Quercus glauca* tree in 2008 and 2009, Hiroshima Prefecture, Japan. 4 (right). Height of *Lymantria dispar japonica* egg mass on *Quercus glauca* trees in 2008 and 2009, Hiroshima Prefecture, Japan.

Discussion

Region-specific oviposition preference in forests with evergreen broad-leafed trees. Egg mass surveys included all forest tree species within plots sampled (Tables 1 and 2), almost all egg masses were found on the undersurface of leaves of evergreen broad-leafed tree species (*Q. glauca, C. japonica, E. japonica* and *I. purpurea*) (Table 2). *Q. glauca, C. japonica* and *E. japonica* are tree species characteristic of evergreen broad-leafed forests in western Japan (Miyawaki 1977). Clearly in this study area, the typical survey of tree trunks would have proven highly ineffective (Table 1). In October of 2009, many more egg masses were recorded on the undersurface of leaves of *Q. glauca* in the study sites of Takehara and Mihara Cities where the initial surveys focused on the higher portions of tree trunks with a 6 m ladder were carried out (Jikumaru, unpublished).

In areas where trees are utilized predominately for oviposition, Schaefer (1978) and Higashiura (1987) showed HGM oviposited almost exclusively on the white surfaces of trunks of white birch, *B. platyphylla*, in Hokkaido

Prefecture. Higashiura (1989) found HGM and JGM egg masses on higher parts of deciduous trees (trunks and branches), in regions without snow, but on lower sections of tree trunks (mostly beneath the snow in winter), in snowy regions in central and northern Japan. Females of the nominate subspecies in North America, Europa and North Africa also oviposit on tree trunks, generally not far from where they eclosed in forests (e.g. Liebhold et al. 1994, Villemant and Andreï-Ruiz 1999, Camerini 2009, Pogue and Schaefer 2007). In the Russian Far East, AGM (might be *L. dispar asiatica*) egg masses are laid on the undersides of leaves of deciduous trees (Yurchenko and Turova 1984, Baranchikov et al. 1998). Ovipositional behavior similar to this study is that of Ryukyu Gypsy Moth, now referred to as *L. postalba* Inoue, which reportedly oviposit on the undersurfaces of palm fronds, *Livistona chinensis* R. Br. var. *subglobosa* Becc. in Miyazaki Prefecture, Kyushu (Nakazima and Furukawa 1933). The oviposition site preference reported in this study appears to be unique for JGM and may occur more widely in those areas of Japan where evergreen hardwood trees occur.

Oviposition traits of JGM on Q. glauca. Numbers of egg masses recorded are not independent of tree species. Of the four evergreen tree species on which egg masses were recorded, *Q. glauca* or *C. japonica* were better hosts for oviposition over the two year survey period. *Q. glauca* was the second most dominant tree species in the study sites in terms of both number of trees (22.8%) and basal area (18.6%), and bore 84.6% and 95.6% of all egg masses recorded in 2008 and 2009, respectively (Table 5). Mean longevity of *Q. glauca* leaves was estimated at more than three years (Kikuzawa 2005), thus egg masses deposited in 2008 were countable on the leaves in 2009. In contrast, *C. japonica* was not as common as *Q. glauca* yet in 2008 relatively many egg masses found in Onomichi were laid on *C. japonica* (Table 2). Further discussion in this section is limited to egg masses placeed on *Q. glauca*.

With the mean height of all egg masses on *Q. glauca* being 2.33 m (Figure 4), it is not surprising that egg mass height was positively correlated with *Q. glauca* tree height in both years. The fact that a tree oviposited upon in 2008 was more likely to be oviposited on again in 2009 suggests that certain *Q. glauca* trees are more suitable for JGM oviposition or were positioned favorably in the forest setting. These findings suggest that egg mass detection efforts should focus first on *Q. glauca* in those forests where it is present.

Quercus glauca is distributed widely throughout central and southern Japan, China and Jeju Island in Korea (Ito 2009). Egg masses located on the undersurface of leaves of *Q. glauca* were recognized previously in Kyoto Prefecture (Y. Higashiura, personal observation, 24 January 1983). So, it would be useful to determine the range over which this unique oviposition habit occurs in Japan and in other places such as China and Jeju Island where AGM and *Q. glauca* are sympatric. Additionally, any adaptive significance of the region-specific oviposition site selection is worthy of further clarification.

Noting the difficulty in detecting egg masses in Japanese forest areas, Liebhold et al. (2008) also reported that egg mass detection might have been affected by habitat characteristics. Knowledge of region-specific oviposition preferences by JGM would be useful in designing future egg mass survey protocols, making informed management decisions associated with control strategies to mitigate the effects of non-native introductions between Japan and North America.

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