The spread of the introduced Melodious Laughing Thrush *Garrulax canorus* in Japan

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Abstract The Melodious Laughing Thrush *Garrulax canorus* is an introduced species in Japan, and it has been recorded in the wild since the 1980s. The distribution of this species was estimated based on questionnaires. Four populations of this species have been confirmed in the western Kanto, northern Kyushu, southern Tohoku and Nagano Prefecture. There is a possibility that the expansion of this species is limited by elevational conditions and snowfall. Nevertheless, the distribution is still expanding. Therefore, it is necessary, as soon as possible, to assess the effect of the Melodious Laughing Thrush on the native birds.

Key words Conservation, Expansion of distribution, *Garrulax canorus*, Introduced birds, Melodious Laughing Thrush

The Melodious Laughing Thrush *Garrulax canorus* is an introduced species in Japan, and it has been observed in the wild since the 1980s (Sato 2000). The reason why this species naturalized in Japan is not clear. It is naturally distributed in southern China, Taiwan, Laos and Vietnam (Long 1981; Zheng 1982). It is a popular cage bird in China and Southeast Asia and a large number of individuals have been exported from Hong Kong (Nash 1999). This species has been imported into Japan since the seventeenth century (Isono & Uchida 1992). This species was introduced to the Hawaiian Islands in the early 1900s and to California in 1941 accidentally and purposely (Long 1981). While it failed to establish a population in California, it succeeded in naturalizing in the Hawaiian Islands, where it became the most common species below 1200 meters in elevation (Long 1981; Mountainspring & Scott 1985). The cause of disappearance in California is not known.

The Melodious Laughing Thrush prefers dense understory as breeding and foraging habitat and is sedentary in China and the Hawaiian Islands (Long 1981; Mountainspring & Scott 1985; Cheng et al. 1987). It is omnivorous and forages mainly on the ground for arthropods, earthworms, fruits and other

food (Long 1981; Cheng et al. 1987; Yamaguchi 2000; Kawakami 2002). This species was shown to have out competed native species on the Hawaiian Islands (Mountainspring & Scott 1985). Thus, there is concern that this species might give an impact the native species such as thrushes and bush-warblers that utilize the same prey and microhabitats (Kawakami 2002).

Thus far, the Melodious Laughing Thrush has been observed in northern Kyushu, in the Kanto, and in Fukushima Prefecture in Japan (Sato 2000; Yamaguchi 2000; Kawakami 2002). While it appears to be expanding its range in Japan (Sato 2000; Kawakami 2002), there is no study on its nationwide distribution to provide essential information for a management strategy. The aim of the present study is to show the past and present distribution of the species and to discuss factors limiting its population. With questionnaire, the distributions were clarified. With the data of recent distributions, we discussed on two limiting factors of range expansion: elevation and deepest snow depth of normal years. As the Melodious Laughing Thrush has been observed in lowland montane areas (Sato 2000; Yamaguchi 2000), there is a possibility that elevation limits its distribution. Since it frequently forages on the ground and is resident, deep snow might prevent it from foraging. We therefore compared its distribution with maps showing the

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deepest snow depth of normal years.

METHODS

1) Questionnaires

Questionnaires were used to collect information on its distribution. As the Melodious Laughing Thrush spends much of its time in bushes, it is not easy to observe. However, its song is loud and conspicuous (Kawakami & Yamaguchi unpublished). Therefore, it is easy to detect its presence. Questionnaires were distributed through some mailing lists (Jeconet ML, Wildlife ML, Jbnest ML), newspapers (Sankei Shimbun 18 January 2000, Tokyo Simbun 27 January 2000, Asahi Shimbun 2 February 2000) and magazines ("Yacho" of Wild Bird Society of Japan, "Watashitachi no Shizen" of Japanese Society for Preservation of Birds, "Yacho Fukuoka" of WBSJ Fukuoka branch, "Kusunoki" of The Nature Interpreter Society of Fukuoka).

The questions were simple: 1) Have you seen or heard the Melodious Laughing Thrush? 2) If yes, when and where did you see or hear it? The morphological character was described with the questions as follows. "The body size is similar to the Dusky Thrush *Turdus naumanni*. Body color is bright brown, and there are white teardrop patterns around the eyes. The color of bills and legs is yellow". Questionnaires in newspapers and magazines also included photographs of the bird.

The Grey Starling *Sturnus cineraceus* is a very common bird species in Japanese lowlands, and it has similar morphological characters to the Melodious Laughing Thrush (i.e. similar body size, brown bodies, white pattern on their cheeks and yellow bills and legs). The two species can be easily confused with one another and some responses were misidentification. However, their ecological habits are very different. Especially, the Grey Starling prefers open habitats, while the Melodious Laughing Thrush prefers forests or bushes. Therefore, we excluded questionable answers from the analysis that involved ecological habits of Grey Starlings, such as "perching on wires side by side", "nesting under a roof" and "foraging at open habitats in residential areas". Responses were collected from January 2000 to August 2001.

2) Literature citation

Though the questionnaire method is useful to cover a wide area, its credibility is not high (Fujimaki &

Konishi 1996). In order to compensate for questionable information, we referred to the past reports of observations, specifically the Kanagawa chapter of WBSJ (1998), Kunihiro (1999), Sonoda (1999), Sato (2000), Yamaguchi (2000) and the records of inquiries on Melodious Laughing Thrushes at the Yamashina Institute for Ornithology.

3) Field detection

Based on the information of the questionnaire method, we investigated the existence of Melodious Laughing Thrushes at the edges of their distributions in western Kanto and southern Tohoku and Nagano Prefecture. The playback method was used to identify the species. This species readily responded to songs played on a tape recorder both in the breeding and non-breeding seasons (Kawakami & Yamaguchi unpublished). We played the songs in forests that had grown bushes near the edge of the distributions and recorded the existence of the species. This survey was conducted from January 2000 to August 2001.

4) The distribution and expansion of each population

We made distribution maps with grid maps consisting by square grids for each year based on the above information. Each grid was about 25 km² that was consisted of 5×5 grids based on standard grid data (Ministry of Environment 1997a–l). We calculated areas of 100% minimum convex polygon connecting the midpoint of each grid for each population for each year. Based on these values, we got the regression formula between the year and the square root of the area.

5) Snow depth and elevational conditions

In order to assess the influence of snowfall, the distribution map of the species was superimposed on the map showing the deepest snow depth of normal years (Japan Meteorological Agency 1993). And, in order to clarify the elevational conditions of the habitats, the elevation of each plot in which the species was recorded was classified into 6 categories, 0–200 m, 200–400 m, 400–600 m, 600–800 m, 800–1000 m and more than 1000 m. As there were plots that can not be recognized their reliable elevation, we excluded such data from analysis. The frequency of elevation data belonging to each category was shown for each population.

RESULTS

1) The distribution and expansion of each population

Four populations were identified at northern Kyushu, western Kanto, southern Tohoku and Nagano Prefecture (Fig. 1). We obtained 173, 557, 37 and 39 records by questionnaire for the four populations, respectively, and 184, 32 and 5 records by field detection for latter three populations, respectively. Figs. 2–5 show the distribution and expansion of each population. The Kyushu population originated in Fukuoka Prefecture in 1985 and expanded to southward. Melodious Laughing Thrushes were found in Fukuoka, Oita, Saga and Kumamoto prefectures in 2000. No map could be drawn for 2001 because no additional information was obtained for that year.

The first record of the Kanto population was reported at Fujino Town, Kanagawa Prefecture in 1987. The distribution extended in all directions along mon-

tane habitats. The eastward expansion stopped at the urban area. The species occurred in Kanagawa, Tokyo, Yamanashi, Saitama, Gunma and Shizuoka prefectures in 2001. The Tohoku population origi-

Fig. 1. The distribution of introduced Melodious Laughing Thrushes in Japan. a) The Kyushu population, b) The Kanto population, c) The Tohoku population, d) The Nagano population.

Fig. 2. The distribution of introduced Melodious Laughing Thrushes by year in Northern Kyushu. The gray area shows the range where the deepest snow depth of normal years is more than 20 cm.

Fig. 3. The distribution of introduced Melodious Laughing Thrushes by year in Western Kanto. The symbol is the same as Fig. 2.

nated in Fukushima City, northern Fukushima Prefecture in 1997, and expanded toward the east and south. By 2001, this population had spread to southern Miyagi and northern Ibaraki prefectures. The Nagano population appeared at Saku City in 1995 and the distribution was restricted to near the city. Although the area was expanded once, it has subsequently decreased.

We excluded the following records from the analysis, because no record was obtained in subsequent years near the site; at Hachioji, Tokyo in 1981; at Sakai City, Osaka in 1994; and at Mt. Tsukuba, Ibaraki in 1998. We also excluded the record from Yasato City, Ibaraki in 2000, because it was far from main populations and could not be classified.

Fig. 6 shows the relationship between the square root of the area of 100% minimum convex polygon occupied by Melodious Laughing Thrushes (y) and the year (x) for each population. The relationships between them are expressed as $y=2.30x-4560$ (a, 1985–1994, $r=0.947$) and $y=3.03x-5990$ (b, 1995–2000,

$r=0.979$) for the Kyushu population, $y=1.29x-2570$ (c, 1987–1993, $r=0.896$) and $y=8.90x-17700$ (d, 1994–2001, $r=0.990$) for the Kanto population and $y=13.4x-26800$ (e, $r=0.959$) for the Tohoku population.

2) Snow depth and elevational conditions

The areas that have more than 20 cm deepest snow depth of normal years (heavy snow area) were shown in Fig. 2–5. There was no heavy snow area near the center of the distribution for the Kyushu population (Fig. 2). At the Kanto population, Melodious Laughing Thrushes extended its range mainly without the heavy snow area. Though the distribution extended across the heavy snow area, the route was along the low elevation area where is considered to have relative light snow (Fig. 3). At the Fukushima population, the distribution seemed to spread avoiding the heavy snow area (Fig. 4). There was a light snow area about 20 km west of the Nagano population, though the species occurred in a heavy snow area

Fig. 4. The distribution of introduced Melodious Laughing Thrushes by year in Southern Tohoku. The symbol is the same as Fig. 2.

(Fig. 5).

There was no record for elevations higher than 1400 m. The ranges of elevations of the four populations were 0–1000 m (Kyushu), 0–1400 m (Kanto), 0–600 m (Tohoku) and 400–800 m (Nagano; Fig. 7).

DISCUSSION

1) Nationwide distribution

There were four populations of Melodious Laughing Thrushes: in northern Kyushu, western Kanto, southern Tohoku and Nagano Prefecture. The oldest information was from 1985 in northern Kyushu, while Sato (2000) noted that the species had already been observed in the early 1980s at Rikimaru Dam in northern Fukuoka Prefecture.

These four populations had discrete origins and occurred discontinuously since the 1980s. The Red-billed Leiothrix *Leiothrix lutea* was also naturalized at various region of Japan since the 1980s, most likely due to releases by individuals and shops (Eguchi 2002). The patterns of distributions were similar between the two species. The same likely oc-

curred with Melodious Laughing Thrushes, though the cause of the naturalization is unclear. One presumable cause of naturalization is the increase of dense understory. This species prefers dense understory as breeding and foraging habitats (Long 1981; Cheng et al. 1987; Sato 2000; Kawakami 2002). In lowland forests, shrub cover has increased and become thicker because of the depression of the forestry industry and insufficient management of rural forests for past few decades (Takeuchi et al. 2001; Forestry Agency 2003). The increase in shrub cover might accelerate the naturalization of this species.

Since the 1980s, four introduced Timalliinae species, i.e. the above two species plus the Masked Laughing Thrush *G. perspicillatus* and the White-browed Laughing Thrush *G. sannio*, have increased in Japan (Nakamura 1993; Eguchi & Amano 1999; Kawakami 2002). These four species and Chinese Bamboo Partridge *Bambusicola thoracica*, which became feral in Japan in the early twentieth century, have similar original distributions, mainly in southern China (China Wildlife Conservation Association

Fig. 5. The distribution of introduced Melodious Laughing Thrushes by year in Nagano Prefecture. The symbol is the same as Fig. 2.

Fig. 6. The square root of the area of 100% minimum convex polygon occupied by Melodious Laughing Thrushes in the four population zones of Kyushu, Kanto, Tohoku and Nagano Prefecture.

Fig. 7. Elevations of known Melodious Laughing Thrushes habitats. The sample sizes were 218, 71, 14 and 32 for Kanto, Kyushu, Nagano and Tohoku populations, respectively.

1995). There might be a tendency for bird species in this area to naturalize easily in Japanese forests. The environments of original and introduced habitats are considered to be similar, because they belong to the same temperate zone and are geographically close. The conditions might induce these species to naturalize.

The ranges of the species in northern Kyushu, western Kanto and southern Tohoku had been expanding since their occurrences and are considered to be still growing. The expansion rate was initially low but rose subsequently in northern Kyushu and western Kanto. Most introduced species are considered to have establishment period during which they expand their range slowly and expansion period during which they intensively expand (Shigesada 1992). This pattern has been reported for various introduced bird species such as the Common Starling *Sturnus vulgaris* and the House Finch *Carpodacus mexicanus* (Okubo 1988). The pattern of Melodious Laughing Thrushes is considered to be similar as them. The reason why subsequent expansion rate was not so high in northern Kyushu is probably the lack of information, as we could not carry out field observations there. Thus, the actual distribution probably should be wider for 2001. Regarding the Tohoku population, there was no establishment period probably because of lack of initial information. It is probably because of the difficulty to find individuals when the population is small. At western Kanto, we got a typical pattern of expansion, and it likely reflects relative large number of observers in the area.

2) Factors limiting distribution

The distribution in Tohoku and Kanto suggested that the range was limited by the snow depth. Melodious Laughing Thrushes mainly forage on the ground in the non-breeding season (Yamaguchi 2000; Kawakami unpubl.), and they are mainly resident (Long 1981; Mountainspring & Scott 1985). Therefore, it appears that they are not able to inhabit heavy snow areas because the snowfall prevents them from foraging in the non-breeding season.

Near the population in Nagano Prefecture, there was an area of light snow (Japan Meteorological Agency 1993). This suggests that the population was established in an area of comparatively light snow. As the data of the normal years is the average value for latest thirty years (Japan Meteorological Agency 1993), there may be annual variation in snow depth. The snow depth was relatively low in 1998 and 1999

beside the previous years in Nagano Prefecture (Snow Research Center 2003), when Melodious Laughing Thrushes increased. When it was deeper in Nagano Prefecture in 2000 and 2001, the population became smaller (Fig. 6). This finding supports the possibility of that the snowfall limits the distribution.

Snowfall in Japan is considered to have decreased since the 1990s (Japan Meteorological Agency 2002). This trend may have facilitated the establishment of populations in Tohoku district and Nagano Prefecture which usually have heavy snowfall. As global warming has occurred since the last century, it would decrease snowfall hereafter. If so, Melodious Laughing Thrushes will likely expand their range northward.

The distribution was restricted to lowland forests and they mainly occurred at elevations below 1000 meters in all areas. This is consistent with a report on the native population, which mentioned that this species occurs at 0–1500 m (Cheng et al. 1987). This tendency might be caused by the snowfall condition above mentioned, as higher elevational area has relative heavy snowfall. And, there is a possibility that the other ecological factors exclude the species from the higher elevational area, such as poor food resources in winter and the insufficiency of appropriate habitats. At the same time, there is a possibility that underestimation was arisen by the lack of observations at higher elevational area. In order to clarify it, more information is required.

Although Melodious Laughing Thrushes are considered to be resident in principal, there might be a population that shows a degree of movements. There is a possibility that individuals that breed at high elevational area move to lower area in winter at Mt. Tanzawa, Kanagawa Prefecture (Y Kato pers. comm.). It is necessary to investigate the seasonal vertically movement in detail.

3) Conservation of native forest birds

Some studies have showed that introduced birds tend to select anthropogenic habitats whilst native birds favour forests (Greig-Smith 1986; Moffat & Minot 1994). Most of introduced bird species in Japan were also established at anthropogenic habitats (Eguchi & Amano 1999). Melodious Laughing Thrushes, however, have been found in natural forests (Eguchi & Amano 1999). Thus, there is a concern that the species would have an impact on the population of Japanese native forest birds such as thrushes that utilize the same resources as Melodious Laughing Thrushes (Yamaguchi 2000; Kawakami

2002), like the cases of other introduced species (e.g. Wootton 1987; Jones 1996). Mountainspring & Scott (1985) indicated that Melodious Laughing Thrushes competed with native species and affected their population densities in the Hawaiian Islands. But there has been no study on the impact of this species in Japan.

They have already become one of the commonest birds in lowland forests in the Kanto district (K Kawakami unpubl.). In order to control the population of Melodious Laughing Thrushes, it might be effective to remove the understory vegetation, which this species prefers as habitat (Kawakami 2002). But this measure would also impact native species. Above all things, it is necessary to assess effects of this species on native birds in future studies and provide possible countermeasures before Melodious Laughing Thrushes thrive in Japan.

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