

# Dwarfism of Lymantriid Moths of *Ivela auripes* (Lepidoptera) Breaking out in the Garden of the Institute for Nature Study, Tokyo, in 2008

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自然教育園で大発生したキアシドクガ (鱗翅目, ドクガ科)  
成虫の小型化について, 2008 年

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**Abstract:** Dwarfism of lymantriid moths of *Ivela auripes* in the Institute for Nature Study, Tokyo, in 2008 is investigated and compared with the results in 2005, 2006 and 2007. The length of male forewing in 2008 is significantly smaller than those in 2005–2007. The length of female forewing is also significantly smaller than those in 2005–2007, though it did not change during the three years, 2005–2007. In 2008, defoliation of *Swida controversa* caused by larvae of *I. auripes* was very serious, and the population density of *I. auripes* in 2008 was evidently larger than before. It is surmised that the decrease of the male and female forewing length could be derived from increase of the population density, that is, in 2008 lesser food was available for larvae of *I. auripes* than those of 2005–2007.

## Introduction

The lymantriid moth of *Ivela auripes* was recognized first in 2001 at the garden of Institute of Nature Study (INS), Tokyo (Owada *et al.*, 2001). The population size of the moth was small in 2002 and 2003. In the spring of 2004, heavy defoliation was observed in some host plants, *Swida controversa*, Cornaceae, and the outbreak of the moths started (Yano & Kuwahara, 2006). In 2005, defoliation of *Swida controversa* by *I. auripes* was so serious that investigations of this outbreak were carried out on the damage of host-plant (Yano & Kuwahara, 2006, 2007, 2008) and on the population size and dwarfism of *I. auripes* (Owada *et al.*, 2007, 2008).

In 2008, the outbreak of *I. auripes* in the forest of INS was still maintained. The population size of this lymantriid moth seemed larger than that in 2007, and the dwarfism of moths was obviously progressed. In this paper, we are going to record this sampling result, and to discuss the population dynamics of *I. auripes* at INS, Tokyo.

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Sampling and metrical methods

The sampling day, May 27, 2008, was fine, and Yano considered it the peak of occurrence of *I. auripes*. Owada used a pole (6 m in length) with a net (60 cm in diameter), and collected moths as many as possible from 10:00 to 12:00. This sampling method, interval and condition of occurrence are almost equivalent to those in the investigations of INS 2006 and 2007, but different from those in INS 2005 and the Imperial Palace, Tokyo (IPT 2005) (Table 1) (see Owada *et al.*, 2007).

The forewing length is a distance from the basal hinge to the apex. Moths collected in this research were set in paper pouches, dried, and measured in millimeters with rounding to the nearest whole number. All the specimens investigated in this study are preserved in the National Museum of Nature and Science, Tokyo.

Results

A total of 301 males and 101 females were collected during two hours in 2008 survey (INS 2008). The 2006 and 2007 surveys (INS 2006, INS 2007) were conducted in the same way as in INS 2008, and a total of 522 males and 132 females were collected in INS 2006, and 189 males and 86 females were collected in INS 2007. The population size of *I. auripes* in INS 2008 is increased to ca. 146 % of that in INS 2007 (Table 1).

Table 1. Forewing length (mm) of *I. auripes* at the Imperial Palace, Tokyo (IPT 2005), and the Institute for Nature Study (INS 2005, INS 2006, INS 2007, INS 2008).

|      | IPT 2005 |        | INS 2005 |        | INS 2006 |        | INS 2007 |        | INS 2008 |        |
|------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|
|      | Male     | Female | Male     | Female | Male     | Female | Male     | Female | Male     | Female |
| Mean | 25.7     | 29.8   | 22.5     | 22.8   | 21.4     | 23.5   | 22.5     | 23.4   | 20.6     | 21.6   |
| SD   | 0.8      | 1.1    | 2.3      | 2.7    | 1.8      | 2.5    | 2.2      | 2.6    | 2.0      | 2.1    |
| N    | 76       | 9      | 183      | 28     | 522      | 132    | 189      | 86     | 301      | 101    |

IPT 2005: June 1st, 2005, 10:00–11:00; INS 2005: May 29th, 2005, 9:00–12:00; INS 2006: May 26th, 2006, 10:00–12:00; INS 2007: May 26th, 2007, 10:00–12:00; INS 2008: May 27th, 2008, 10:00–12:00.

During the sampling in 2008, Owada felt that moths, flying over tree crowns, were fewer, and those, flying near ground and resting on tree branches, are much more than those in 2007. The dwarfism of moths is as obvious in INS 2008 as those in INS 2005, INS2006 and INS 2007 (Owada *et al.*, 2008), and variance of their forewing length and the mean length with SD are shown in Fig. 1 and Table 1.

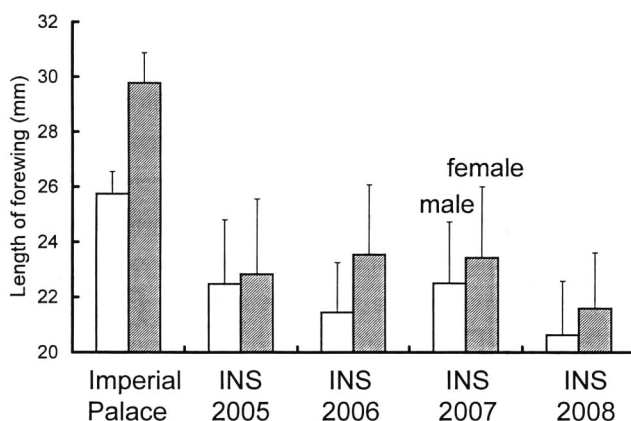


Fig. 1. Mean lengths and SD of the forewing of *I. auripes* at the Imperial Palace, Tokyo, 2005, INS 2005, INS 2006, INS 2007 and INS 2008.

In the male forewing length in INS 2008, the minimum size has been equivalent in 16 mm to INS 2007, while it is 17 mm in 2005 and 2006, and the maximum size is 26 mm, which is equal in INS 2006 and is 1 mm shorter than that of INS 2007. The mean length (20.6 mm, SD=2.0) of INS 2008 is smaller than those of INS 2007 (mean=22.5, SD=2.2), INS 2006 (mean=21.4 mm, SD=1.8) and INS 2005 (mean=22.5 mm, SD=2.3). The difference between the four years was statistically significant (one-way ANOVA,  $F_{3, 1191}=48.91$ ,  $P<0.0001$ ). Comparing the two groups, we found statistically significant difference between INS 2005 and INS 2006, INS 2005 and INS 2008, INS 2006 and INS 2007, INS 2006 and INS 2008, and between INS 2007 and INS 2008 (both Turkey,  $P<0.01$ ).

In the female forewing length in INS 2008, the minimum size has advanced to 17 mm, while it is 18 mm in INS 2007 and INS 2006, and 19 mm in INS 2005. The maximum size of INS 2008 is 28 mm, which is equal to that of INS 2005, 1 mm shorter than that of INS 2007, and 2 mm shorter than that of 2006. The mean length (mean=21.6 mm, SD=2.1) of INS 2008 is smaller than those of INS 2007 (mean=23.4 mm, SD=2.6), INS 2006 (mean=23.5 mm, SD=2.5) and INS 2005 (mean=22.8, SD=2.7). The difference between the four years was statistically significant (one-way ANOVA,  $F_{3, 343}=14.26$ ,  $P<0.0001$ ). In comparison of the two groups, we found statistically significant difference between INS 2006 and INS 2008, and INS 2007 and INS 2008 (both Turkey,  $P<0.01$ ).

## Discussion

In INS 2008, moths of *I. auripes* were not so much active and significantly smaller than those in INS 2005–2007. The relationship between the decline of flight activity and dwarfism is obvious, and it can be surmised that the dwarfism of *I. auripes* in the garden of the Institute for Nature Study, Tokyo, may have reached the limit. The minimum length of male forewing is 16 mm in INS 2007 and 2008 (17 mm in INS 2005

and 2006), and that of female forewing is 17 mm in INS 2008 (18 mm in INS 2006 and 2007) (Fig. 2).

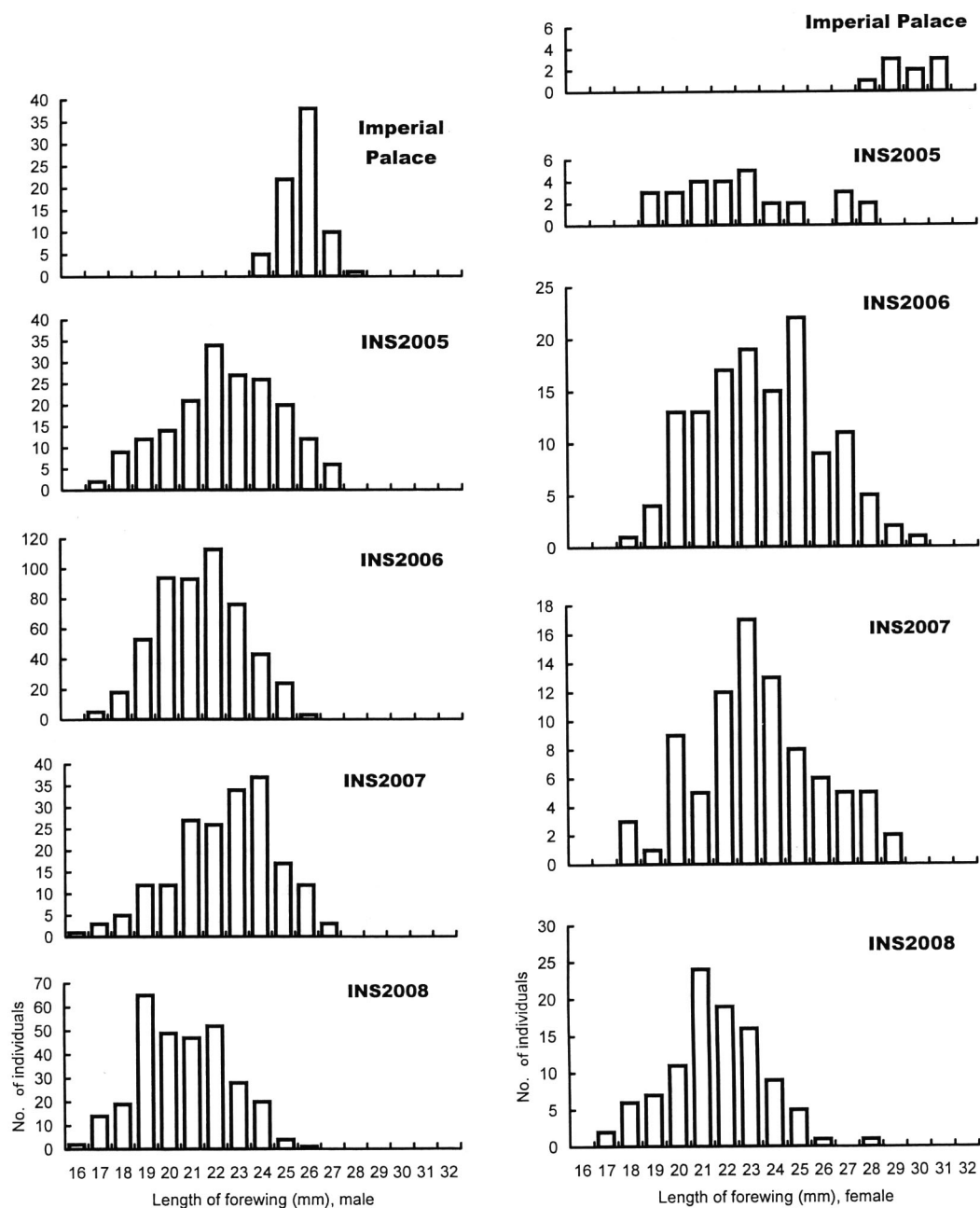


Fig. 2. Length of the forewings of male (left) and female (right) *I. auripes*. Imperial Palace, Tokyo, 2005, control, larvae grown under sufficient leaves, and INS 2005, INS 2006, INS 2007 and INS 2008.

The grounds of the Institute for Nature Study, Tokyo are ca. 20 ha, and since 1949 the forest has been left strictly to the natural selection, that is, no insecticide has been sprayed to *I. auripes* for controlling the defoliation of the host plant, *Swida controversa*. The forest is completely surrounded by buildings and roads, and moths of *I. auripes* were unable to disperse to other areas in their overcrowding state. Female moths have to lay eggs on the damaged host plants in the same forest (Owada *et al.*, 2007).

During the three years, 2002-2005, ca. 100 trees (7 %) within 1,369 individuals of *S. controversa* died in the garden of the Institute for Nature Study, Tokyo (Yano & Kuwahara, 2006). In one year, 2005-2006, 86 trees (6.7 %) within 1,285 trees died, and as many as 162 trees (13.4%) within 1,208 trees died during 2006-2007 (Yano & Kuwahara, 2008). And, during 1.5 years, 2007-2008, as many as 373 trees (35.6 %) died within 1,046 trees (Yano & Kuwahara, 2009). In total, during 6.5 years, 2002-2008, 721 trees (52.7 %) died within 1,369 trees.

In 2008, dwarfism of *I. auripes* may have progressed to the final stage, i. e., the average of the male forewing is 20.6 mm, which is 80.2% of the control population, av. 25.7 mm in IPT 2005, and that of female is 21.6 mm, which is 72.5% of av. 29.8 mm in IPT 2005 (Table 1). In converting the percentages into cubic contents, they are calculated 52% in male and 38% in female.

The size of the female forewing did not change in 2005, 2006 and 2007, and in 2008 the forewing length is significantly smaller than those in 2005-2007. It can be surmised that the population size of *I. auripes* becomes larger in comparison to the population size of the host plant, *Swida controversa*.

In the forest of the Institute for Nature Study, Tokyo, *Swida controversa*, Cornaceae, is the dominant tree in the taller tree stratum. In 2005, a total of 1,269 trees of *S. controversa* was separated into four categories by the degree of defoliation by *I. auripes*, that is, 0 (no damage): 393 trees (31 %); I (a part of foliage fed): 368 trees (29 %); II (most of foliage fed): 144 trees (11 %); III (completely defoliated): 364 trees (29 %) (Yano & Kuwahara, 2006). In 2006, defoliation of a total of 1,199 trees progressed to 0: 39 trees (3 %); I: 188 trees (16 %); II: 185 trees (15 %); III: 787 trees (66 %) (Yano & Kuwahara, 2007), and in 2007 of 1046 trees, 0: 4 trees (0.0 %), I: 188 trees (18 %), II: 397 trees (38 %), III: 457 trees (44 %) (Yano & Kuwahara, 2008). In 2008, however, investigation of the defoliation degree was not carried out, since most of remaining trees were in the categories II and III. It is doubtless that the damage of *S. controversa* trees is quite serious.

## 摘 要

2004年から開始された継続的なキアシドクガの大発生によって、発生した成虫が小型化していることが明らかになったが、2006年と2007年に行ったサンプリング調査とまったく同じ調査を2008年5月27日に行ない、個体数とサイズの変化を調べた。樹冠部を飛ぶ雄の個体数は2007年に比べて減少したと感じたが、地上から3-4 mを飛ぶ個体は明らかに増大した。2時間で採集できたのは301♂101♀で、2007年の189♂86♀をはるかに上まわった。雄の前翅長の平均は20.6 mmで、2005年から2007年の結果に対し有意に小型化し、2005年から2007年で有意な変化のなかった雌の前翅長も21.6 mmとなり、はじめて有意に小型化が進行した (Table 1, Fig. 1)。

樹冠部での飛翔個体の減少と地上から2-4 mで飛翔する個体の増加は、雄の飛翔能力の低下に起因するもので、自然教育園におけるキアシドクガの小型化が進行したことによるものと考えられる。ま

た、雌の小型化の進行によって、産卵数の減少も明らかである。

自然の推移に任せた自然教育園の森では、殺虫剤等の散布を一切行っていない。周囲をビルや高速道路に囲まれたこの森では、キアシドクガ个体群が過密化しても周囲に分散することができず、雌は衰弱した寄主ミズキに産卵を繰り返すことになる。ミズキの枯死は2002年から2005年の3年間で約100本（1,369本中の約7 %）、2005-2006年の1年間で86本（1,285本中の 6.7 %）、2006-2007年では162本（1,208本中の 13.4 %）と急速に進行し、2007-2008年の1.5年間では373本（1,046本中の35.6 %）が数えられ、2002年から2008年の6年間で721本（1,369本中の52.7 %）に達している。この間にキアシドクガの方も、食料不足のために体サイズが減少し、前翅長で皇居の平均値（♂：25.7 mm；♀：29.8 mm）に対して雄が20.6 mm（80.2%）、雌が21.6 mm（72.5%）に減少した（Fig. 2）。体積に換算すると、正常値に比べ雄で52%、雌では38%になってしまったことになる。

雌のサイズが2005-2007年の3年間保持してきたサイズを維持できずに、さらに小型化が有意に進行したのは、キアシドクガの个体群サイズが自然教育園のミズキ群集に対して、个体群の崩壊を招くほどの過度の大きさに達したからで、この原因は、園内のミズキの枯死が急速に進んだことによるものと推定でき、現在、自然教育園に残っているミズキもきわめて深刻な状況にある。

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