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〈原著論文　Original Article〉

Seasonal occurrence of *Thylodrias contractus* Motschulsky, 1839 (Coleoptera, Dermestidae), in a wooden architecture in Kyoto Prefecture, Japan

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京都府の木造建築物におけるマサカカツオブシムシ（コウチュウ目，カツオブシムシ科）の季節消長

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Abstract. We conducted a survey of the odd beetle *Thylodrias contractus* Motschulsky, 1839 using sticky traps for walking insects in a historical wooden architecture in Kyoto Prefecture, central Honshu, Japan. Ecological knowledge of this species in Japan is lacking; as a result of continued surveys, new findings on its life cycle have been obtained. The results consistently confirmed the presence of *T. contractus* larvae over multiple years. Only a few adults were obtained from May to June, followed by a noticeable increase in the number of larvae in early summer. This suggests that this species occurred within the survey site, and it is assumed that the increase in collected larvae through early summer is due to adults laying eggs and subsequent hatching of larvae during this period. Especially in the domestic built-up environments of central Honshu, where temperature control is not particularly stringent, we considered that keeping a close eye on the traps installed in early summer (early July) would help control this species.

Key words: alien species, historical wooden architecture, Integrated Pest Management, museum pest, odd beetle.

Introduction

Dermestidae is a family of Coleoptera with 1,914 species described in the world (Háva 2024), of which 56 species have been recorded from Japan (Suzuki 2024), including species that feed on dry animal and plant specimens as well as dried food and textile (Tanaka 1995). In Japan, several dermestid beetles are well known as food pests or museum pests, for example, *Anthrenus verbasci* Linnaeus, 1767 and *Attagenus unicolor japonicus* Reitter, 1877 (Tanaka 1995).

The odd beetle, *Thylodrias contractus* Motschulsky, 1839, (Fig. 1), is recognized as having unique adult

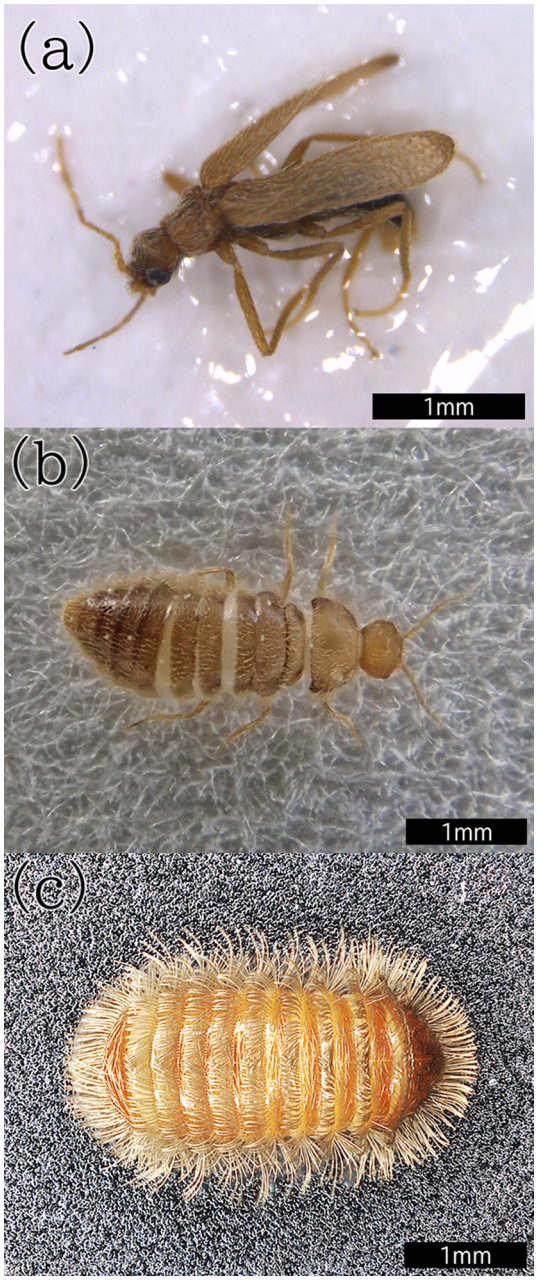

Fig. 1. Habitus of *Thylodrias contractus* from Kyoto Prefecture, Japan: (a) adult male; (b) adult female; (c) larva.

morphology distinguished from all other members of the dermestid beetles, with the male apparently resembling a small cantharid beetle and the female lacking wings and having a larval form (Ohbayashi 1977; Tanaka 1995). This species was described in Imperial Russia, has been recorded in many countries and regions (Europe; Africa: Algeria; Egypt; Tunisia; Morocco; Asia: "Caucasus"; China; Iran; Japan; Kazakhstan; South Korea (introduced); Kyrgyzstan; Russia; Turkmenistan; North America (introduced): Canada; Hawaiian Is.; U.S.A.; Central and South America (introduced): Brazil; Venezuela; Australia (introduced): Australia) (Shin & Kim 2002; Háva 2015), and is

native to Asia in arid and cool-temperate regions (Berder 1947). The first record of odd beetles in Japan was of a single male in Kyoto Prefecture in 1954 (Nakane 1966), followed by limited collection records in Aichi Prefecture in 1972 (Ohbayashi 1977), Osaka Prefecture in 1994 (Tominaga 1998), Fukuoka Prefecture in 1996 (Kido 2023), and Tottori Prefecture in 2020 (Kawakami & Honjo 2024). This beetle is considered an alien species in Japan (Shiyake *et al.* 2020), and its records are fragmentary and mostly from urban areas (Yoshimichi 2008), suggesting that its distribution has expanded due to anthropogenic factors (Barber 1947). However, information on the life history and habitat of this species in Japan is scarce, and has only been published by Yoshimichi (2008). In addition, this species is considered a silk pest worldwide and is recognized as a major threat to museum materials (especially specimens of natural history) (Querner 2015), in Japan, unique climatic conditions such as hot and humid summers and high annual precipitation exist (Toishi 1990), and these factors may influence the habitat and reproduction of this species. These factors make it difficult to fully explain the situation in Japan based solely on research results from other countries. Therefore, the accumulation of basic data for assessment of the species as a museum pest in Japan is still insufficient.

The first author collected odd beetles from a historical wooden architecture in Kyoto Prefecture. This paper reports on the seasonal occurrence of this species (especially larvae) obtained from surveys conducted throughout the year and presents precautions to be taken for this species as a museum pest in Japan.

Additionally, this study reveals that the species has established itself in Japan's historical wooden architecture, providing valuable insights as a case study of infestation in cultural heritage architecture.

Material and Methods

The obtained individuals were observed for morphological characters using a stereo microscope "LEICA SAPO, MC170HD (Leica Microsystems Co., Ltd., Tokyo, Japan)" and digital microscope "RH-2000 (Hirox Co., Ltd., Tokyo, Japan)", and were identified based on Slosson (1908), Ress (1943), Hinton (1945), Ohbayashi (1977, 1985). In addition, on April 12, 2024, larvae were collected at the survey site and reared to adulthood as an aid for identification. For rearing, a polystyrene container (100 mm in diameter × 40 mm in height) with a 40 mm ventilation hole in the center of the lid covered with nylon net was used. Filter paper was placed on the bottom of the container to provide a surface suitable for movement. Unsalted dried sardines were provided as food for the larvae. No specific temperature or humidity conditions were set; the larvae were reared at room temperature in a dark room. Some of the obtained specimens were preserved as 99.8% ethanol immersed specimens and stored in the Center for Conservation Science, Tokyo National Research Institute for Cultural Properties (Ueno, Taito-ku, Tokyo).

The survey site is a historical wooden architecture in Kyoto City, Kyoto Prefecture, Japan. It is located in a low-lying inland area surrounded by urban areas, including residences and restaurants. The architecture is still used for daily events and is cleaned regularly by the cleaning staff.

Eight insect traps were placed in the architecture, and these traps were collected and reinstalled 13 times between May 12, 2023, and July 12, 2024, at intervals of approximately one month. Due to site-related circumstances, no trap collection or reinstallation was conducted in February or March 2024. Sticky traps were deployed in four rooms, with two traps placed in each room. Trap No. 1 and No. 2 were set in the southwestern room, positioned along the eastern and southwestern walls, respectively. Trap No. 3 and No. 4 were placed in the northwestern room, positioned along the southern and northwestern walls, respectively. Trap No. 5 and No. 6 were also installed in a different northwestern room, positioned along the northeastern and southwestern walls, respectively. Trap No. 7 and No. 8 were set in the eastern room, positioned along the northeastern and southeastern walls, respectively. All traps were installed along the walls, and placed on the floor except for Trap No. 8, which was set under the floor. The traps used in the surveys were sticky traps for walking insects (made of paper, length 88 mm × width 155 mm × height 22 mm,

without attractants; Semco Co. Ltd. Osaka, Japan). The number of *T. contractus* (adults and larvae) captured in the traps was counted.

Temperature and humidity at the survey site were measured to investigate the environment. Those data were obtained using two data loggers "HOBO U10-003" (Onset Computer Corporation, Bourne, Massachusetts, USA), and were measured at 15-min intervals (Fig. 2). Two data loggers were installed at the same locations as Trap No. 2 and Trap No. 5. Both loggers were placed on the floor, approximately 5 cm away from the respective traps. The study period was from May 1, 2023, to December 1, 2023. The survey area in a wooden architecture is equipped with an air-conditioning system. Although air conditioning may be turned on when the architecture is used in summer, the temperature and humidity are uncontrolled. The temperature and humidity of outdoor in Kyoto City (Japan Meteorological Agency 2023) are shown in Fig. 2c for comparison. Indoor temperature and humidity (Fig. 2a, b) fluctuated less than outdoors based on information from Kyoto Local Meteorological Office, Kyoto City (Fig. 2c), with temperatures generally ranging between 10 and 35°C and humidity between 30 and 65%, and seasonal variations were observed.

Results

The larvae collected on April 12 emerged as adults on May 20. Observation of the emerged adults revealed that they were female adults of *Thylodrias contractus*. This identification was based on confirmation of the adults' morphological characteristics, referencing Slosson (1908), Hinton (1945), and Ohbayashi (1977).

Details of the number of *T. contractus* obtained using sticky traps are shown in Table 1 and Fig. 3. Four male adults and 234 larvae were collected for the survey. Only a few adults were obtained from May 12 to 31, 2023 (1st survey) and from April 12 to June 20, 2024 (11th and 12th surveys). Larvae were found every time throughout the survey period. The number of larvae increased from May 31 to June 16, 2023 (2nd survey), reaching a maximum of 45 larvae from June 16 to July 7, 2023 (3rd survey), and more than 20 larvae were observed on both August 26 (5th survey) and September 27 (6th survey) of the same year. The number of individuals decreased drastically starting from October 30 (7th survey). The number of larvae captured during the surveys from April 12 to May 28 (11th survey) showed a similar increase as that in the previous year, and the number of larvae captured during the surveys from May 28 to June 20 (12th survey) immediately increased to 30 individuals. A total of 44 larvae were observed in a subsequent survey conducted from June 20 to July 12 (13th survey).

Discussion

Thylodrias contractus male adults were obtained in May in both Kyoto and Aichi Prefectures (Nakane 1966, Ohbayashi 1977). In a survey conducted in Osaka Prefecture from January 1998 to December 1999 (Yoshimichi 2008), the peak of adult emergence was observed in May, which coincided with the results from this survey site.

Larvae were obtained throughout the year in the research period, indicating that this species occurred at the survey site.

The trend in both years (2023 and 2024) suggests that the number of larvae increases approximately one month after the emergence of adults and subsequently peaks. This increase is likely due to adult egg-laying in early summer, as well as rising temperatures that promote larval activity. According to a life history study of *T. contractus* by Mertions (1981), it takes approximately one year from egg to adult for this species, and the life cycle in our study area was also estimated to be annualized based on the number of larvae captured. In the indoor environments of central Honshu, Japan, where temperatures are not particularly controlled like the study sites (Fig. 2a, b), the adults

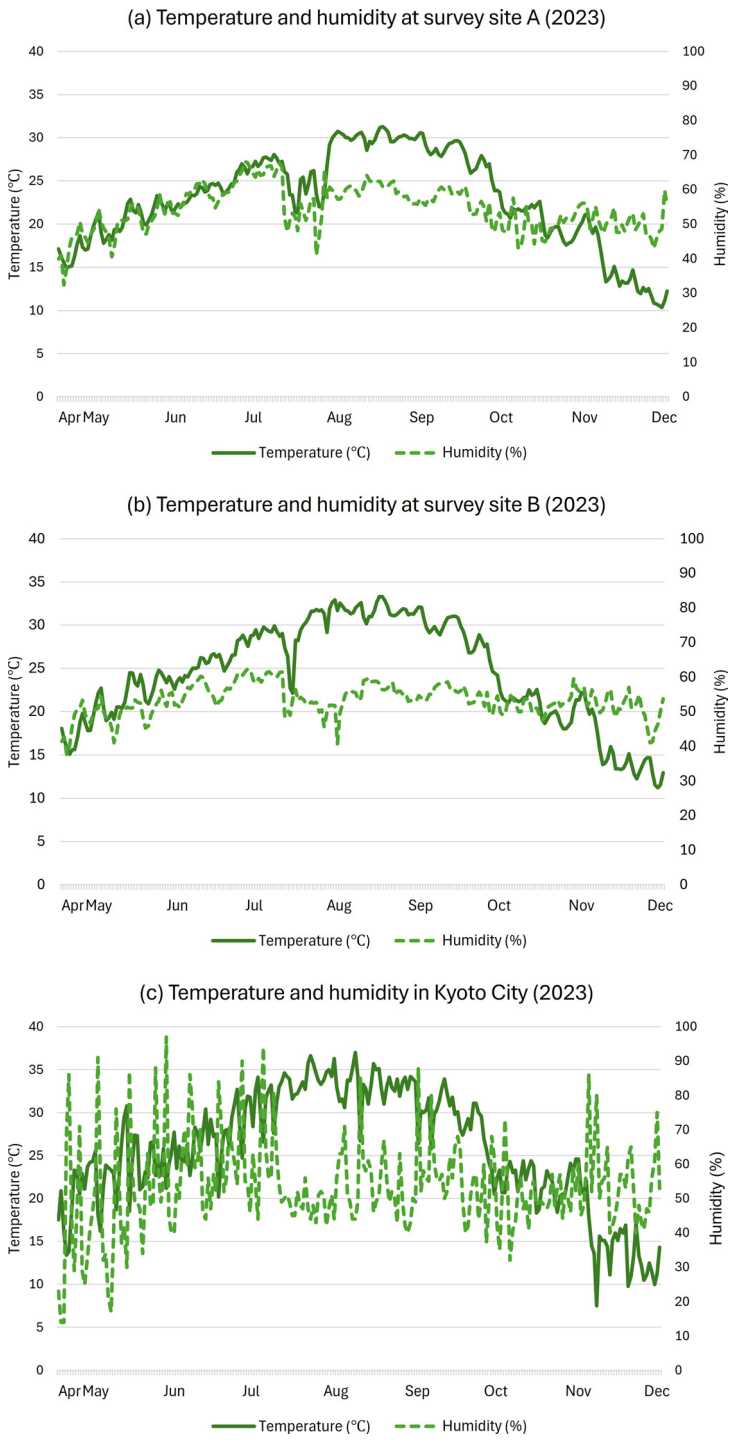

Fig. 2. The temperature and humidity at survey in 2023: (a) site A; (b) site B; (c) outdoor in Kyoto City by Japan Meteorological Agency.

Table 1. Number of *Thylodrias contractus* obtained by sticky traps in this survey, in 2023 and 2024.

	Year	2023								2024				
	Month/ Day	5/12	5/31	6/16	7/7	7/28	8/26	9/27	10/30	11/24	1/23	4/12	5/28	6/20	7/12
	Number of Survey	Start	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th
Number of individuals	Trap number 1	—	0	6	6	2	4	5	0	0	0	2	2	5	7
	No. 2	—	0	4	20	8	7	3	2	1	0	1	1	5	12
	No. 3	—	1	2	2	0	6	0	0	1	0	0	1	4	9
	No. 4	—	1	2	7	7	3	8	0	0	0	0	1	1	6
	No. 5	—	2	0	0	0	2	0	0	0	0	0	2	7	6
	No. 6	—	1	0	1	0	0	2	1	0	0	1	0	5	0
	No. 7	—	1	3	9	3	5	8	0	1	0	0	0	3	2
	No. 8	—	1	1	0	0	0	1	0	0	1	0	1	1	2
Total : Larva		—	6	18	45	20	27	27	3	3	1	4	6	30	44
Total : Adult		—	1	0	0	0	0	0	0	0	0	0	2	1	0
Average±SD*		—	0.875±0.60	2.25±1.92	5.625±6.30	2.50±3.08	3.375±2.45	3.375±3.08	0.375±0.70	0.375±0.48	0.125±0.33	0.5±0.71	0.75±0.71	3.75±1.96	5.5±3.74
(Min.–Max., n=8)**		—	(0–2)	(0–6)	(0–20)	(0–8)	(0–7)	(0–8)	(0–2)	(0–1)	(0–1)	(0–2)	(0–2)	(1–7)	(0–12)

*Average number of traps captured per trap.

**Minimum (Min.) to maximum (Max.) number of traps captured per trap.

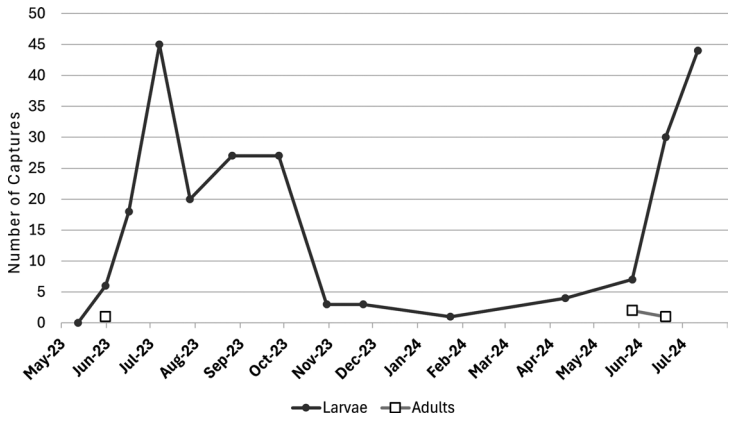

Fig. 3. Seasonal occurrence of *Thylodrias contractus* obtained by sticky traps in this survey, in 2023 and 2024.

occur in early summer, and the likelihood of humans finding larvae is expected to increase. Therefore, we considered keeping a close eye on the traps installed in early summer (early July) as a way to help control this species.

Unless one is highly knowledgeable about beetle diversity, the adults of *T. contractus* are not recognizable at first glance as members of the family Dermestidae, and the larvae may be confused with those of another related dermestid species. Therefore, it is expected that this species will not be easily recognized, especially in historical and art museums. This species is not listed in the "Cyclopedia of Museum Insects, (Tokyo National Research Institute for Cultural Properties 2001)" which is often for species-identification of the detected pests by curators of local museums for cultural properties in Japan, and there is concern that it may be overlooked by the museums that have little connection with insect specialists. Although Integrated Pest Management (IPM) has been promoted in museums and cultural properties (Cultural Properties Department, Agency for Cultural Affairs 2001), it is estimated that many curators who identify the detected pests specialize in local history, art, and history, based on the ratio of the

number of museums by category (Japanese Association of Museums 2024). Therefore, it is important to publicize the existence of *T. contractus* in museums and cultural properties to improve the accuracy of pest control.

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