



Overwintering population of the rice stink bug *Niphe elongata* (Hemiptera: Pentatomidae) on mondo grass, *Ophiopogon japonicus*

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Abstract

The rice stink bug *Niphe elongata* (Dallas) (Hemiptera: Pentatomidae) is a serious pest of rice in central and western Japan, causing grain sterility and grain surface discoloration. Effective management of this pest requires knowledge of its overwintering habitats and the seasonal movements of overwintering adults. We surveyed potential habitats of the overwintering population of *N. elongata* on several plant species in Tsukuba, Ibaraki Prefecture, Japan, in February. Adults were found in high densities on clumps of mondo grass (*Ophiopogon japonicus*; Asparagales: Asparagaceae). Over the following 2 years, we monitored the seasonal occurrence of adults on mondo grass and in rice fields. Adults were present on mondo grass from September to early July, with peak densities in early autumn and late spring. These findings indicate that mondo grass is a habitat for *N. elongata* during the overwintering period, mainly in autumn and late spring. Mondo grass is a promising monitoring site for overwintering populations to predict subsequent infestations in rice fields. In early autumn, adults appeared in late-season rice fields and their density on mondo grass increased, suggesting that they migrated to mondo grass for overwintering. In early summer, light trap catches suggested that overwintering adults dispersed from these sites then.

Keywords Sterile rice · Pecky rice · Heteroptera · *Lagynotomus elongatus*

Introduction

The rice stink bug *Niphe elongata* (Hemiptera: Pentatomidae) is an important insect pest of reproductive-stage rice in East Asia (Chen et al. 2011; Higuchi 2019). In recent years, infestations of *N. elongata* have become increasingly severe in central and western Japan (Honda et al. 2021; Kitano and Masuda 2022; Matsuda et al. 2022; Ota et al. 2020; Yasue et al. 2022). This pest pierces the basal part of rice spikelets with their mouthparts to feed on developing grains from heading through to maturity (Takeuchi et al.

2004). Feeding damage causes surface discoloration at the base of the affected grains, leading to their classification as ‘pecky rice’, which reduces market value (Tomokuni et al. 1993). Furthermore, feeding during the period from heading to the milk-ripe stage can induce grain sterility (Tanaka et al. 2022). To control stink bugs responsible for sterility damage, insecticides are applied during heading (Honda et al. 2021). However, because insecticide application during this period to control other pest insects is generally omitted due to managerial considerations, the recent outbreaks of *N. elongata* have led to additional economic costs.

Because *N. elongata* adults first invade early season rice fields at heading (Ishijima et al. 2020) and cause sterility damage, accurately predicting their abundance is crucial for optimizing management strategies and minimizing unnecessary insecticide use. Conventional forecasting methods for stink bugs that cause pecky rice typically rely on monitoring their abundance on gramineous weeds in early summer, which serve as sources of migration into fields. However, this approach is not suitable for *N. elongata*, because it has so far been found almost exclusively on rice plants in the field (Shimada and Sugiura 2020). Therefore, identifying the

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overwintering sites and understanding the migration patterns of overwintering adults is crucial for developing a practical forecasting method for this pest.

Several overwintering habitats have been reported for *N. elongata*, including beneath leaf litter on south-facing hillsides, at the base of dead gramineous plants (Kobayashi 1960; Ogawa et al. 1960; Ouchi 1953; Torikai et al. 2021), and in leaf litter on the trunks of the Chinese arborvitae *Platycladus orientalis* (Cupressales: Cupressaceae) (Sumita and Takematsu 2022). Over 70 years ago, Ouchi (1954) reported that adult *N. elongata* emigrate from their overwintering sites between late July and early August and return in early September. More recently, Torikai and Higuchi (2022) reported that adult *N. elongata* completely emigrate from the base of dead gramineous plants by mid-July. However, current knowledge of the overwintering sites of *N. elongata* adults and their migration patterns remains limited and is based on short-term observations (Ouchi 1954; Torikai and Higuchi 2022). Recently, adult *N. elongata* have been observed on mondo grass (*Ophiopogon japonicus*; Asparagales: Asparagaceae) in late spring (Shibata et al. 2025). However, whether *N. elongata* actually overwinters on mondo grass remains unclear, because the observation was limited to late spring in a single year.

In this study, we confirmed the presence of *N. elongata* adults on mondo grass during overwintering period through field surveys conducted over three consecutive winters in Tsukuba, Ibaraki Prefecture, Japan. We report here the densities of overwintering *N. elongata* on several plant species, along with their seasonal occurrence on mondo grass and in rice fields. These findings provide important information for the development of practical forecasting methods for this pest.

Materials and methods

Surveyed fields

All surveys were conducted in the experimental fields of the National Agriculture and Food Research Organization (NARO), Tsukuba, Ibaraki Prefecture, Japan (36°01'32.8"N, 140°06'55.8"E). This study site covers approximately 100 ha of flat terrain and includes rice fields, vegetable plots, stands of trees, and buildings. The rice fields cover about 5 ha and consist of multiple paddies, where rice seedlings are transplanted between May and late June. Heading occurs from early July to September, and harvesting takes place from August to mid-October.

Survey of overwintering sites of *N. elongata*

Overwintering sites of *N. elongata* were surveyed on 16 February 2023 in nine distinct plots (A–I), classified according to vegetation type and geographical position (Fig. 1; Table 1). Plots A and B were near the rice fields, while plots C to I lay ~800 m away. Colonies of mondo grass were present in six plots (A, B, C, F, G, and I).

Plots A and I were shaded areas under coniferous trees and were covered with fallen leaves. Plots F and G were located at the edges of a stand of coniferous trees, facing north and south, respectively. Plot B was on the northwest side of a mixed stand of deciduous trees and shrubs, and Plot C was an open area with minimal vegetation cover. Mondo grass in Plots B and C grew in clumps resembling small mounds. Plot D, under coniferous trees, was covered with bamboo grass and fallen leaves. Plots E and H were open areas—a south-facing sloped lawn and a field of withered Italian ryegrass, respectively.

The number of *N. elongata* adults was carefully assessed in three microhabitats: on the topsoil, beneath fallen leaves, and within growing plants. To compare population densities across sites, we sampled in a 50-cm × 50-cm quadrat. We recorded the number of adults collected in each plot. The number of quadrats per plot ranged from 1 to 73, with an average of 25.1, depending on the area available for sampling at each site.

Seasonal occurrence of *N. elongata* in mondo grass

The seasonal occurrence of *N. elongata* on mondo grass—where large numbers of overwintering adults had been observed in the overwintering survey—was monitored over 2 years from June 2023 to July 2025. Sampling was usually conducted once a month, with increased frequency in July, September, and October, when migration of *N. elongata* adults from and to mondo grass was expected.

Adults were collected using a suction device (THB-260PFS; Nikko Tanaka Engineering, Chiba) equipped with an 11.5-cm-diameter inlet and a trapping net, as described by Matsukura et al. (2009). Each sampling event consisted of twenty 1-s suction taken from the top of mondo grass.

Adult density (adults per square meter; denoted as *D*) was calculated from the number of collected individuals per sample (*N*) as

$$D = N / [\pi \times (0.115/2)^2 \times 20]$$

Occurrence of *N. elongata* in rice fields and surrounding areas

To examine the timing of emigration from rice fields to overwintering sites, we monitored the occurrence of *N. elongata* in a field of late-season rice ('Hinohikari') from September

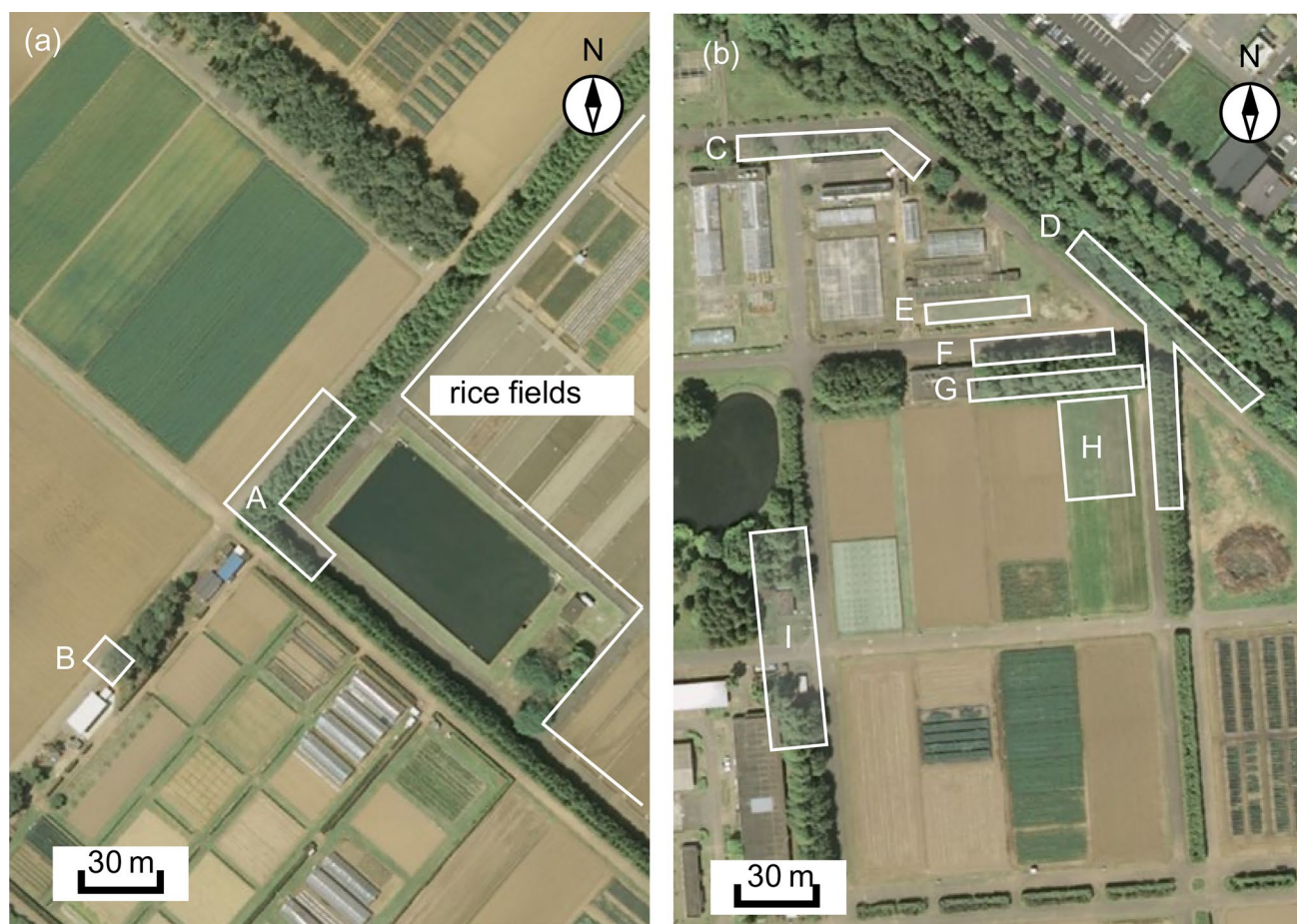


Fig. 1 Study sites of *Niphe elongata* overwintering **a** near rice fields and **b** ~800 m away in the experimental fields of the National Agriculture and Food Research Organization, Tsukuba, Ibaraki Prefecture.

Sampling plots A–I are overlaid on orthoimages published by the Geographical Survey Institute of Japan in 2008

Table 1 Environmental conditions and number of 50-cm × 50-cm quadrats and *Niphe elongata* collected at overwintering study sites in a survey on 16 February 2023

Plot	Vegetation	Position	Number of 50-cm × 50-cm quadrats	Number of <i>N. elongata</i> collected
A	<i>Ophiopogon japonicus</i> , fallen leaves	Beneath a stand of coniferous trees	53	6
B	Clump of <i>Ophiopogon japonicus</i>	Beneath the northwest side of a stand of trees and shrubs	1	18
C	Clumps of <i>Ophiopogon japonicus</i>	Area with minimal vegetation cover	8	4
D	Bamboo grass, fallen leaves	Beneath a stand of coniferous trees	46	0
E	Lawn	South-facing slope	10	0
F	<i>Ophiopogon japonicus</i>	Northern edge of a stand of coniferous trees	10	0
G	<i>Ophiopogon japonicus</i> , fallen leaves	Southern edge of a stand of coniferous trees	71	93
H	Withered Italian ryegrasses	–	13	0
I	<i>Ophiopogon japonicus</i> , fallen leaves	Beneath a stand of coniferous trees	12	0

to October in 2023 and 2024. Populations of *N. elongata* on rice plants on the outer edge of the field were monitored weekly in sampling units consisting of 20 hills. Adults and

nymphs were counted weekly from 7 September to 5 October 2023 and from 17 September to 11 October 2024. In the 2024 survey, nymphs were classified into early instars

(first-to-third instars) and late instars (fourth and fifth instars). The number of sampling units per survey date ranged from 6 to 12, corresponding to 120–240 rice hills per survey.

To investigate the timing of immigration of *N. elongata* adults into early season rice fields at heading, we recorded the number of adults on 100 rice plants at the outer edge of a field of early season rice ('Yumefuwari') daily from 3 to 26 July 2024, excluding 14 July. The heading date of the field—defined as the date on which more than 50% of the rice hills had headed—was 6 July. The insecticide fenitrothion was applied following the survey on 11 July.

The seasonal occurrence of *N. elongata* in the census area was also monitored using a light trap (MT-7-N2; Ikeda Rika, Tokyo) installed ~200 m from the fields, operating from April to October in both 2023 and 2024. The trap was equipped with a 100-W mercury lamp (HF100X/N; Panasonic, Osaka) set to automatically turn on at 1800 and off at 0600.

Results

Overwintering sites

A total of 121 *N. elongata* adults were collected from leaf litter and mondo grass (Table 1). Among the nine plots, adults were found in four plots, where mondo grass was present. Notably, in Plot G, located on the sunny southern edge of a stand of coniferous trees (Fig. 1), 93 adults were collected, including 44 individuals from a clump of mondo grass on the south side beneath a tree (Fig. 2). In Plot B, 18 adults were collected from a clump of mondo grass on the north-west side beneath a tree.

In contrast, no adults were found in mondo grass located at the northern edge of a stand of coniferous trees (Plot F), or in the withered Italian ryegrass field (Plot H) or the south-facing lawn slope (Plot E).

Seasonal occurrence of *N. elongata* adults on mondo grass

The suction device collected *N. elongata* adults throughout most of the year, except in late July and August of both 2023 and 2024 and in March 2024 (Fig. 3), although we saw adults on mondo grass in March 2024. No nymphs were collected from mondo grass at any time during the study period.

Adult density on mondo grass showed similar seasonal patterns in both years. Density increased steadily from early September to early October, declined during the colder months, rose again in late spring, and dropped to zero by late July.



Fig. 2 *Niphe elongata* on a clump of *Ophiopogon japonicus* on the south side beneath a tree in the experimental fields of the National Agriculture and Food Research Organization, Tsukuba, Ibaraki Prefecture on 16 February 2023

Occurrence of *N. elongata* in rice fields and light trap catches

Both adults and nymphs were observed in late-season rice fields from mid-September to early October (Fig. 4). Nymphal density steadily declined from mid-September, while adult density increased correspondingly until late September. The trend was similar in 2024. In that year, early instar nymphs disappeared from the field after mid-September, whereas late instar nymphs could still be observed until early October. In both years, few or no *N. elongata* individuals were observed in October.

In the early season rice field, large numbers of adult immigrants were observed from the heading date (6 July) until 11 July 2024, when insecticide was sprayed (Fig. 5b). Adults were also captured by the light trap beginning in late June, with peaks in mid-July 2023 and early July 2024 (Fig. 5).

Discussion

Our 3-year study demonstrated that mondo grass is a habitat for *N. elongata* during the overwintering period, mainly in autumn and late spring. Although adults were found on mondo grass throughout the overwintering period, seasonal fluctuations in adult density (Fig. 3) indicated that most adults left mondo grass in the coldest season. During our investigation, we often found overwintering adults below the soil surface around mondo grass (Fig. 6), supporting an observation by Ouchi (1953) that some adults settle below the soil surface in winter. The temporal decrease in adult density on mondo grass suggests that

Fig. 3 Seasonal occurrence of *Niphe elongata* adults on *Ophiopogon japonicus* in the experimental fields of the National Agriculture and Food Research Organization, Tsukuba, Ibaraki Prefecture, from 2023 to 2025. Densities were calculated using an equation based on the number of individuals collected by a suction device (see Materials and Methods). Vertical bars indicate SEM

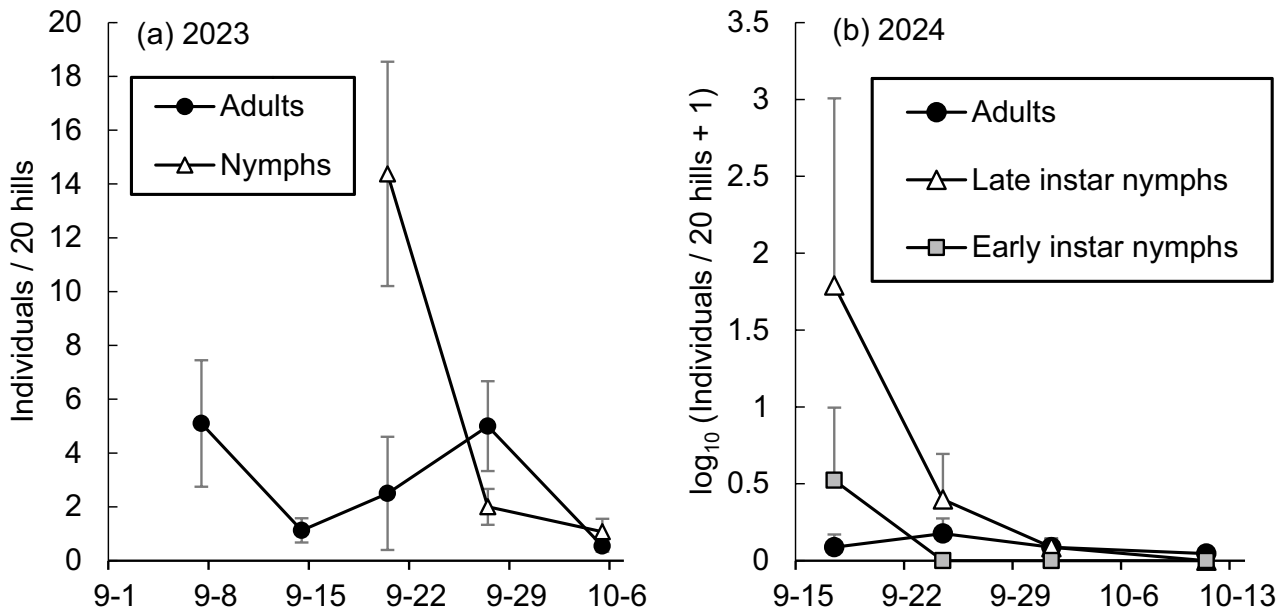
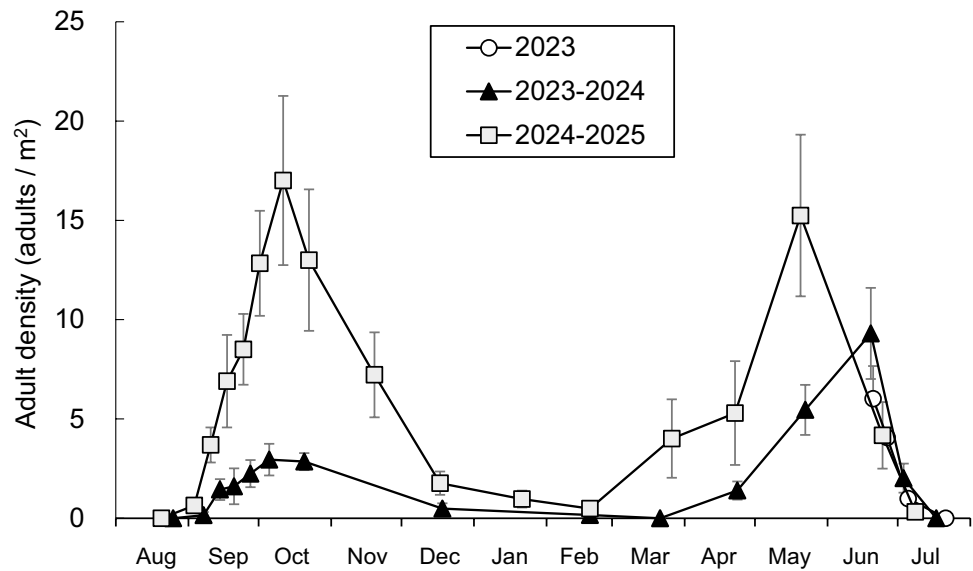


Fig. 4 Adult and nymphal densities of *Niphe elongata* in a late-season rice field from September to mid-October in **a** 2023 and **b** 2024. In 2024, nymphs were categorized into early instars (first to third) and late instars (fourth and fifth). Vertical bars indicate SEM

most overwintering adults migrate below the soil surface during the coldest season. A similar short-distance migration of the overwintering population has been observed in the brown marmorated stink bug *Halyomorpha halys* (Hemiptera: Pentatomidae), which does not immediately settle in its overwintering site but, wanders around it for several weeks beforehand (Watanabe et al. 1994). Indeed, Ouchi (1953) reported that adult *N. elongata* wanders around their overwintering sites in late spring. Further

ecological studies are needed to clarify the migration of the overwintering adults of *N. elongata*.

Mondo grass is a promising monitoring site for overwintering populations to predict subsequent infestations in rice fields. Given that mondo grass is widely distributed in Japan (Ohashi et al. 2015) and commonly occurs near rice fields, it is likely that it serves as a habitat for *N. elongata* during the overwintering period across the distribution range of *N. elongata*. As an evergreen perennial, mondo grass

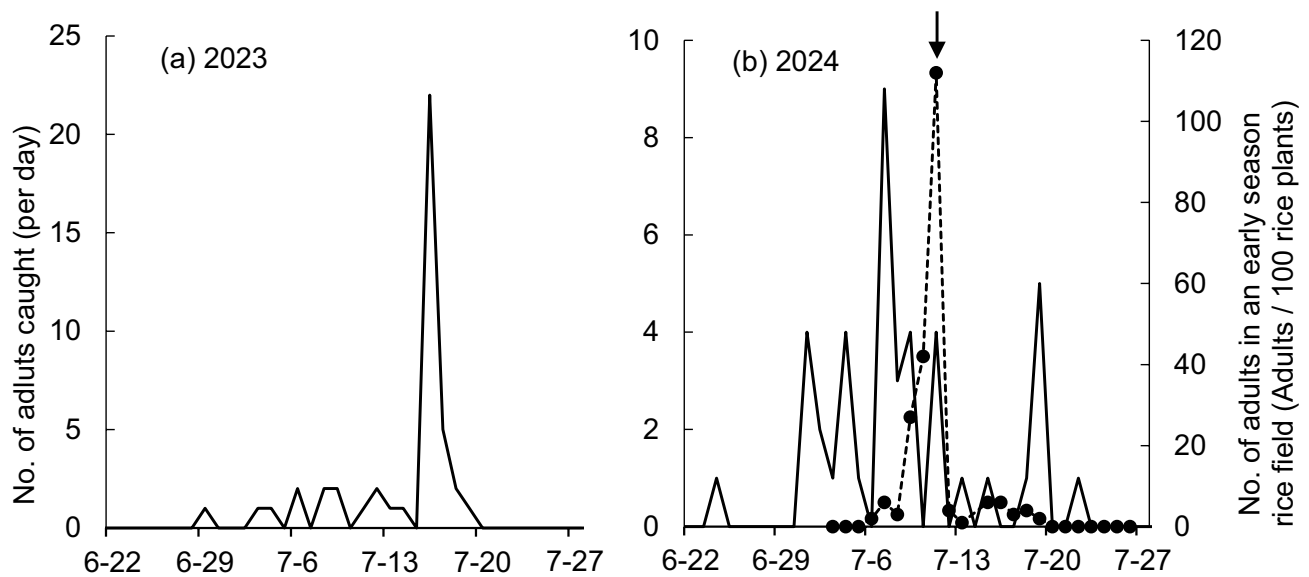


Fig. 5 Daily fluctuations in the numbers of *Niphe elongata* caught in the mercury lamp trap (solid line) and observed in an early season rice field (dashed line) from June to July in **a** 2023 and **b** 2024. The arrow indicates the date of insecticide application



Fig. 6 *Niphe elongata* beneath soil near *Ophiopogon japonicus* in the experimental fields of the National Agriculture and Food Research Organization, Tsukuba, Ibaraki Prefecture on 17 December 2024

offers a stable and accessible site for annual monitoring of overwintering adults. In addition, because it is commercially available as a horticultural plant, it could be strategically

positioned as an artificial overwintering site. Monitoring overwintering populations is a fundamental component of pest management strategies for certain insect pests and is essential for forecasting subsequent infestations (Régnière et al. 2023; Yamada et al. 1983). Seasonal fluctuations in adult density (Fig. 3) indicate that overwintering individuals are reliably present on mondo grass in late spring, and the density decreases in early July. Furthermore, the increase in light trap catches in late June (Fig. 5) suggests that dispersal from overwintering sites begins in late June. These facts indicate that the optimal monitoring period for *N. elongata* adults on mondo grass would be late spring, from May to mid-June for precise forecasting of this pest. Besides, monitoring *N. elongata* on mondo grass in autumn may be effective for early forecasting for rice cropping in the next year. Although *N. elongata* may suffer partial mortality during the cold season—as do other stink bug species in temperate regions (Kiritani 2007), earlier prediction of the *N. elongata* abundance would help farmers to make cropping plan including pest control. Further investigation into the relationship between overwintering population size on mondo grass and subsequent abundance in rice fields would support the development of practical forecasting tools for *N. elongata*.

Our survey also provided insights into the population dynamics of *N. elongata* in autumn. In the late-season rice field, a decline in nymphal density followed by a subsequent increase in adult density (Fig. 4) suggests that nymphs developed and emerged as adults in the field through early October. During the same period, the density of *N. elongata*

on mondo grass increased (Fig. 3), suggesting that adults that emerged in the rice field migrated to mondo grass to overwinter. These observations suggest that late-season rice fields may be at least one important source of overwintering adults. Clarifying the relationship between *N. elongata* occurrence in late-season rice fields and occurrence in the following year would support the development of an effective forecasting method for this species.

The early summer survey provided valuable insights into the emigration of overwintering *N. elongata* adults from their overwintering sites. Results from the light trap and mondo grass surveys conducted from mid-June to early July suggest that dispersal of adults from their overwintering sites began in late June, before heading of rice plants in the census area. A substantial number of adults were subsequently caught in the light trap from early to mid-July (Fig. 5), and no overwintering adults were observed on mondo grass thereafter (Fig. 3). These findings indicate that overwintering adults had fully dispersed from their overwintering sites by mid-July. Although the initial dispersal in late June was not directly examined, it is possible that these adults migrated to rice plants before heading or to graminaceous weeds, such as southern crabgrass (*Digitaria ciliaris*), barnyard grass (*Echinochloa oryzicola*), and Johnson grass (*Sorghum halepense*), as reported in previous studies (Ogawa et al. 1960; Sakai 2024; Shibata et al. 2025). Early dispersal may lead to earlier emergence of the next generation on these host plants, potentially increasing the number of generations per year and affecting management strategies for *N. elongata*. Further research is required to clarify the post-dispersal habitats, behavior, and environmental factors influencing emigration.

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Declarations

Conflict of interests The authors have no competing interest to disclose.

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