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Takecallis nigroantennatus Wieczorek (Hemiptera: Aphididae) – IMPLICATIONS OF THE ABILITY TO HOLOCYCLE AND OVERWINTERING OF EGGS ON THE SPREAD OF A POTENTIALLY INVASIVE BAMBOO APHID SPECIES

Beata Borowiak-Sobkowiak[1], Aleksandra Raut[1], Roma Durak[2],
Karina Wieczorek[3]✉

[1] Department of Entomology and Environmental Protection, Poznan University of Life Sciences, Dąbrowskiego 159, 60-594 Poznań, Poland

[2] Institute of Biology, University of Rzeszów, Pigonia 1, 35-310 Rzeszów, Poland

[3] Institute of Biology, Biotechnology and Environmental Protection, Faculty of Natural Sciences, University of Silesia in Katowice, Bankowa 9, 40-007 Katowice, Poland

ABSTRACT

The bamboo-feeding aphid genus *Takecallis* (Hemiptera: Aphididae) contains eight taxa of Oriental origin. Four of them are introduced to Europe, where they are treated as a pest on Bambusoideae, showing invasive behavior with regard to range expansion, host plant spectrum and the ability to engage in an anholocyclic (without sexual phase) mode of reproduction. In contrast, the current field study confirms that the newly described species, the hardy bamboo aphid *Takecallis nigroantennatus*, reproduces holocyclically in temperate climatic conditions. The previously unknown morphs, i.e. the oviparous females and winged males, are described and illustrated in light and scanning electron microscopy. Chlorophyll fluorescence measurements were employed to evaluate the effects of insect feeding on the photosynthetic performance and general health of the host plant. The implications of the ability to holocycle and the overwintering of eggs on the spread of a potentially invasive aphid species are discussed.

Keywords: cryptic species, *Fargesia* spp., male, oviparous female, sexual generation

INTRODUCTION

Holocycly, the phenomenon wherein organisms exhibit both asexual and sexual reproductive modes within their life cycle, represents a remarkable adaptation strategy observed in various taxa, including aphids. In the case of these hemipterans, holocyclic behavior is characterized by the alternation between parthenogenetic viviparous generations and a sexual generation, which includes oviparous females and males. Both generations play distinct roles in population dynamics, genetic diversity, and adaptation to environmental pressures. In particular, parthenogenetic generations facilitate rapid population growth and host plant colonization. Sexual generation promotes genetic recombination and dispersal, enhancing the adaptive potential of aphid populations [Hales et al. 1997, Simon et al. 2002, Le Trionnaire et al. 2008, Loxdale et al. 2020]. Despite their ecological importance, the sexual generation of aphids remain relatively understudied, posing challenges to comprehending their evolutionary ecology and life history strategies [Pérez Hidalgo et al. 2016, Casiraghi et al. 2020, Trela et al. 2020, Kanturski and Lee 2024]. Moreover, alien spe-

✉ karina.wieczorek@us.edu.pl

cies of aphids, dispersed outside their natural range, exhibit anholocyclic behavior, meaning they reproduce without the need for sexual reproduction. Consequently, the sexual generation of these alien, often invasive species remains unknown, further complicating understanding of their life cycles and ecological dynamics in new environments [Poljaković-Pajnik and Petrović-Obradović 2002, Scheurer and Binazzi 2004, Wieczorek and Chłond 2019a, 2020].

The bamboo-feeding aphid genus *Takecallis* Matsumura (Hemiptera: Aphididae) comprises eight taxa of Oriental origin. Four of these have been introduced to Europe, where they are considered pests on Bambusoideae, displaying invasive behavior regarding range expansion, host plant spectrum, and the ability to reproduce in an anholocyclic mode [Blackman and Eastop 2024]. Among these aphids, a significant knowledge gap exists regarding their sexual generation, a crucial aspect of their life cycle that remains largely unexplored. Across various species within this genus, oviparous females and winged males have been documented infrequently. Oviparae and vagrant winged males of *Takecallis affinis affinis* L.K. Ghosh were recorded on *Arundinaria jounsarensis* in Mashobra, Himachal Pradesh, India, in October 1974 [Ghosh 1986]. Similarly, *T. arundinariae* (Essig) showcases its sexual morphology through oviparae found on *Sasa kurilensis* in Seoul, South Korea, in November 1971, whereas ovipara of *T. taiwana* (Takahashi) was detected on bamboo in China, Chengtu, Sichuan Province, in October 1936. All of these observations provide insight into the reproductive behavior of this species in its natural range of distribution [Quednau 2003]. Reports of a sexual generation outside the natural range of these aphids are even rarer. Oviparous females of *T. arundicolens* (Clarke) were found on bamboo in the USA, Oakland, California, in November 1938 [Quednau 2003]. Additionally, Leclant [1966] reported oviparae on *Arundinaria* sp. in southern France, Montpellier, in January 1965. Despite these documented sexual forms, it is worth noting that *Takecallis* species are likely to exhibit anholocyclic reproduction, particularly when introduced into new environments.

The role of human trade in plant material plays a significant part in the dispersion of alien species of aphids. Through the international movement of ornamental plants, these aphids can be inadvertently transported to new regions where they may establish populations outside their natural range [Irwin et al. 2007, Couer d'Acier et al. 2010, Wieczorek and Chłond 2019b]. Ornamental bamboo cultivation and trade are integral components of the global horticultural industry. However, they inadvertently facilitate the translocation of associated pests, such as aphids, to new environments. A notable example is the discovery of *T. nigroantennatus* Wieczorek, linked to the recent introduction of frost-resistant varieties of bamboo (i.e., *Fargesia* spp.) commonly found in European garden centers [Wieczorek 2023, Wieczorek and Sawka-Gądek 2023, Wieczorek et al. 2024]. This discovery presented an opportunity to conduct a field study, confirming the reproductive behavior of this newly described hardy-bamboo aphid species in temperate climatic conditions, specifically investigating its ability to reproduce holocyclically. Therefore, the aims of this study are: (1) to elucidate the biology of this species and assess the impact of feeding by the sexual generation on the condition of the host plant; (2) to describe and illustrate previously unknown morphs of *T. nigroantennatus*, specifically oviparous females and winged males, utilizing both light and scanning electron microscopy techniques; (3) to discuss the implications of *T. nigroantennatus*'s ability to holocycle and the overwintering of eggs on the potential spread of this invasive aphid species.

MATERIALS AND METHODS

Aphids and plants

Live specimens of *T. nigroantennatus* were collected from *Fargesia* sp. Franch. in July 2023 in one of the garden centers near Poznań. The aphids were then reared on the cold hardy bamboo variety *Fargesia nitida* 'Jiuzhaigou' in Poznań (52°25.14'N, 16°53.19'E), Wielkopolskie Voivodeship, Poland. The plant came from a local garden center and was not infected with other insects. It had been left outside all year round for the season 2023–2024. Aphid colonies were partially maintained under an insulator (Fig. 1A).

Specimen collection and identification

The aphids (winged males and oviparous females) were collected directly from the host plant using a fine brush and placed into Eppendorf tubes containing 70%

ethanol. Insects were slide-mounted using the method of Wieczorek in Wieczorek and Chłond [2020], examined using a Nikon Ni-U light microscope equipped with a phase contrast system and photographed using a Nikon SMZ 25 stereoscopic microscope with a DS-Fi2 camera. Field photographs were taken using a Realme GT 2 Pro with Macro Zoom 40×. The measurements were taken according to Ilharco and van Harten [1987] and are given in millimeters. Voucher specimens were deposited in the entomological collection of the University of Silesia in Katowice, Poland (DZUS). The figures were prepared using CorelDRAW ver. 21 (Corel Corporation, Ottawa, Ontario, Canada).

The temperature conditions were available from an online weather service https://www.weatheronline.co.uk/Poland/Poznan.htm.

Scanning electron microscopy

Specimens for SEM analysis (one winged male and two oviparous females) were preserved in 70% ethanol. Dehydration of preserved samples was conducted by ethanol series of 80%, 90%, and 96% and two changes of absolute ethanol as follows: 20 min in 80% ethanol, 15 min in 90% ethanol, 10 min in 96% ethanol, and two baths in absolute ethanol, 10 min each.

Whole samples of male and oviparous females were dried in a Leica EM CPD300 critical point dryer (Leica Microsystems, Vienna, Austria). Samples were mounted on aluminum stubs with double-sided adhesive carbon tape and sputter-coated with a 30-nm layer of gold using a Safematic CCU-010 HV coating unit (Safematic GmbH, Zizers, Switzerland). Coated samples were imaged with a Hitachi SU8010 field emission scanning electron microscope (Hitachi High-Technologies Corporation, Tokyo, Japan) at 7 and 10 kV accelerating voltage with a secondary electron detector.

Chlorophyll fluorescence measurements

Chlorophyll fluorescence was measured using a PAR-FluorPen FP 110D fluorimeter (PSI Company, Czech Republic). Leaf fragments were shaded with a special leaf clip for 30 min. The OJIP test was conducted to measure the selected chlorophyll fluorescence parameters: F_0 – initial fluorescence, ABS/RC – light energy absorbed by the PSII antenna photon flux per active reaction center, TR_0/RC – total energy used to reduce QA (primary quinone electron acceptor) by the unit reaction center of PSII per energy captured by a single active RC, ET_0/RC – the rate of electron transport through a single RC.

Measurements were performed in October 2023 under natural climatic conditions on *Fargesia nitida* 'Jiuzhaigou' colonized by sexual morphs by *T. nigroantennatus* and on the leaves free of aphids (control). Measurements were performed in ten repetitions on the same day within an hour.

The results for the respective parameters were processed by means of a one-way analysis of variance, and the Duncan test was used to separate the groups of means (α = 0.05).

RESULTS

Field observations

Living specimens of a sexual generation of *T. nigroantennatus* were observed from October 2023 to January 2024. Both oviparous females and males (Fig. 1B) were recorded from late October. The aphids (mostly oviparous females and females of the viviparous generation) had infested the upper sides of the leaves, causing serious defoliation. Later, the density of the population increased, causing the drying of these leaves (Fig. 1C). Copulating pairs (Fig. 1D) were observed from the beginning of November. The sex ratio was strongly female-biased, estimated as 10:1. Eggs, firstly bright yellow and then dark brown, were recorded hidden in the leaf sheaths of the host plant from the middle of November (Fig. 1E). One oviparous female produced between four to seven eggs. Despite temperatures of around –10°C, live oviparous females were still observed at the beginning of January 2024. The lowest temperature the eggs were exposed to during the 2023-2024 season was –16°C. The eggs successfully overwintered, and the hatching stem mothers were observed at the beginning of March 2024.

Observations of live oviparae in January 2024 were undoubtedly influenced by daily temperature fluctuations and the partial cover of the host plant. Generally, the season from October 2023 to March 2024 in western Poland was warmer than average (Tab. 1). Throughout this period, temperatures remained above the norm, with milder conditions persisting even during the traditionally colder months. October 2023

Table 1. Comparison of average monthly temperatures (October 2023–March 2024) with 2018–2023 and multi-year deviation in western Poland

Month	Average monthly temperature (°C) in 2023/2024	Average monthly temperature (°C) from 2018–2023	Deviation from average multi-year temperature
October	11.5	11.5	0.0
November	4.8	5.7	–0.9
December	2.8	2.1	+0.7
January	0.6	1.8	–1.2
February	6.3	2.3	+4
March	7.9	4.5	+ 3.4

began with higher-than-usual temperatures, extending warmth further into autumn. As winter progressed through November and December, temperatures remained unseasonably warm, with fewer cold snaps. January 2024, typically the coldest month, experienced relatively mild conditions. Daytime highs frequently rose above freezing, while nightly lows rarely dipped to extreme cold, with only a relatively short cold spell. This trend of warmer temperatures continued into February 2024. By March 2024, the transition to spring was smoother and earlier than usual, with warmer days arriving sooner. The milder winter was associated with an earlier onset of the growing season.

Morphology

Description – oviparous female (Figs 2–3, Tab. 2). Color in life: yellow, with brown dorsal sclerites, pale antennae and legs and red eyes (Fig. 2A).

Pigmentation of cleared specimens on slide: thorax and abdomen colorless with distinct darkened dorsal sclerites and dusky head, antennae (without basal part of ANT III), legs and siphunculi (Fig. 2B).

Morphometric characters: body oval with end of abdomen elongated, constituting 1/3–1/4 of the body length (Fig. 2C). Front of head convex. Head with two pairs of anterior pointed discal setae, each measuring 0.07–0.08 mm in length, and one pair of posterior pointed discal setae, each measuring 0.01–0.02 mm in length. Median protrusion on frons, epicranial suture and antennal tubercles developed. Compound eyes are large, with triommatidia. Clypeus with large nose-like processus (Fig. 2D–E). Six-segmented antennae, covered with pointed, short, almost colorless setae that are never longer than the basal articular diameter of antennal segment III. Antennal segment I large, rectangular. Antennal segment II square shaped. Antennal segments III-V of the same width. Antennal segment IV is slightly longer or as long as antennal segment V. Antennal segment V is always shorter than antennal segment VI. Antennal segment V with one rounded and ciliated primary rhinarium near the apex (Fig. 3A). Base of antennal segment VI with one elongated and ciliated major rhinarium and 4–6 small accessory rhinaria situated around the major rhinarium (Fig. 3B). ANT 0.57–0.79×body length (BL). PT 1.05–1.38×BASE; other antennal ratios: VI:III 0.84–1.00, V:III 0.54–0.69, IV:III 0.57–0.74. ANT I with 2–3 setae, ANT II with 2–3 setae, ANT III with 12–13 setae, ANT IV with 6–7 setae, ANT V with 2–3 setae. Base of antennal segment VI with one, short pointed seta, processus terminalis (PT) with 4 basal and 1 apical setae. Rostrum very short, reaching fore coxae. Apical rostral segment (ARS) blunt, with 4 accessory setae, 0.24–0.28×ANT III and 0.90–1.00×second segment of hind tarsus (HT II). Thorax with large, dorsal sclerites. Fore coxae enlarged. Distal end of tibiae with rows of small spinules and 2–3 rastral spines. Hind tibiae swollen with 45–56 oval or irregular scent plaques (pseudosensoria) on almost whole length of tibiae, except of the distal part (Fig. 3C–E). First tarsal segment with 4 setae. Empodial setae spatulate. Abdominal tergites membranous, tergite I with large, oval marginal sclerites and teardrop-shaped spino-pleural sclerites, tergites II–VI with large, oval marginal

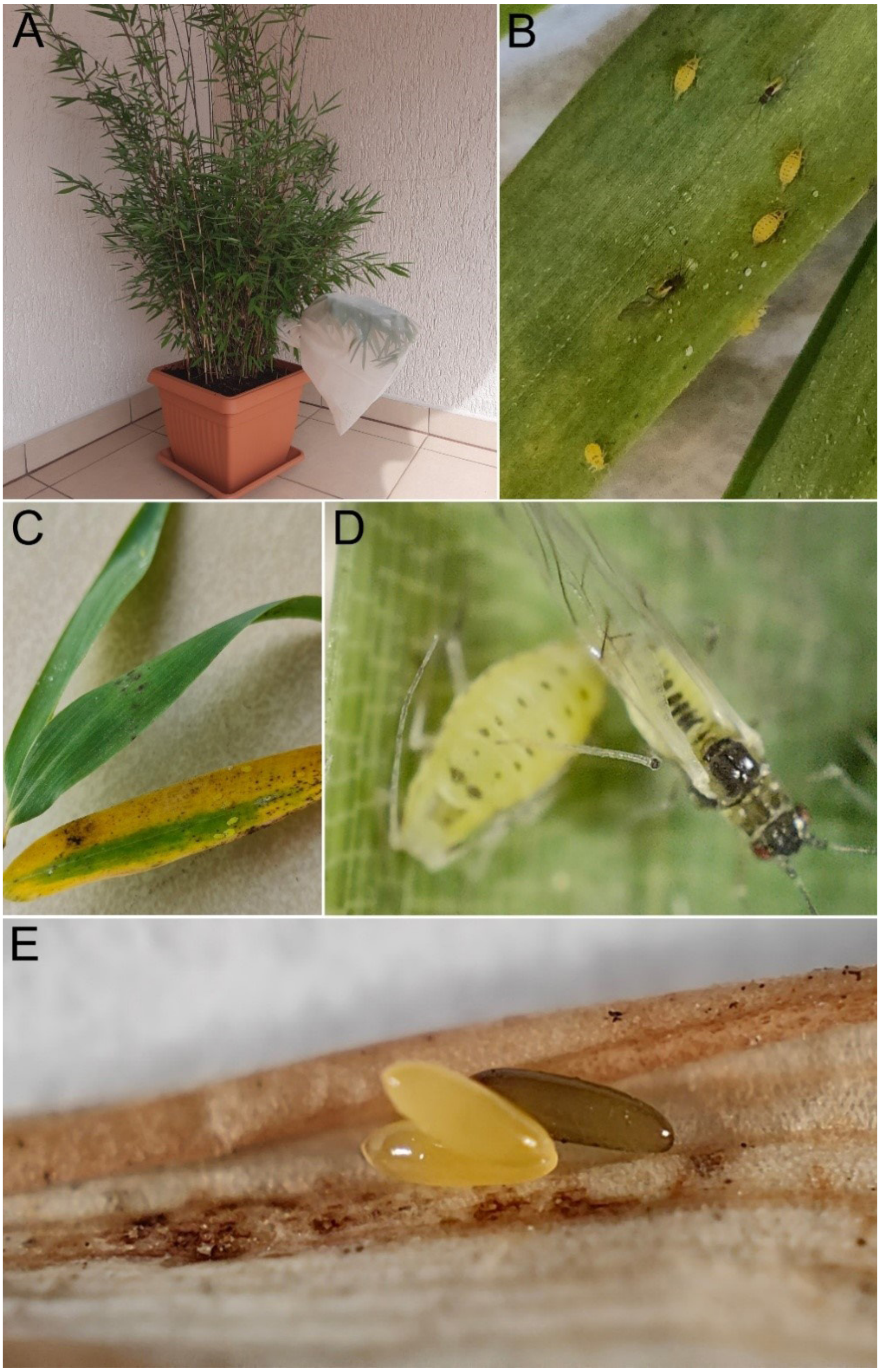

Fig. 1. *Fargesia nitida* 'Jiuzhaigou', the host plant of *Takecallis nigroantennatus* (A) with winged males and oviparous females observed from late October (B). In the late autumn, infested leaves were yellow and curled with edges covered by sooty mold colonies (C). Copulating pairs were observed from the beginning of November (D). Eggs, firstly bright yellow and then dark brown, were recorded hidden in the leaf sheaths of the host plant from the middle of November (E)

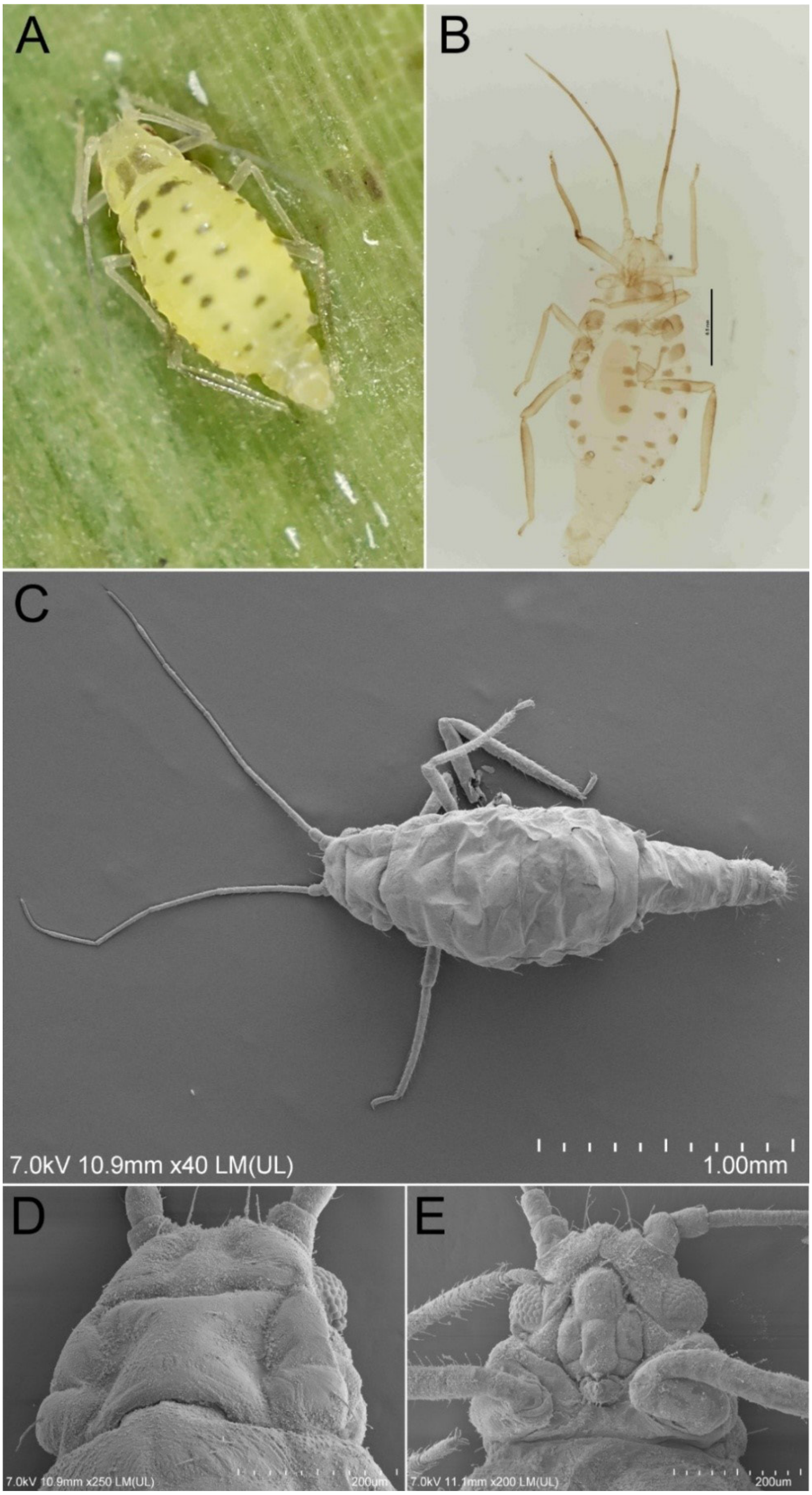

Fig. 2. Oviparous female of *Takecallis nigroantennatus* – living (A) and mounted (B) specimens. SEM of the whole specimen (C), dorsal (D) and ventral (E) side of the head, clypeus with visible large nose-like processus

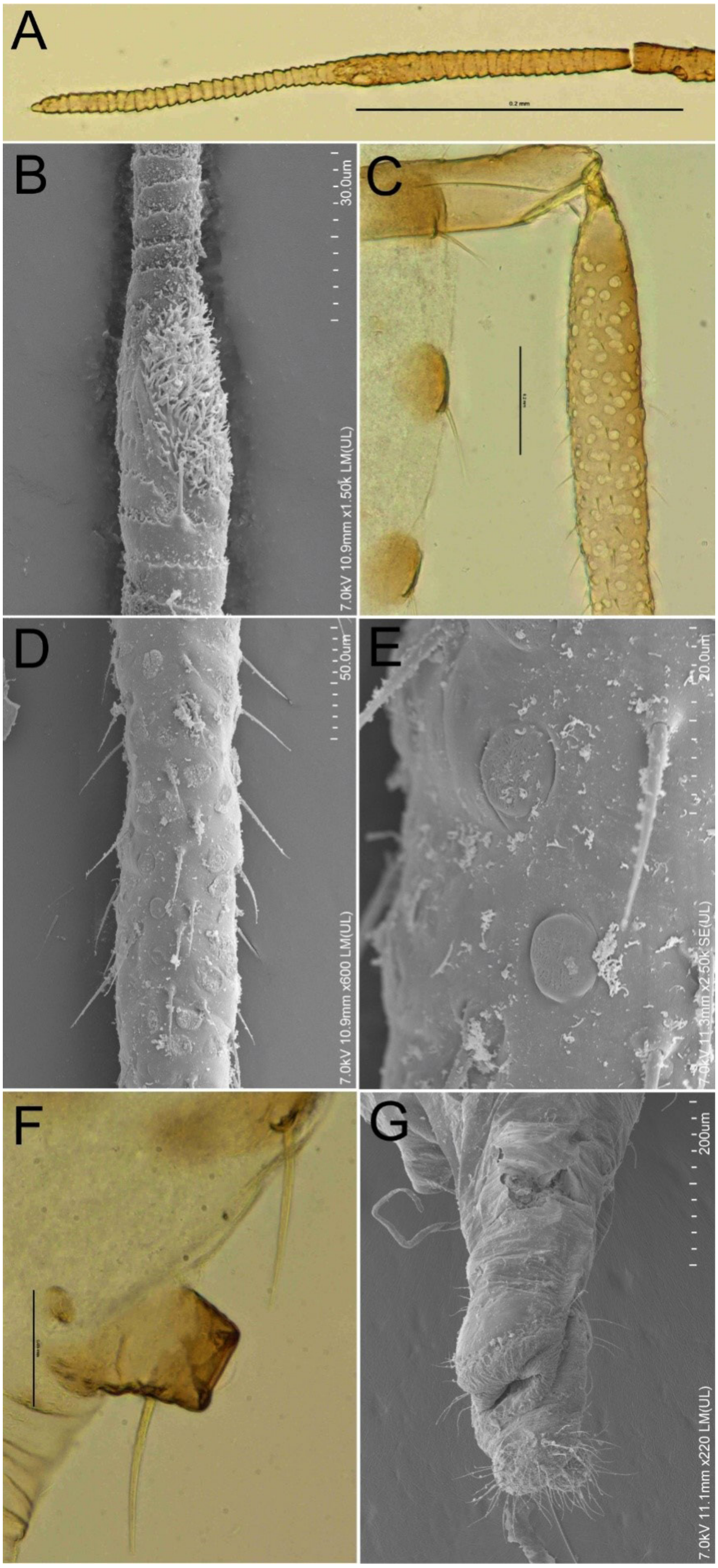

Fig. 3. Oviparous female of *Takecallis nigroantennatus* – antennal segment VI (A), base of antennal segment VI with major and accessory rhinaria (B), part of hind tibia with numerous oval or irregular scent plaques (pseudosensoria) (C–E), truncate siphunculus with single seta (F), elongated end of abdomen (G). A, C, F – LM; B, D, E, G – SEM

Table 2. Measurements of oviparous females of *T. nigroantennatus* (n = 5)

No.	Body	Antenna	Antennal segments								ARS	HTII
			I	II	III	IV	V	VI BASE	VI PT	BASE + PT		
1	1.71	1.28	0.05	0.07	0.38	0.22	0.22	0.15	0.19	0.34	0.1	0.1
2	1.59	1.26	0.07	0.06	0.37	0.24	0.22	0.13	0.18	0.31	0.09	0.1
3	2.03	1.33	0.07	0.06	0.35	0.26	0.24	0.17	0.18	0.35	0.09	0.1
4	2.06	1.18	0.06	0.06	0.35	0.20	0.20	0.13	0.18	0.31	0.1	0.1
5	1.69	1.32	0.06	0.07	0.37	0.26	0.20	0.16	0.20	0.36	0.1	0.1

Table 3. Measurements of winged males of *T. nigroantennatus* (n = 3)

No.	Body	Antenna	Antennal segments								ARS	HTII
			I	II	III	IV	V	VI BASE	VI PT	BASE + PT		
1	1.38	2.26	0.07	0.07	0.73	0.48	0.44	0.25	0.22	0.47	0.08	0.10
2	1.22	1.97	0.07	0.06	0.65	0.40	0.33	0.20	0.26	0.46	0.07	0.09
3	1.30	2.35	0.08	0.07	0.72	0.51	0.45	0.27	0.25	0.52	0.07	0.09

and spinal sclerites, pleural sclerites inconspicuous. Tergite VII with small, rounded marginal, pleural and spinal sclerites, tergite VIII without sclerites. Sclerites with one, blunt seta each, marginal ones measuring 0.06–0.08 mm in length, spinal ones measuring 0.03–0.04 mm in length. Siphunculi short, truncate, with surface smooth and single marginal seta measuring 0.07–0.09 mm in length, situated half the length of siphunculi, without flange (Fig. 3F). Cauda broadly rounded, with 10–16 setae. Anal plate bilobed, each lobe with 18–21 setae (Fig. 3G).

Description – winged male (Figs 4–5, Tab. 3). Color in life: yellow, with black head, thorax, dorsal spino-pleural cross-bars and genitalia. Antennae black, except for the antennal segments I–II and the very base of segment III, which are pale (Fig. 4A). Dusky legs, siphunculi, wing veins, pterostigma. Red eyes. The same coloration is clearly visible in the freshly fixed specimen (Fig. 4B).

Pigmentation of cleared specimens on slide: brown head, thorax, dorsal sclerites, genitalia, dusky antennae (without basal part of ANT III), legs, siphunculi, wing veins, pterostigma (Fig. 4C).

Morphometric characters: elongated body. Front of head convex. Head with 2 pairs of anterior and 2 pairs of posterior very short and pointed discal setae, median protrusion on frons developed, epicranial suture and antennal tubercle developed. Compound eyes are large, with triommatidia. Clypeus with large nose-like processus (Fig. 4D). Antennae 6-segmented, covered with pointed, short, almost colorless setae that are never longer than the basal articular diameter of antennal segment III. Antennal segment I large, square-shaped. Antennal segment II rectangular. Antennal segment III is slightly wider than antennal segment IV–V. Antennal segment III is the longest. Antennal segment IV is longer than antennal segment V. Antennal segment V is always shorter than antennal segment VI.

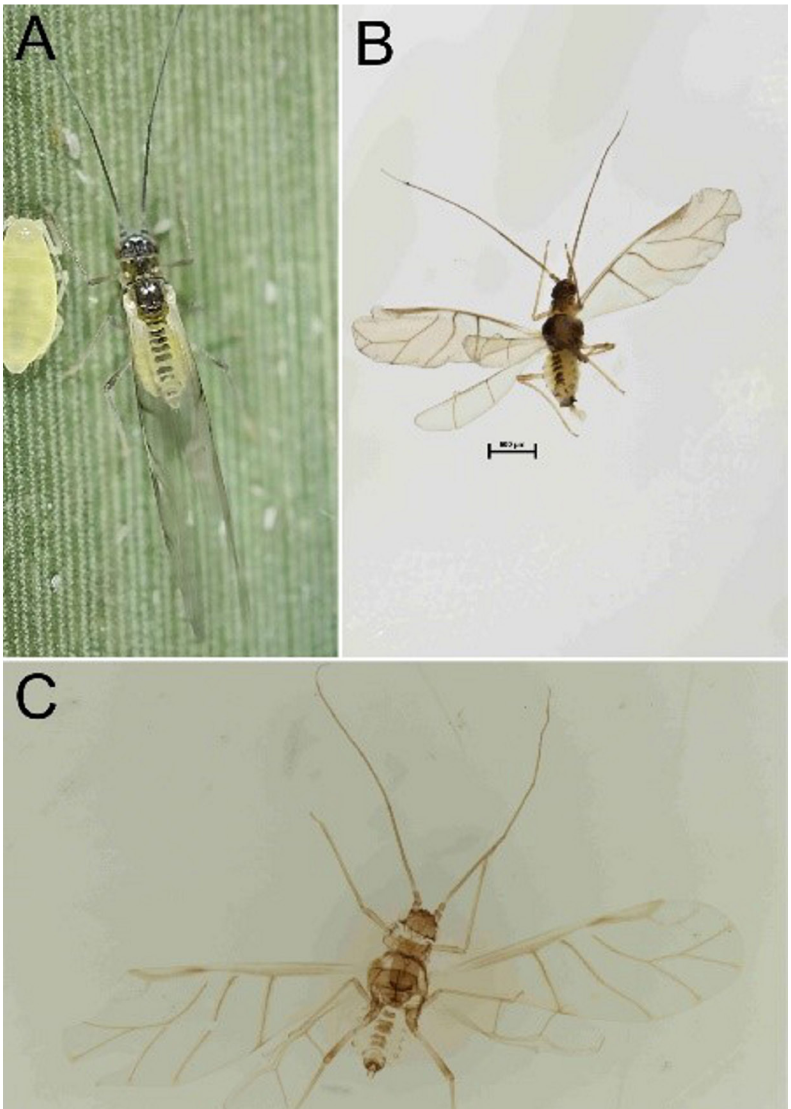

Fig. 4. Winged male of *Takecallis nigroantennatus* – living (A), fixed in 70% ethanol (B) and mounted (C) specimens observed in the light microscopy. SEM of the ventral side of the whole specimen (D)

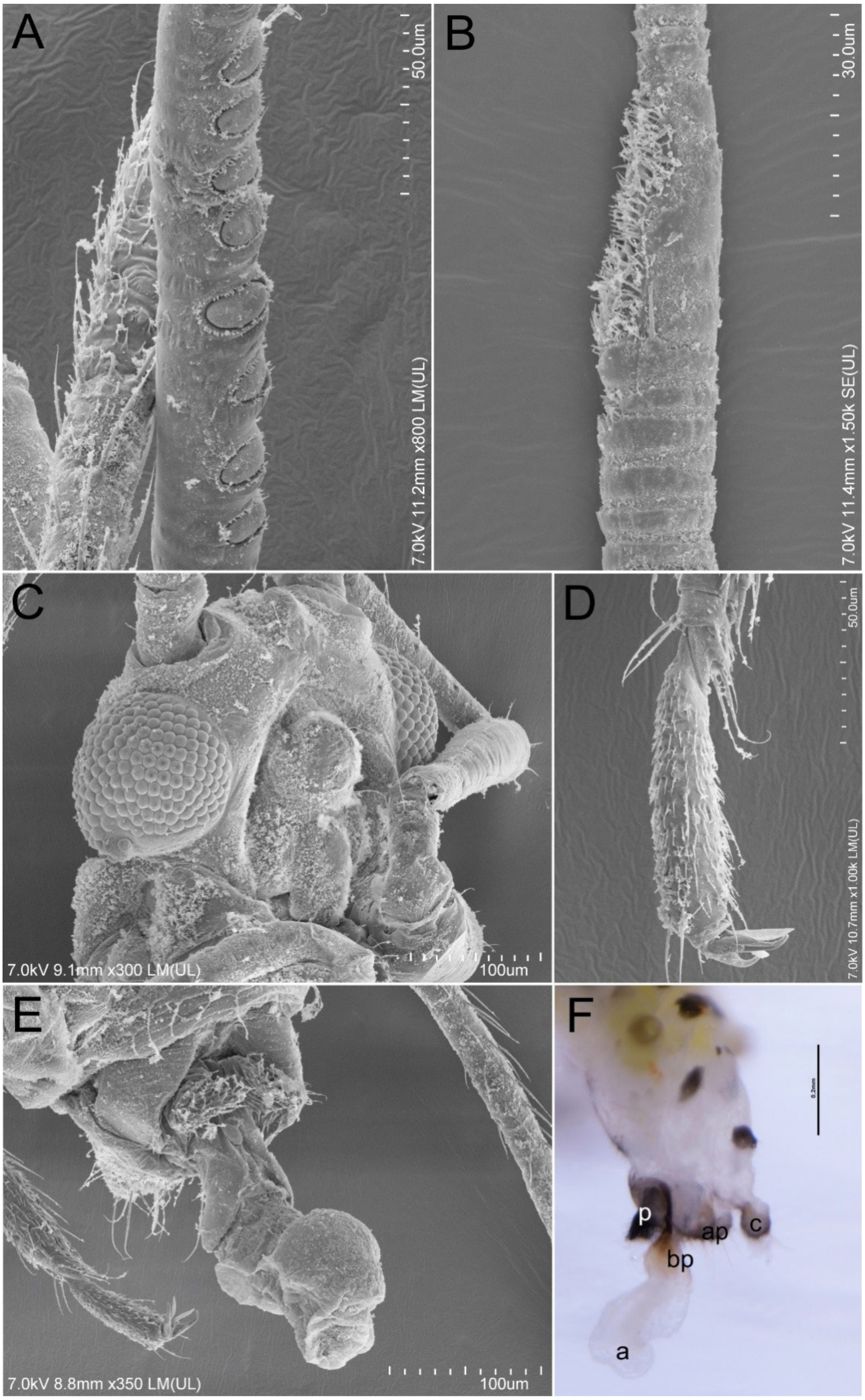

Fig. 5. Winged male of *Takecallis nigroantennatus* — antennal segment III with transversely elliptical ciliated secondary rhinaria (A), base of antennal segment VI with major and accessory rhinaria (B), ventral side of the head, clypeus with visible large nose-like processus (C), hind tarsus (D), ventral view of genitalia (E), lateral view of genitalia (F); p – parameres, bp – basal part of phallus, a – aedeagus, ap – anal plate, c – cauda. A–E – SEM, F – LM

The base of antennal segment VI is almost as long as processus terminalis. Antennal segment III with 17–19 transversely elliptical ciliated secondary rhinaria distributed on the whole length of the segment (Fig. 5A). Antennal segment IV without secondary rhinaria. Antennal segment V with three, rounded and ciliated primary rhinaria near the distal part of the segment. The base of antennal segment VI with 1–3 rounded and ciliated primary rhinaria, one elongated and ciliated major rhinarium and 3–4 small accessory rhinaria situated around the major rhinarium (Fig. 5B). ANT 1.61–1.81×BL. PT 0.88–1.30×BASE; other antennal ratios: VI:III 0.64–0.72, V:III 0.51–0.62, IV:III 0.62–0.71. ANT I with 2–3 setae, ANT II with 1–2 setae, ANT III with 8–12 setae, ANT IV with 3–6 setae, ANT V with 1–2 setae. The base of antennal segment VI with one, short pointed seta, processus terminalis with 4 basal and 1 apical setae. Rostrum is very short, reaching fore coxae (Fig. 5C). Apical rostral segment blunt, with 4 accessory setae, 0.10–0.11×ANT III and 0.78–0.80×HT II. Thorax sclerotized. Fore coxae enlarged. Distal end of tibiae with rows of small spinules and 2–3 rastral spines. First tarsal segment with 4 setae. Empodial setae spatulate (Fig. 5D). Forewings typical with a normal venation, radius curved, media with three branches. Hind wings have two oblique veins. Dorsal abdominal tergites I-VII with spino-pleural cross-bars, each with a pair of short, pointed seta measuring 0.01–0.02 mm in length; marginal seta of similar length. Tergite VIII without scletites, with setae measuring 0.03–0.04 mm in length. Siphunculi short, truncate, with surface smooth and single marginal seta measuring 0.01–0.02 mm in length situated half the length of siphunculi, without flange. Cauda knobbed with 5–8 setae. Anal plate bilobed, each lobe with 6–8 setae. Parameres large, triangular, with numerous long setae on the whole surface. The basal part of phallus long, spatulate, with few setae. Aedeagus long, with a distal part about two times wider than its basal part (Fig. 5E-F).

MATERIAL EXAMINED

SA02-367-04-003 *Takecallis nigroantennatus*, two oviparous females, Poznań, Poland, 29.X.2023, *Fargesia nitida* 'Jiuzhaigou', B. Borowiak-Sobkowiak leg.;

SA02-367-04-004 *Takecallis nigroantennatus*, three oviparous females, Poznań, Poland, 10.XI.2023, *Fargesia nitida* 'Jiuzhaigou', B. Borowiak-Sobkowiak leg.;

SA02-367-04-005 *Takecallis nigroantennatus*, three alate males, Poznań, Poland, 29.X.2023, *Fargesia nitida* 'Jiuzhaigou', B. Borowiak-Sobkowiak leg.

Chlorophyll fluorescence measurements

A significant impact of sexual generation feeding on the physiological condition of plants was demonstrated. The initial fluorescence (F0) significantly deteriorated compared to the control (Tab. 4). It was shown that under the influence of *T. nigroantennatus* feeding on the *Fargesia nitida* 'Jiuzhaigou' leaves, specific energy flows deteriorated: the flow of the stream of photons absorbed by the chlorophyll molecules of the PSII antennas expressed as RC (ABS/RC), the flow of retained (QA-reducing) photons in PSII expressed as RC (TR0/RC), electron transport rate through one active reaction center (RC) (ET0/RC) (Tab. 4).

Table 4. The influence of a sexual generation of *T. nigroantennatus* feeding on selected mean chlorophyll fluorescence parameters in *Fargesia nitida* 'Jiuzhaigou' leaves. Duncan test was performed at the significance level α = 0.05

	F_0	ABS/RC	TR_0/RC	ET_0/RC
Control	5398.3 a	1.181 a	0.888 a	0.521 a
Infested	6232.4 b	1.115 a	0.847 b	0.468 b

DISCUSSION

The unintentional human-assisted movement of invertebrate plant pests between countries is a pressing concern for global agriculture, ecosystems, and economies [Smith et al. 2007, Hulme 2021, Fenn-Moltu et al. 2023]. Among these pests, aphids are notorious for their ability to rapidly spread and cause significant damage to a wide range of crops and natural vegetation [Blackman and Eastop 2000]. Bamboo, a group of perennial grasses belonging to the subfamily Bambusoideae, is renowned for its ecological, economic, and cultural significance worldwide. Spanning diverse habitats ranging from tropical rainforests to temperate woodlands, bamboo forests play a pivotal role in ecosystem functioning, providing habitat for numerous species, regulating water cycles, and mitigating soil erosion [Ben-zhi et al. 2005]. Ornamental bamboo, valued for its aesthetic appeal and versatility in landscaping, is cultivated and traded globally, facilitating the inadvertent transport of associated pests, including aphids, to new areas. Originating from the Oriental region, the *Takecallis* genus, associated with bamboo, has seen several of its species become widely distributed. In particular, *T. arundicolens* is found in Europe, North Africa, and North America (USA). *T. arundinariae* has been introduced to Europe, North and South America, Australia, and New Zealand, while *T. taiwana* is known in Europe, North and South America, New Zealand, and South Africa. With some exceptions, the life cycle of these species is unknown, but they are likely to be anholocyclic when introduced [Blackman and Eastop 2024].

The findings presented in the current study shed light on several important aspects of the biology and ecology of the bamboo-feeding aphid genus *Takecallis*, particularly focusing on the newly described species, *T. nigroantennatus*, and its reproductive behavior in temperate climates. Through field observations and microscopic analysis, the study confirms the ability of *T. nigroantennatus* to reproduce holocyclically, revealing the presence of the previously unknown sexual generation, including oviparous females and winged males, observed in autumn. The observation of eggs hidden in the leaf sheaths of the host plant from the middle of November indicates an adaptation strategy for overwintering survival. Despite harsh winter conditions, with temperatures reaching as low as –10°C and the eggs being exposed to temperatures as low as –16°C during the winter season, the eggs successfully overwintered. This suggests a high degree of resilience and adaptability to cold temperatures in the species, allowing for the persistence of populations in temperate climates. However, the winter season from December 2023 to March 2024 in western Poland was notably warmer than average, reflecting a broader trend of mild winters observed across Europe in recent years. Throughout the winter months, temperatures frequently remained above long-term averages, with fewer cold spells. These warmer conditions created a more favorable environment for the sexual generation of *T. nigroantennatus* confirmed by the observation of live oviparous females at the beginning of January 2024. This resilience could have implications for the species' range expansion and colonization of new habitats in colder regions. The observed resilience of the species to survive and reproduce under cold conditions suggests that it may thrive in environments experiencing warming temperatures due to climate change. This adaptability could be particularly relevant in regions where ornamental bamboo distribution is common, as warming temperatures may facilitate the spread and establishment of this species in new habitats. As global warming continues to alter environmental conditions, there is the possibility of an expansion in the range and population size of this species, posing potential challenges for pest management and ecosystem dynamics in affected regions. The observation of hatching stem mothers at the beginning of March 2024 indicates the successful completion of the overwintering period and the initiation of the next generation. This timing of hatching aligns with the onset of favorable environmental conditions in early spring, allowing for the rapid population increase and colonization of host plants. Overall, these ecological observations underscore the species' ability to adapt to and persist in challenging environmental conditions, which have implications for its population dynamics and distribution, and potential impacts on the host plant community. Understanding these ecological dynamics is crucial for effective pest management and conservation efforts in affected ecosystems.

The current research also showed the impact of aphid feeding on the photosynthetic performance and overall health of the host, as evidenced by chlorophyll fluorescence measurements. Initial fluorescence (F0) significantly deteriorated compared to controls. This parameter indicates the appearance of stress in the plant under the influence of aphid feeding and possible degeneration of PS II [Calatayud et al. 2006, Gorbe and Calatayud 2012]. Gantner and Michałek [2010] noted the Fv/Fm relationship (change in the potential quantum efficiency of PSII) as a parameter sensitive to changes caused by aphid feeding. Those authors also showed that in the case of leaves damaged by aphids, this parameter deteriorated significantly, which demonstrated the impact of the biotic stress factor on the health and vitality of the plant. The current research has shown that the presence of the sexual generation and its feeding significantly affects the aesthetic value of the host plant, which is particularly noticeable in the late autumn.

By focusing on the strategic control of the sexual generation of the hardy bamboo aphid species, the cultivation of *Fargesia* spp. can be optimized. The primary goal of disrupting aphid sexual reproduction is to prevent the formation of overwintering eggs, which are resilient and become the source of new aphid populations in the spring. By reducing the number of eggs laid in the autumn, growers can effectively prevent early-season aphid infestations that typically require intensive management. To achieve this, regular inspection of bamboo plants, particularly in late summer and early autumn, is essential. Growers should look for signs of aphid activity, such as sticky honeydew, sooty mold, or the presence of winged aphids, which are intensely yellow. Accurate identification of aphid species and their reproductive stages is crucial, with a focus on detecting the sexually-reproducing individuals (males and oviparous females) during the autumn (from October to November), as these are critical for the formation of overwintering eggs.

Implementing control measures during the autumn, when aphid sexual reproduction occurs, is the most effective time to reduce the following season's aphid population. For instance, pheromone traps specifically designed to target aphid males can be used during this period to disrupt mating processes [Hardie et al. 1996]. Moreover, the use of biogenic amines has an impact on the lifespan of oviparous females [Wieczorek et al. 2021]. Biological control methods can also be employed, such as introducing or encouraging natural predators like ladybugs, lacewings, or parasitic wasps targeting aphid populations [Rakhshani et al. 2017, 2020]. Fungal pathogens, which can be applied during cooler autumn weather, are another option, as they can infect and kill aphids before they reproduce [Kim et al. 2013]. From an economic perspective, focusing pest control efforts on the autumn season can significantly reduce the need for more extensive and costly measures in the spring. This approach not only cuts down on chemical costs and labor but also enhances the economic viability of cultivating *Fargesia* spp. Furthermore, by reducing reliance on chemical pesticides through targeted autumn interventions, growers can contribute to more sustainable farming practices. This preserves beneficial insects and reduces environmental impact, ultimately leading to a healthier and more productive cultivation of bamboo species.

The discovery of *T. nigroantennatus*, associated with the recent introduction of frost-resistant varieties of *Fargesia* in European garden centers, highlights the role of human activities in the spread of alien and invasive aphid species [Wieczorek et al. 2024]. *Fargesia* sp. 'Jiuzhaigou I' was collected in Jiuzhaigou Park in northern Sichuan, China, by a German pharmacist Stephan Wagner. It was brought back to Europe as a seedling in 1986, where it was gradually propagated and started to become available for purchase by the public. The species is native to cool, forested mountains of China and unlike other clumping bamboo varieties, the *Fargesia* sp. 'Jiuzhaigou' is cold hardy down to –25°C [Gielis and Oprins 2009]. *T. nigroantennatus*, mostly associated with *Fargesia* species, has been documented in the UK, Belgium, and Poland, all within its introduced range [Dransfield and Brightwell 2024]. However, given its small size and similarity to other common species of the *Takecallis* genus found in Europe, coupled with the increasing availability of various varieties of *Fargesia* in trade, it is reasonable to anticipate that its distribution within the introduced area is more extensive than currently reported. Moreover, trade-mediated dispersal represents a substantial pathway for the introduction and establishment of this species, especially in the context of the discovery of the ability of this species to overwinter in the form of well-hidden eggs.

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