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Impact of warm weather events on prolongation of the life cycle of *Stomaphis* Walker (Hemiptera, Aphididae, Lachninae)

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Abstract: Termination of the life cycle of sexually reproducing aphids usually takes place in autumn, during October and November, in the climatic conditions of Central Europe. However, episodes of warm weather are suspected to trigger prolongation of the life cycle. Observations of *Stomaphis* spp. in early winter of 2013/2014 in southern Poland support this thesis. Surprisingly, adult females of two species were collected as late as early January and early March. High daily temperatures during this period were the probable cause of aphid survival, despite frosty nights. The possibility of the influence of warm weather episodes (higher temperature) on prolongation of the life cycle in aphids, or such episodes causing permanent parthenogenesis, is discussed.

Key words: Climate change, overwintering, permanent parthenogenesis

1. Introduction

Sexual reproduction is an adaptation in aphids for survival of winter in a moderate climate. Despite aphids being parthenogenetic throughout most of the year, at the end of the growing season, bisexual generation occurs under the influence of various environmental factors (e.g., photoperiod or temperature) (Simon et al., 2002). After copulation, the oviparous female lays overwintering eggs and the remnants of the colony are usually inhibited under the influence of unfavorable weather. This is the general mode of overwintering for holocyclic aphids (Dixon, 1998). Only anholocyclic species are able to survive winter as larvae or adults, usually well hidden underground in ant chambers (e.g., aphid genera *Trama* or *Forda*).

However, aphids are characterized by very high plasticity and may endure even in generally unfavorable conditions, taking advantage of even short periods of favorable weather. We present observations of two aphid species, an undetermined species of *Stomaphis* Walker, and *S. graffii* Cholodkovsky, when an event of warm weather prolonged survival of aphids in the winter season of the year, long after typical termination of the cycle.

2. Materials and methods

Both observations were conducted in winter 2013/2014. Unlike in other years, the autumn in 2012 and the winter in the beginning of 2013 were mild to warm in Central Europe; thus, interesting observations of the aphid life cycle could be conducted. Climatic conditions preceding both observations are presented in the Table, based on the internet database for the airport in Katowice (www.wetteronline.de). Generally, the mean temperature of the period from 01.11.2013 until collection of *Stomaphis* sp. was 2.15 °C warmer, and until collection of *Stomaphis graffii* was 2.50 °C warmer, than the mean values for the respective periods. Aphids were collected and preserved in 70% ethanol, and were later mounted following procedures described by Kanturski and Wieczorek (2012). The specimens were photographed using a Nikon Eclipse 600. Mounted specimens are deposited in the Aphidoidea collection of the Department of Zoology, University of Silesia, Katowice, Poland (UŚ).

3. Results

An unidentified species belonging to the genus *Stomaphis* (Lachninae) was observed on 05.01.2014 in Gliwice, Poland (50°35′N, 18°64′E), ca. 250 m a.s.l. Six adult apterous females were located under the bark of an older tree of *Salix* sp. associated with ants determined as *Lasius brunneus*. The aphids were very similar to *S. wojciechowskii* Depa, except for their smaller size (ca. 4.84–5.13 mm) and slightly different pattern of dorsal sclerotization in the posterior part of the abdomen, and they were most probably viviparous females (Figure 1a). Aphids were located in ant chambers built by ants under the bark at a height of about 1.5–2.0 m. They were not feeding, but

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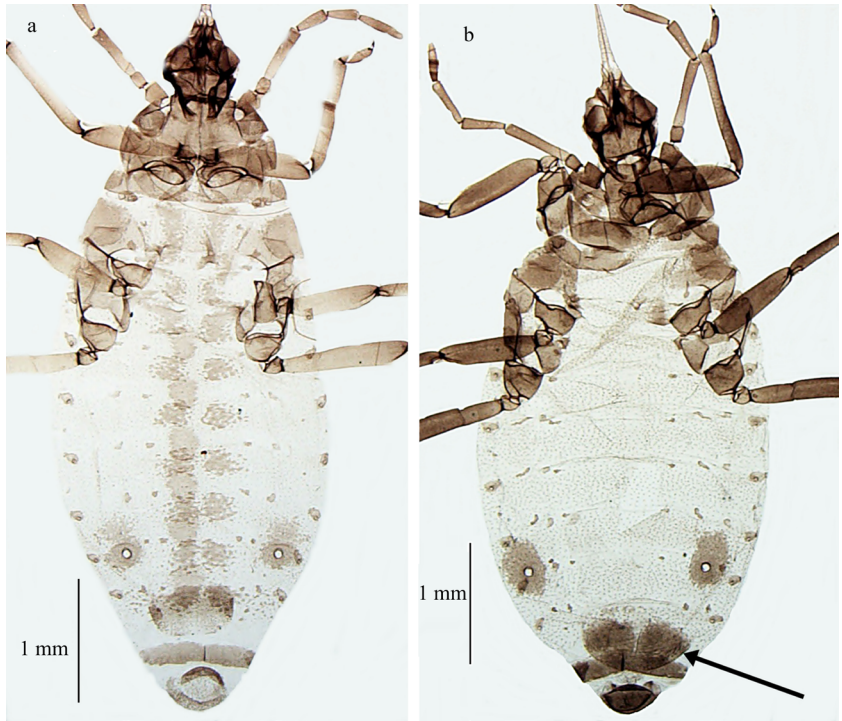

Figure 1. Apterous female of *Stomaphis* sp. collected on 05.01.2014 **(a)**; oviparous female of *S. graffii* collected on 01.03.2014 **(b)** (arrow indicates large subgenital plate, typical of oviparous females).

they were surrounded by ant workers palpating the bodies of the aphids. Additionally, a few laid eggs of aphids were present in these chambers. Eggs were darkish, indicating that they had been laid at least a few weeks earlier.

The second observation concerned *Stomaphis graffii*, which was found alive as late as 1 March 2014 (three apterous females) under the bark of *Acer pseudoplatanus* at the base of the trunk. The second observation was conducted in the vicinity of Bednarka (49°64′N, 21°35′E) near Gorlice, at the foothills of the lower Beskidy Mountains, ca. 400 m a.s.l., in southern Poland. In this instance, the aphids could be easily recognized after mounting as oviparous females, due to the very large subgenital plates (Figure 1b). Again, the size of these aphids was significantly smaller than that of normal oviparous females. In one specimen, there was still a single egg inside of the abdomen.

4. Discussion

Species of this genus are mostly holocyclic, with oviposition taking place in Poland during September and October (Depa, 2013). After this time, viviparous and oviparous females usually die from harsh winter conditions. In this case, adult females managed to survive up to 4 months longer than usual, probably due to higher temperatures, as presented in the Table.

Table. Climatic conditions preceding observations in the area of Katowice: mean monthly values, °C (www.wetteronline.de).

	Nov	Dec	Jan	Feb	Mar
1982–2012	3.6	–0.4	–1.5	–0.6	3.5
2013/2014	5.2	2.3	–0.1	3.7	6.8

It is generally accepted that the parthenogenetic mode of breeding in aphids is an adaptation to a rapid increase of abundance in changed habitats, e.g., after some kind of catastrophic event (Templeton, 1982), while sexual breeding is an adaptation to exploit various ecological niches and also serves as a form of overwintering in the developmental stage of an egg. The presented observations suggest that there is also high plasticity of sexual reproduction, which may last as long as appropriate weather conditions allow it to. It has been observed that warm winter weather may trigger changes in the life cycle of aphids in areas where their life cycle normally ends in autumn (Ruszkowska, 2007; Depa, 2010). If later oviposition increases the chances for the egg to survive winter (e.g., by shorter exposure to lower temperatures), then exploiting the warm weather events of late autumn

and early winter may also increase the number of fundatrices (stem mothers) in spring.

It is also possible that such warm weather events play a role in the development of the anholocycle of nonhost-alternating (monoecious) aphids. *Stomaphis acquerinoi* is known to be monoecious and anholocyclic in the warm Italian climate (Binazzi, 2001), and *S. cupressi* is suspected to be anholocyclic. The observed *Stomaphis* spp. had laid eggs, probably in October and early November; however, feeding larvae of *S. graffii* were observed as late as at the beginning of November (Depa, 2013). Worse feeding conditions in late autumn could result in smaller body size, and the lack of males (at least not observed with collected females) made laying fertilized eggs impossible (Dixon, 1987, 1998). However, observations suggest that even holocyclic aphids react immediately to favorable conditions and have significant resistance to low temperatures, as temperatures dropped below –15 °C for a few consecutive days preceding the collection of living aphids on 1 March. Oviparous females could have been born by sexuparae not later than at the beginning of November (Depa, 2013), which means they had survived for 4 months. It is known that some Lachninae may survive winter, but as viviparous females (e.g., *Trama*, *Cinara tujafilina*) (Durak et al., 2008) of permanently anholocyclic lines, not as oviparae. *Pterochloroides persicae* Cholod. (also a representative of Lachninae) is anholocyclic in warm climates, but can reproduce sexually and overwinters in the egg stage in colder climates (Wieczorek et al., 2013). Interestingly, both *Trama* and *C. tujafilina* are myrmecophilous and overwinter hidden in ant nests, usually underground. Thus, it is possible that ants also enabled *Stomaphis* to overwinter by creating a favorable environment for winter survival. Both observed species live under the bark of trees. This phenomenon—overwintering of oviparous females—has not been observed so far in holocyclic *Stomaphis*, despite detailed observation of the life cycle of *S. quercus* (Goidanich, 1958; Lorenz and Scheurer, 1998).

It seems that some aphids may literally be 'up to date' with weather and react immediately to favorable conditions and adapt their life cycle to ongoing weather conditions. Surviving the sporadically occurring episodes of warm weather may be difficult, yet under the influence of climate change leading to higher frequency of such events, parthenogenetic lineages of holocyclic *Stomaphis* species might occur also in areas with moderate climate. Certainly, more detailed observations are required on a broader spectrum of species of *Stomaphis* (and possibly other Lachninae) to determine whether our observation is only an exceptional case or is a demonstration of a more general ability of lachnine aphids to overwinter as adult morphs.

References

Binazzi A (2001). A new species of *Stomaphis* Walker from Italy, *S. acquerinoi* sp. n. (Aphididae Lachninae). Redia 84: 91–103.

Depa Ł (2010). Possibility of overwintering of *Aphis sambuci* Linnaeus, 1758 (Hemiptera, Aphididae) on secondary host in the climatic conditions of Poland. Aphids and Other Hemipterous Insects 16: 21–26.

Depa Ł (2013). Life cycle of maple-tree aphid *Stomaphis graffii* Cholodkovsky, 1894 (Hemiptera, Aphididae). Anim Biol 63: 313–320.

Dixon AFG (1987). Seasonal development in aphids. In: Minks AK, Harrewijn P, editors. Aphids: Their Biology, Natural Enemies, and Control. Volume A. Amsterdam, the Netherlands: Elsevier, pp. 315–320.

Dixon AFG (1998). Aphid Ecology: An Optimization Approach. London, UK: Chapman & Hall.

Durak R, Sadowska-Woda I, Machordom A, Borowiak-Sobkowiak B (2008). Biological and genetic studies of a Polish population of *Cinara tujafilina*. Bull Insectol 61: 159–160.

Goidanich A (1958). Le migrazioni coatte mirmecogene dello *Stomaphis quercus* Linnaeus, afide olociclico monoico omotopo. Bollettino dell'Istituto di Entomologia Università Bologna 23: 93–131 (in Italian).

Kanturski M, Wieczorek K (2012). Metody zbioru i preparowania mszyc (Hemiptera, Aphidoidea) w badaniach faunistycznych, taksonomicznych i molekularnych. Młodzi Naukowcy dla polskiej Nauki VIII, t. 5: 137–143 (in Polish).

Lorenz H, Scheurer S (1998) Biology and generation-order of *Stomaphis quercus* (Lachnidae) living on *Betula pendula* near Berlin, Germany. In: Nieto Nafria JM, Dixon AFG, editors. Aphids in Natural and Managed Ecosystems. León, Spain: Secretariado de publicaciones, Universidad de León, pp. 243–250.

Ruszkowska M (2007). Across the Transformation Life Cycle of *Rhopalosiphum padi* (L.) (Homoptera, Aphidoidea): Coevolution with Temperature. Poznan, Poland: Rozprawy Naukowe Instytutu Ochrony Roślin.

Simon JC, Rispe C, Sunnucks P (2002). Ecology and evolution of sex in aphids. Trends Ecol Evol 17: 34–39.

Templeton AR (1982). The prophecies of parthenogenesis. In: Dingle H, Hegman P, editors. Evolution and Genetics of Life Histories. Hamburg, Germany: Springer, pp. 75–101.

Wieczorek K, Kanturski M, Junkiert Ł (2013). The sexulaes of giant black bark aphid, *Pterochloroides persicae* (Hemiptera, Aphidoidea: Lachninae). Zootaxa 3626: 095–098.