SELECTED ELEMENTS OF THE BIOLOGY AND DEMOGRAPHIC PARAMETERS OF THE ANHOLOCYCLIC SPECIES *MYZUS ORNATUS* (LAING, 1932)

Roma Durak[1]*, Beata Borowiak-Sobkowiak[2]

[1] University fo Rzeszów, Department of Invertebrata Zoology
  Zelwerowicza 4, 35-601 Rzeszów, Poland

[2] University of Life Sciences in Poznań, Department of Entomology
  Dąbrowskiego 159, 60-594 Poznań, Poland

Abstract: *Myzus ornatus* (Laing, 1932) is an anholocyclic and polyphagous species. In winter it can continue developing by infesting decorative plants in greenhouses and houses. This paper verified the length of the pre-reproductive, reproductive and post-reproductive stages of wingless and winged female *M. ornatus* that develop in winter months. The total life span and female fecundity were determined. The basic demographic parameters of a *M. ornatus* population were calculated. Significant statistical differences between the post-reproductive phase, life span and fecundity of wingless and winged females are presented. During the development of one generation, the population increases 37.41 fold. The ability to develop in winter, in greenhouses and houses, means it is possible for *M.ornatus* to infest host plants early in spring, as soon as temperatures become advantageous for plant development.

Key words: *Hemiptera, Aphidinea, Myzus* sp.

INTRODUCTION

Only a low percentage of aphids are permanent anholocyclic, which means that their development omits sexual forms (no males). Those species are mainly related to warmer regions of the world, where the climate enables constant parthenogenesis throughout the year. In moderate climates, most aphids undergo a full developmental cycle (cyclic parthenogenesis, the seasonal presence of males) and anholocyclic aphid species are very few. Some aphid species can continue their development in greenhouses or houses. A number of these aphids, while infesting host plants in winter, feed on them until critical temperatures occur.

Myzus ornatus (Laing 1932) is an anholocyclic in the natural environment and a polyphagous species, which infests plant species mostly of Caryphyllaceae, Polygonaceae, Violaceae, Rosaceae, Primulaceae, Compositae families (Heie 1994). *Malva* sp., *Myosotis* sp., *Stellaria media* (Heie 1994) are also reported as host plants. However, in winter it infests *Cineraria* sp., *Fuchsia* sp., *Coleus* sp. and other decorative plants. *M. ornatus* is a vector of various plant viruses and can transmit PLRV and Y virus onto potatoes. The species was found in England in the 1930s and is currently widely spread throughout the world.

In Poland's climate most aphid species develop in a holocyclic manner. Only a few can develop in an anholocyclic way – by wintering in greenhouses, warehouses or houses, and their development is not known well. Therefore, it is of interest to know how the anholocyclic species develop in the winter months, what their population demographic structures are and whether those features are an adaptation to habitat enabling their spreading. The aim of the conducted study was to define the length of the developmental period, fecundity. and demographic parameters of *M. ornatus*.

MATERIALS AND METHODS

The species bionomy was studied from November to March 2008–2010. The aphids were reared on isolated sprouts of *Coleus* sp. at 16°C. The length of particular developmental stages (pre-reproductive, reproductive, post-reproductive) and fecundity of 30 wingless and 30 winged females were determined. At the pre-reproductive stage, the number of moults and the periods between consecutive larvae moults was described. At the pre-reproductive stage, the „waiting stage" was also described. The „waiting stage" occurred from the moment of the last moult to the moment of starting the reproductive stage, namely delivering larvae. The observations were conducted daily from the moment of the larva's birth till its death.

In order to check whether there are significant statistical differences between particular developmental stages

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*Corresponding address:
  rdurak@univ.rzeszow.pl

of winged and wingless specimens as well as their total life span and fecundity, the ANOVA analysis of variance or Kruskal-Wallis test was applied.

The study was conducted in controlled conditions in 2009. The aphids were reared in a climate chamber at a constant temperature of 20°C, with 70% relative humidity, and a photoperiod divided into 12 hours of light and 12 hours of night (12:12 LD). In order to determine demographic parameters of the population, 100 larvae were studied. The larvae and adult mortality was determined as well as overall life span. Population demographic parameters were calculated using the Birch method (1948):

a) intrinsic rate of increase – r_m,
b) net reproductive value – R_0,
c) finite rate of increase – λ,
d) mean generation time – T.

RESULTS

It was found, that in winter months in cage, both wingless and winged specimens develop in the *M. ornatus* population. The total life span for wingless parthenogenetic females of *M. ornatus*, observed during lab tests, was from 15 to 39 days, with c.25 days, on average (Fig. 1). The pre-reproductive stage was from 8 to 15 days long.

The „waiting stage", *i.e.* the period when females had completed their last moult, but did not give birth to larvae yet, lasted from 0 to 4 days. During the pre-reproductive period there were 4 moults, every 2.75, 2.25, 2.13 and 2.37 days, on average. The „waiting period" was about 1.37 days, on average.

The reproductive period lasted from 4 to 28 days, while the post-reproductive one from 0 to 5 days.

The average values for the developmental stages are presented in figure 1. Female fecundity was from 5 to 28 larvae, 16.2 larvae per female, on average.

The total life span of the winged parthenogenetic *M. ornatus* was from 15 to 19 days, c.16 days, on average (Fig. 1). The pre-reproductive stage took 8 to 10 days, and the „waiting stage" was 0 to 2 days long. During the pre-reproductive stage, 4 moults occurred every 3.0, 1.5, 2.0 and 3.5 days, on average. The reproductive stage took 3 to 9 days. No post-reproductive stage was recorded. The fecundity of winged females was 2 to 9 larvae, 6.2 per female, on average.

A statistical analysis did not prove any significant statistical differences between the pre-reproductive (H = 0.079; p > 0.05), „waiting" (F = 2.33; p > 0.05) and reproductive stages (F = 2.17; p > 0.05) for wingless and winged forms.
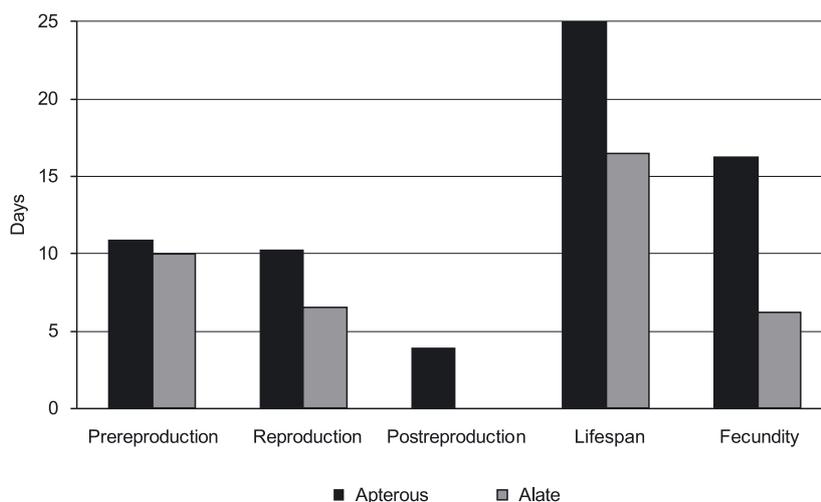

Fig. 1. Average length of developmental periods, average longevity, average fecundity of apterous and alate virginoparae from generations of *M. ornatus*
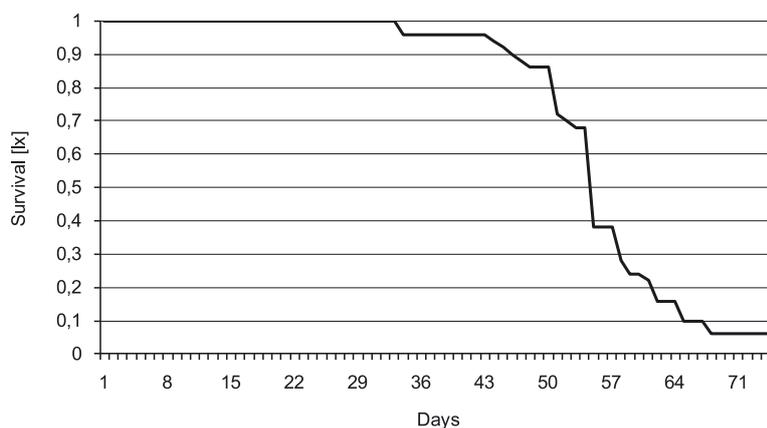

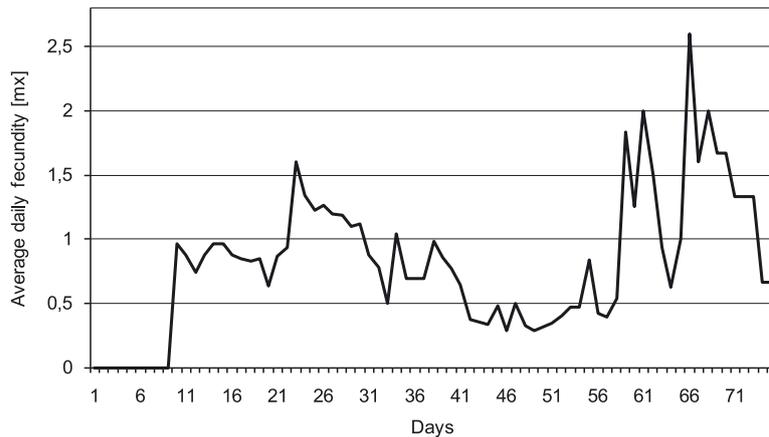Fig. 2. The survival of *M. ornatus* reared under controlled conditions

Fig. 3. The fecundity of *M. ornatus*, wingless virginoparae reared under controlled conditions

Significant statistical differences were proven between the post-reproductive stage (H = 12.52; p < 0.005), life span (H = 6.99; p < 0.005) and fecundity (H = 4.83; p < 0.05) of wingless and winged females.

In controlled conditions, the pre-reproductive stage took 9 days, and the reproductive one – 66 days. A post-reproductive stage did not occur. As many as 96% larvae of *M. ornatus* reached maturity on their 10th day of life (Fig. 2). The development of one generation took 75 days. The maximum daily fecundity was 2.6 larvae per female, on the 66th day of life (Fig. 3).

The calculated demographic parameters of the population proved that during the 24-hour period the population increased $\lambda = 1.18$ fold. One generation took T = 20.94 days to develop, and during that time the population increased $R_o = 37.41$ fold. The intrinsic rate of increase r_m, of *M. ornatus* population on *Coleus* sp. sprouts was 0.17.

DISCUSSION

M. ornatus is a species of poorly known bionomy (Blackman and Eastop 1984). In a moderate zone it can overwinters in greenhouses and houses. *M. ornatus* develops in an anholocyclic manner. The occurrence of both wingless and winged forms reported from that period suggests the permanent ability of this species to infest new host plants. The studies of another anholocyclic species, namely *Cinara tujafilina* (Del Guercio 1909) in the overwintering period, proved that only wingless forms could develop (Durak *et al*. 2006).

In insectarium studies, the winged and wingless *M.ornatus* developed similarly. The average lengths of developmental stages between those forms did not differ significantly. Wingless and winged forms of aphid generations that develop in summer most often differ in terms of the pre-reproductive stage, which takes longer, and the reproductive one, which is shorter for winged forms (Borowiak-Sobkowiak 2005; Borowiak-Sobkowiak 2006). In summer, winged morphs are also characterised by lower fecundity and shorter total longevity, resulting from the shortening or lack of a post-reproductive stage. Those features were also found for *M. ornatus* that develop in winter. The lack of differences in the larvae developmental stage and the reproductive one between morphs, is an adaptation to faster , dynamic infestation of new host plants.

The development stage of wingless *M. ornatus* females was similar in length to that reported for *M. persicae*. Horsfall (1924) also reports that the development of this species takes 23 days on average, the pre-reproductive stage is 10.8 days, and the reproductive one is 14.8 days long. Subsequent moults of *M. persicae* occurred every 2.0, 2.1, 2.3 and 2.0 days, which can be deemed similar to those reported for *M. ornatus*. However, unlike *M. ornatus,* during the pre-reproductive stage of *M. persicae,* no "waiting stage" was reported. Also van Emden *et al*. (1969) report that the larva of *M. persicae* develop quickly, taking from 10 to 12 days. Hazell *et al*. (2010) proved that the development period for *M. ornatus* larvae shortens as the temperature rises. On the other hand, the species is not resistant to high temperatures and it can develop in the range from 5 and 25°C. Temperatures above 25°C inhibit its development (Hazell *et al*. 2010). The ability for winter development in greenhouses and houses enables *M. ornatus* to infest host plants in spring, as soon as the temperatures favours plant development.

The intrinsic rate of increase r_m, is frequently used to define the impact of habitat factors on aphid population growth. The rate is dependent on temperature. *M. ornatus* lives in temperatures which are optimal for aphids. Such optimal conditions mean the intrinsic rate of increase was high, which implies the possibility for quick development in spring. The species also shows a high generational development rate and high reproductive value, comparable with the basic data quoted for other species, *e.g. Macrosiphum rosae* with R_o reaching 40.007 (Cichocka 2003), or *Aphis gossypi* which is considered a serious pest of cucumbers, with R_o equal 37.4 (Tykarska 2000). Those parameters, however, can be much higher for aphids, eg. *Amphorophora idaei* with $R_o = 80.67$ (Borowiak-Sobkowiak 2006). *M. ornatus* prefers a narrow range of temperatures. In summer, *M. ornatus* is exposed to temperatures exceeding its optimum. The negative impact of high summer temperatures above 25°C, will slow down the development rate and lower the survival rate of *M. ornatus*. Thus, climate warming might pose a threat for the species (Ha-

zell *et al*. 2010). On the other hand, permanent anholocyclic development in winter on decorative plants, recorded lengths of developmental stages, and presented demographic parameters indicate that the species may play an important part in *e.g.* transmitting viruses by infesting plants early in spring before holocyclic species start to develop.

REFERENCES

Birch L.C. 1948. The intrinsic rate of natural increase of an insect population. J. Anim. Ecol. 17: 15–26.

Blackman R.L., Eastop V.F. 1984. Aphids on the World's Crops: An Identification and Information Guide. 1st ed. Wiley, New York, 466 pp.

Borowiak-Sobkowiak B. 2005. Bionomy and ecology of *Aphis idaei* v.d. goot on raspberry. Aphids and Other Hemipterous Insects 11: 5–16.

Borowiak-Sobkowiak B. 2006. Bionomy and ecology of *Amphorophora idaei* (Börn.) on raspberry. J. Plant Protection Res. 46 (2): 169–180.

Cichocka E. 2003. Bionomia i parametry demograficzne populacji mszycy różano-szczeciowej (*Macrosiphum rosae* L.) [Biology and demographic parameters of *Macrosiphum rosae* L.]. Prog. Plant Protection/Post. Ochr. Roślin 43 (2): 565–568.

Durak R., Soika G., Socha M. 2006. An occurrence and some elements of ecology of *Cinara tujafilina* (del Guercio 1909) (Hemiptera, Aphidinea) in Poland. J. Plant Protection Res. 46 (3): 269–273.

Hazell S.P., Neve B.P., Groutides C., Douglas A.E., Blackburn T.M., Bale J. 2010. Hyperthermic aphids: Insights into behaviour and mortality. J. Insect Physiol. 56 (2): 123–131.

Heie O.E. 1994. The *Aphidoidea* (*Hemiptera*) of Fennoscandia and Denmark. V. Fauna Ent. Scand. 28: 1–239.

Horsfall J.L. 1924. Life history studies of *Myzus persicae* Sulzer. Pansylvania Agric. Agric. Exp. Station Bull. 185: 1–16.

Tykarska K. 2000. The development of *Aphis gossypii* Glover in field and in glasshouse. Aphids and Other Hemipterous Insects 7: 47–56.

van Emden H.F., Eastop V.F., Hughes R.D., Way M.J. 1969. The ecology of *Myzus persicae*. Annu. Rev. Entomol. 14: 197–270.