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THE OCCURRENCE OF *GASTROIDEA VIRIDULA* DEG. AND *GASTROIDEA POLYGONI* L. (*COL. CHRYSOMELIDAE*) ON *RUMEX CONFERTUS* WILLD. AS BIOLOGICAL REPRESENTATIVES OF WEED POPULATION CONTROL

DARIUSZ PIESIK

UNIVERSITY OF TECHNOLOGY AND AGRICULTURE, DEPARTMENT OF APPLIED ENTOMOLOGY
85-225 BYDGOSZCZ, KORDECKIEGO 20, POLAND
e-mail: piesik@mail.atr.bydgoszcz.pl

Abstract. Weeds are harmful organisms connected with human activities; therefore there is a need for their control. human development and mobility have caused on purpose or purely incidental introduction of plants, exotic very often, to new sites and ecosystems.
A dominating method of weed control is applying chemicals. However, chemical compounds are often of low selectivity, they also contaminate the environment and become ineffective quickly because of acquired resistance of treated organisms. The control of *Rumex confertus* Willd. and other weeds of the genus *Rumex* spp. is often not possible because of economical reasons. Large areas abundant in sorrel populations would require a large sum of money invested in expensive chemical control.
Biological methods of weed control look far more promising solution to this problem. *Rumex confertus* Willd. is a plant corresponding to criteria to qualify it as an object for biological regulation.
The objective of the study was to evaluate dynamic of population and development of the insects of the genera *Gastroidea* spp. (*Gastroidea viridula* Deg. and *Gastroidea polygoni* L.) occurring on *Rumex confertus* Willd.

Key words: biological control of weeds, *Rumex confertus* Willd., biological agent, *Gastroidea viridula* Deg., *Gastroidea polygoni* L.

I. INTRODUCTION

Mossy sorrel (*Rumex confertus* Willd.) that belongs to *Polygonaceae* family has recently spread out widely in Poland. This weed is a 1.5 to 1.8 m high perennial plant (Cavers and Harper 1964) yielding from 100 to 40,000 seeds (Cavers and Harper 1964). It blooms usually in July, August and September (Pawłowski 1921), but large individuals can produce seeds twice a year, i.e. in early and late summer period (Cavers and Harper 1964).

Rumex confertus Willd. occurs commonly in Poland (Trzcińska-Tacik 1963; Kornaś 1970; Rojecka 1960; Sowa 1962) and the world (Rechinger 1984; Valta 1973; Latowski 1993; Paspatis 1987). However, a clear expansion westward can be observed (Żukowski 1960; Kornaś et al. 1959).

Besides usual chemical components such as proteins, carbohydrates and lipids present in this plant also large amount of acidic oxalates was detected. Acidic taste of the plant makes it very attractive to animals (horses, sheep, ruminants) but consumption of large quantities may cause deadly poisoning.

Some authors have included the weeds of the genus *Rumex* spp. into the most dangerous non-cultivable plant of the world (Allard 1965).

Nevertheless, the exclusive use of pesticides is short-minded because of many reasons. Beside of its unquestionably effectiveness, this method discloses serious disadvantages. One of them is the selective creation of resistant biotypes, which are very difficult to control (Boczek 1996; Jędruszczak 1998; Marocchi 1989). Also chemicals change biochemical systems of agricultural plants and contaminate the environment (Boczek 1996), sometimes even destroying natural antagonists capable of limiting the host population under natural conditions.

Biological method with the use of insects, our allies is a good alternative to the pesticide treatments is (Kovalew and Zaitzew 1996; Watson and Wymore 1989).

Gastroidea spp., *Apion* spp., *Pegomya* spp., *Hypera* spp., *Mamestra* spp. groups are of special interest among the numerous species inhabiting *Rumex* spp. (Spencer 1980).

Unfortunately this way of destroying undesirable plants will not stop using the chemicals but it can be an important factor limiting the weeding. It can also play an important role in the integrated methods of plant protection (Labrada 1996).

II. METHODS AND AREA OF THE STUDIES

The experiments were carried out in 1997-1999 in natural site of *Rumex confertus* Willd. near Bydgoszcz – Fordon and Toruń at the Vistula River over the whole vegetation period.

The terrain experiments were divided into several group projects:

1. Studies using sampling with a scoop allowed to evaluate the composition and development of insect population. They were carried out over the whole experimental period from spring to autumn. The catching was performed once a week in 1998 and 1999, while in 1997 it was done once a fortnight. Each time 25 full strikes with entomological scoop were done (one full strike per one leaf rosette tuft), what resulted in 25 plants tested.
2. Studies using shaking insects off from the plants as a method of collecting samples. The material collected in this way was analysed in the laboratory and used for breeding. The sampling took place in 1997 and 1998. Observations of biology, the occurrence of insect and other species injuring the plants were performed over the whole plant vegetation period (May - September). Moreover, development stages were determined, what gave a picture of the number of generations over vegetation.
3. Overwintering of *Gastroidea viridula* Deg. was evaluated in this study. *Gastroidea viridula* Deg. is an insect causing the heaviest plant injury. *Rumex confertus* Willd. plants were put into pots placed in soil to simulate overwintering conditions as close as possible. Ten pots prepared this way were covered with isolators and than ten *Gastroidea viridula* Deg individuals were put into each of them. A number of overwintering beetles appearing for supplementary prey were evaluated in the following year.

The Toruń experiments were performed at Vistula River according to point 1, described for Bydgoszcz. Scooping as well as other observations were done over the whole vegetation period in ten-day intervals in 1998 and 1999.

Laboratory experiments were carried out in the Department of Applied Entomology, UTA, Bydgoszcz in 1997 and 1998.

The following assays were done in the laboratory:

1. Number of eggs laid down by the *Gastroidea viridula* Deg. females of the winter and the following generations were under investigation. The experiment was conducted with four replications on Petri dishes supplied with filter paper. The eggs were counted every day. Filter paper and leaves used by beetles were changed daily. The observations were finished at the moment of female's death.
2. Mortality rate of *Gastroidea viridula* Deg. was evaluated. The breeding was carried out from the egg to imagines stage under controlled conditions at about 25°C. Leaves with a known number of eggs were put into each of four replications. The hatched larvae were growing on Petri dishes with filter paper. Likewise the other breeding methods they were supplied with fresh food every day. The larvae were counted after slough.

III. RESULTS

Gastroidea viridula Deg. is a little larger insect than its relative *Gastroidea polygoni* L. The imago is about 6mm long. Its body and foreback is greenish or yellowish metallic shiny. The surface of the covers is strongly speckled. This is a very common species on the weeds of the genus *Rumex* spp.

Gastroidea viridula Deg. had three generations a year in Bydgoszcz environment (Fig. 1) more and more insects were leaving their winter site what is pictured on the graph.

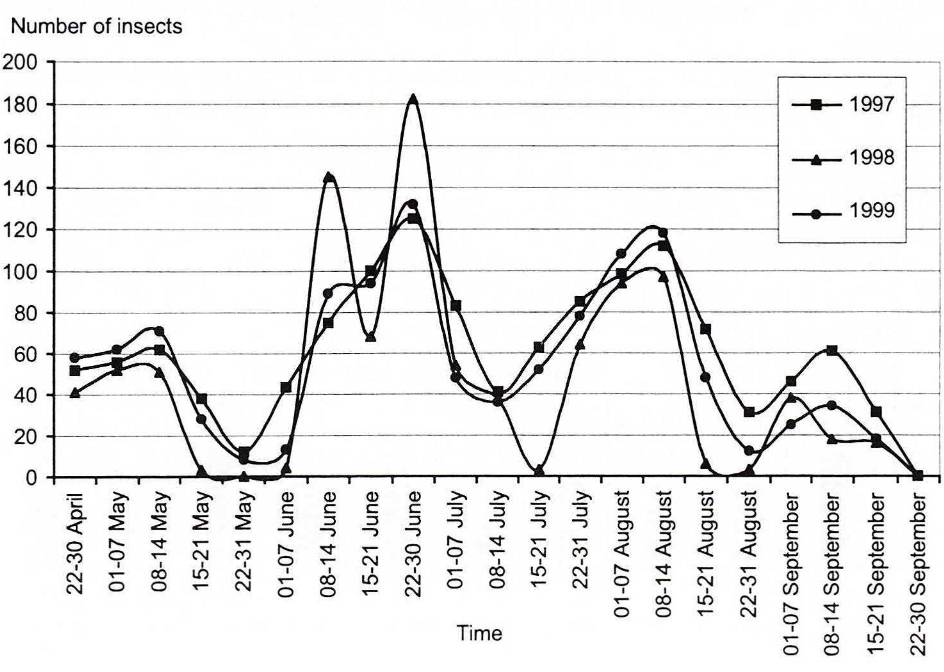

Fig. 1. Dynamic of population of *Gastroidea viridula* Deg. in Bydgoszcz region

Supplementary prey after overwintering lasted almost over the whole may. Copulation and laying eggs took place in this period.

The development of the first insect generation started at the beginning of June and it was over at the mid-July. Three years of experiment gave the same results. Analysis of this generation showed that imagines represented the species the most often in 1998, when one catching in the third decade of June gave not less than 180 individuals. Nevertheless, a decrease of population dynamics (15-21.06) meant neither vigour reduction nor the end of first generation growth. It was confirmed by the next abundant catching. Therefore, a decrease of number of species was probably associated with temporary unfavourable site conditions. Indeed, that measurement was taken under bad weather, a lot of rain and a lower temperature. Usually in such conditions insects often get numbed, they stop preying and look for a shelter.

The second generation occurred for a shorter period and its development was noted from mid-July to the third decade of August. The third generation was observed in September and occurred to be the least numerous. The highest number of caught individuals was 60 in 1997. At the end of this month the imagines of the third generation prepared for overwintering.

Overwintering rate of *Gastroidea viridula* Deg. was evaluated in 1998 and 1999. There were 10 replications analysed. The combination no. 8 appeared to have the highest number of survived insects (Fig. 2). Five insects were left alive. Considering all the isolators the mortality rate of the insect was 64%. This result should be seen as a small percentage, thus survival rate was high. For instance mortality rate ranging from 60 to 90% is accepted for *Chrysomelidae*. Therefore, the insects appeared to be well adapted for unfavourable winter conditions.

Gastroidea polygoni L. preyed on the leaves of plants of the family *Polygonaceae*. Injures were caused both by imagines and larvae, which eat out holes in leaves. Adult indi-

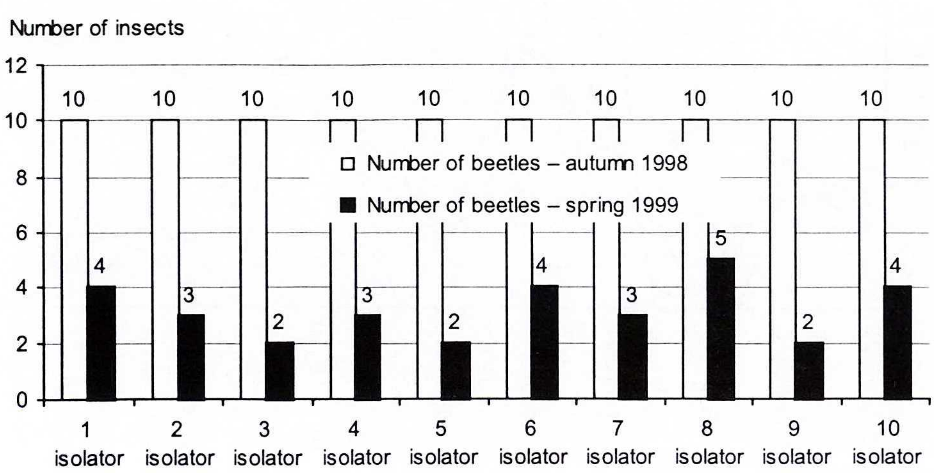

Fig. 2. Dynamic of population of *Gastroidea viridula* Deg. in Bydgoszcz region

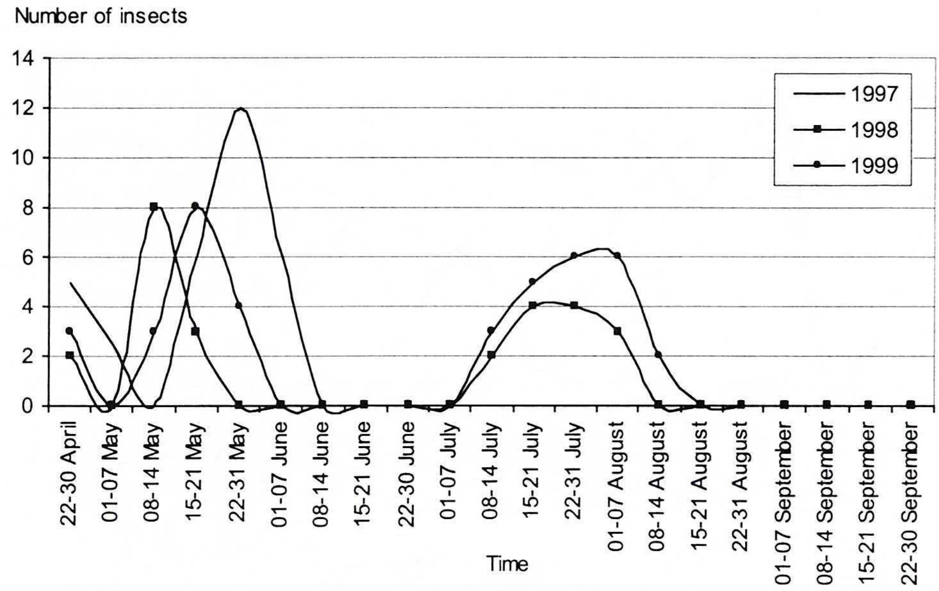

Fig. 3. Dynamic of population of *Gastroidea polygoni* L. in Bydgoszcz region

viduals are about 5 mm long. Their body is green, while the foreback is yellowish-red. This is a taxonomic feature, a good differentiation of both species. *Gastroidea polygoni* L. is a very common insect. However, its occurrence was not as abundant as of *Gastroidea viridula* Deg. described earlier. Two small generations were observed over the year populations (Fig. 3). Overwintering beetles had their supplementary prey at the end of April and beginning of May. Laying eggs took place at the same time. The first generation was growing from mid-May to mid-June. As shown on the figure the highest number of the beetles caught at once was 12 in 1997 and 8 in 1998 and 1999.

The second insect generation, by far less dynamic than the first one, grew in July and August. Only very few *Gastroidea polygoni* L. imagines were fished in these months on two following years (1998 and 1999). It is very interesting that this generation did not occur at all or was very small in 1997. At the beginning of September adult individuals prepared for overwintering. Likewise other *Rumex* spp. species, mossy sorrel is less attractive source of food for insects than polygonum plants of the *Polygonaceae* family.

As compared with other plant-eaters, *Gastroidea viridula* Deg. occurred very abundantly and it was capable to lower the weedy population caused by *Rumex confertus* Willd. near Toruń. It was noted in three generations (Fig. 4). The second site near Bydgoszcz confirmed these observations. The only difference between the two locations was the development time of overwintering and the first progenitor generation. In Bydgoszcz site the beetles were leaving their shelters in spring almost the whole May, while the corresponding time in Toruń seemed extremely short. The second generation was observed in mid-July in Bydgoszcz, while the corresponding moment in Toruń was by two weeks earlier. However, the differences disappeared at preying of the third generation.

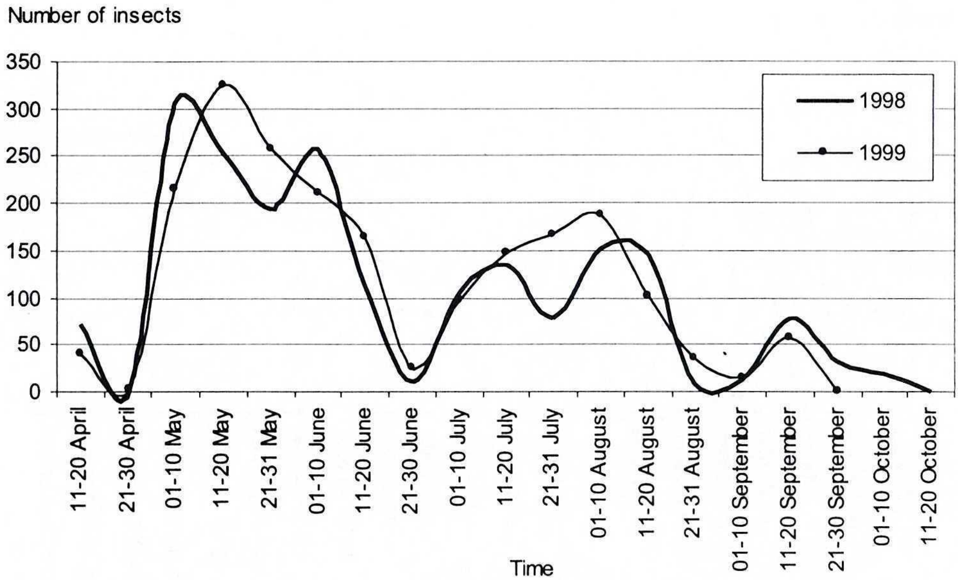

Fig. 4. Dynamic of population of *Gastroidea viridula* Deg. in Toruń region

The first generation observed in Toruń site was very large and it developed in May and June. Not less than 100 up to 300 individuals were catched per 25 scoop strikes in both years. Likewise the first generation, the second one inhabiting the plant for a long time was large. The imagines representing the third generation preparing for overwintering were by far less numerous. Their number never exceeded 100.

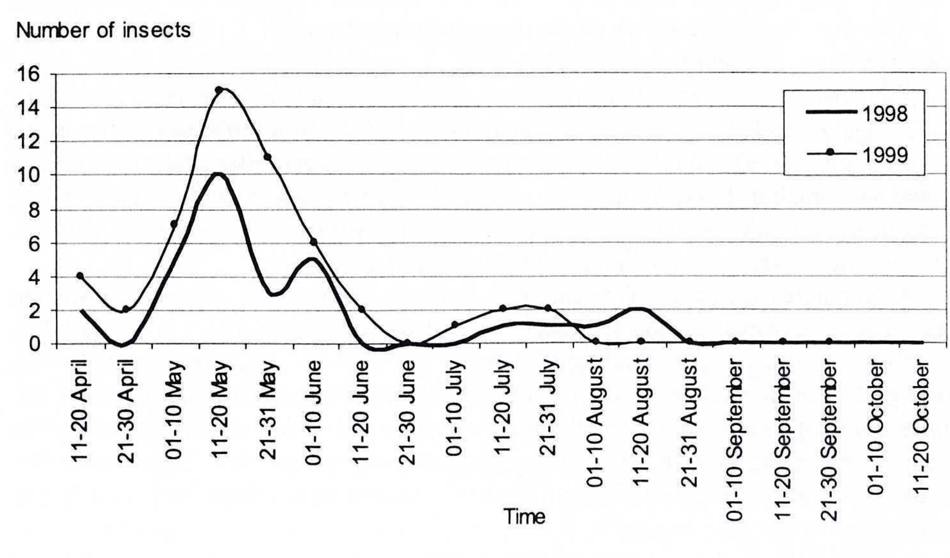

Fig. 5. Dynamic of population of *Gastroidea polygoni* L. in Toruń region

Gastroidea polygoni L. preyed on sorrel for two sequential generations (Fig. 5). The first one was more plentiful than the second. Two years of observations gave the same results. The development of insects took place in May and June. On the other hand the second part of May seemed to be more beneficial for this generation. There were 10 and 15 imagines caught in 1998 and 1999, respectively.

The second generation was less dynamic. The insects were observed on the plants very seldom, despite the occurrence time lasted for 4 weeks and 3 weeks in 1998 and 1999, respectively.

The results of the population and the occurrence time of *Gastroidea polygoni* L. are similar to those obtained for Bydgoszcz site, but the first generation in Toruń appeared a little earlier. The occurrence of two generations was noted for both regions.

Number or % of larvae? The larvae of both species (*Gastroidea viridula* Deg. and *Gastroidea polygoni* L.) were presented on Figure 6 and 7. According to the imagines percentage of both species 97.3% of the total larvae population were these of *Gastroidea viridula* Deg., while only 2.7% were those of *Gastroidea polygoni* L. Moreover, conside-ring the dynamics of *Gastroidea polygoni* L. imagines population over the three experimental years it can be assumed that the third generation is composed entirely of *Gastroidea viridula* Deg. representatives.

Hence, *Gastroidea* spp. larvae of the first generation hatched from eggs laid down by overwintering beetles (Fig. 6). Of course, their the highest numbers were noted at the periods of the lowest occurrence of adult individuals. The first larvae generation was growing from mid-May to mid-June, while the second and third one in July and at the end of August and at beginning of September, respectively. The sequential generations were less and lees dy-

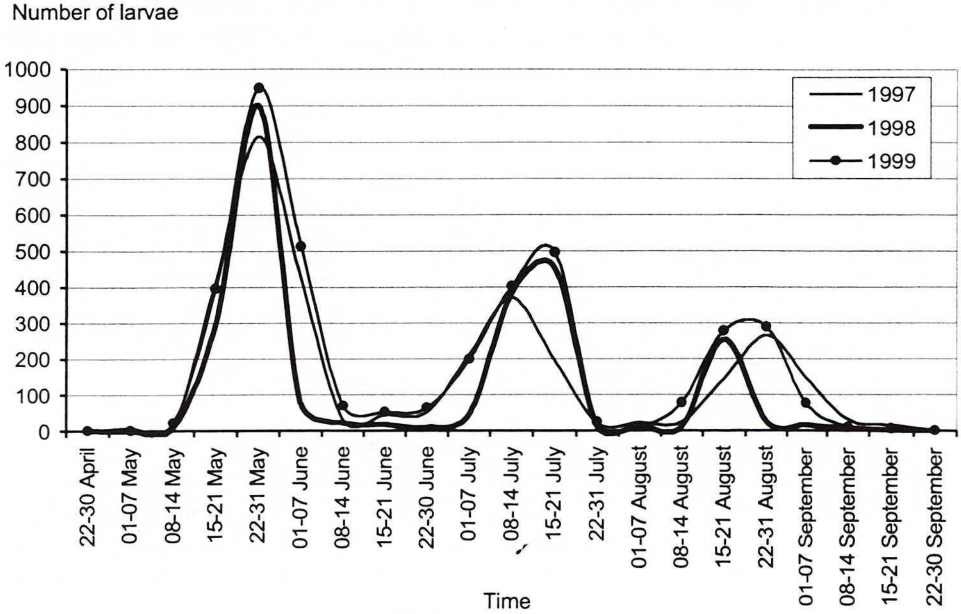

Fig. 6. Occurrence of larvae *Gastroidea* spp. in Bydgoszcz region

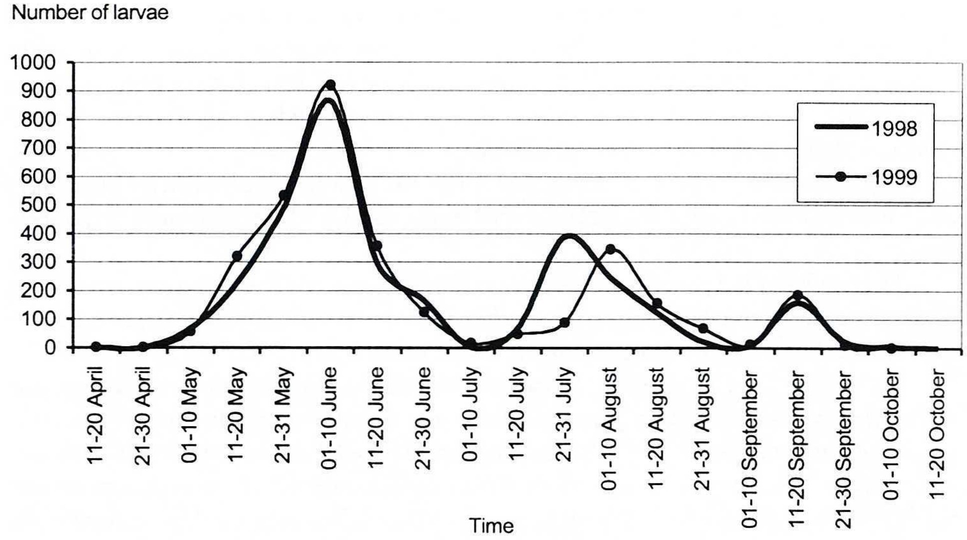

Fig. 7. Occurrence of larvae *Gastroidea* spp. in Toruń region

namic. The number of larvae of the first generation was the highest while the third generation represented the lowest number of larvae.

A clearly decreasing numbers of individuals of the three generations were observed for Toruń location. The second and third generations were by half less dynamic than the first one (Fig. 7). Perhaps the number of fished larvae was a little higher near Bydgoszcz, but in general no significant differences in the *Gastroidea* spp occurrence were noted for both regions.

Fertility and survival rate of *Gastroidea viridula* Deg., species the most common on *Rumex confertus* Willd. were studied at a constant temperature (25°C) and air humidity (about 80%). The observations concerned overwintering generation and two sequential generations.

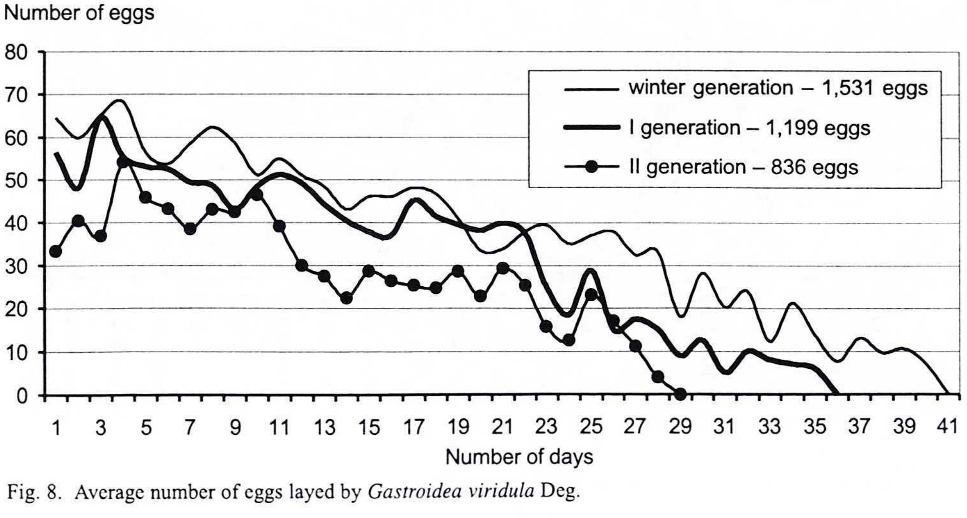

Fig. 8. Average number of eggs layed by *Gastroidea viridula* Deg.

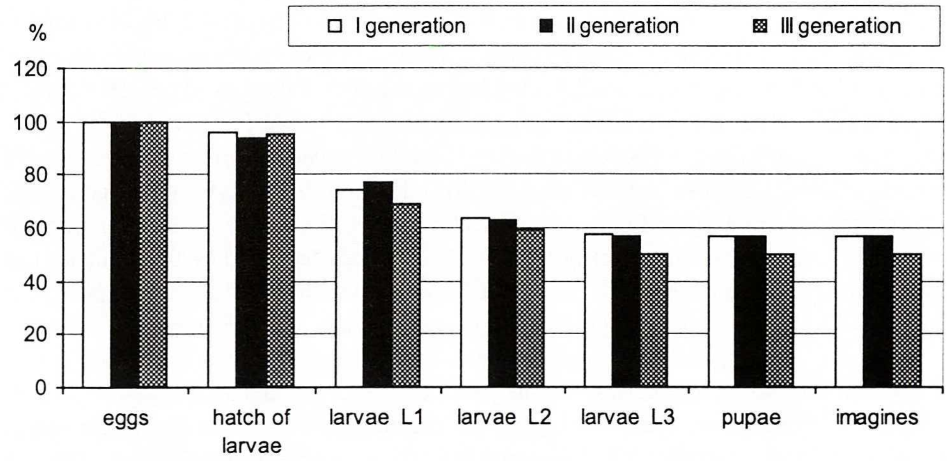

Fig. 9. Survival of *Gastroidea viridula* Deg.

The highest female fertility was observed in spring (Fig. 8). A single individual was lying about 1,530 eggs over the lifespan for 40 days. At the beginning their number in the layer fluctuated about 60. As time went by it was decreasing gradually to reach 35 eggs at the middle of the observation period. This extremely high energetic expense caused a weakening of the female organism and her death in consequence.

The first insect generation was a little less fertile because one female laid only 1,200 eggs. Also a smaller number of eggs per layer as well as a shorter laying period (35 days) was noted.

In relation to the second generation all the parameters were at the lowest rate. Hence, in process of the generation development the number of laid eggs was decreasing. Similarly, the lifespan of females was reduced as well.

Observations of survival rate of this species were carried out under the same temperature and moisture conditions as fertility status (Fig. 9). As compared with other development stages higher larvae mortality was noted. For the first and second generation after the larvae development it was about 40% and 50%, respectively. Another observation dealt with negligibly higher mortality rate of the third larvae generation in relation with the other two. The results clearly indicated that the last insect population was the less numerous and that the individuals of this generation were characterised by the highest mortality. Likewise, dynamic of population and the number of laid eggs were the smallest.

IV. DISCUSSION

The most important plant-eater occurring on *Rumex confertus* Willd. was *Gastroidea viridula* Deg. (*Coleoptera, Chrysomelidae*). Preying of the beetle imagines proceeded in the form of biting out holes of different size in the plant leaves. At the beginning the larvae skeletonized, the leaves and then also made holes. Under natural site conditions *Gastroidea viridula* Deg. damaged vegetative weight of mossy sorrel to a large extent. The observations made over the experimental period showed that insect populations caused severe injuries to the plants. It is also in power in case of L_1 larvae, which preyed on leaves intensely a couple of days after hatching. *Gastroidea viridula* Deg. had three generations a year. Their development lasted roughly 40 days per generation. Speight and Whittaker (1987) and Engel (1956) reported a little longer development periods. Smith and Whittaker (1980) described the same number of generations (3). Bentley and Whittaker (1979) and Bentley et al. (1980) observed that the insects reduced dry weight of roots and indirectly affected the number and weight of seeds produced by plants. Barbattini et al. (1986) and Kismali and Madanlar (1990) speculated that the magnitude of injuries depended also on the condition of the attacked plant. Whittaker et al. (1979) and Kjaer and Elmegaard (1996) described this species as a very important biological factor, as well as integrated programme for regulating the development of undesirable plants.

Gastroidea viridula Deg. was extremely fertile. The female laid on the average 35 eggs a day. The highest number of eggs per layer was higher than 60. Females of the first generation laid eggs for 40 days, while these of the second and third generation only for 35 days and 28 days, respectively. The total female fertility ranged from 836 to 1,531 eggs per lifespan. Engel (1956) observed 586-1,028 eggs per female. Renner (1969) noted a similar number of eggs per layer (-30-40). In his studies Sotherton (1982) found that the time needed for the first generation to lay eggs was 44 days, while it was 25 days for the second one.

Gastroidea viridula Deg. was characterised by a high mortality rate. This was very important in case of the larvae, where more than 40% died. Sotherton (1982) noted the larvae population mortality to be as high as 50%.

An interesting observation was made during the *Gastroidea viridula* Deg. overwintering. This species was rather resistant to winter conditions. With mortality rate of 64% it can be located in the middle of the range commonly accepted for the *Chrysomelidae* family (80 – 90%).

A smaller role of an insect destroying leaves can be attributed to *Gastroidea polygoni* L., mainly because of its smaller population of sorrels. However, feeding of larvae and adult individuals was observed on these weeds. Two generations of this insect species were noted in a year, what is in a good agreement with the findings of Rakhimberdyeva and Shodiev (1989) and Marocchi (1994).

V. CONCLUSIONS

1. Mossy sorrel (*Rumex confertus* Willd.), a weed of the polygonum family (*Polygonaceae*), was injured by *Gastroidea viridula* Deg. and *Gastroidea polygoni* L. The preying was noted over the whole vegetation period, i.e. from the development of leaf rosette to drying up of plants.
2. The number of insect generations occurring on *Rumex confertus* Willd. near Bydgoszcz (1997-1999) and Toruń (1998-1999) was similar.
3. *Gastroidea polygoni* L. had a little smaller impact on limiting the weeding caused by *Rumex confertus* Willd. because of a low population dynamic of population and a smaller number of generations.
4. *Gastroidea viridula* Deg. imagines are characterised by a negligible mortality during winter and a high mortality in the larva development stage.

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Dariusz Piesik

WYSTĘPOWANIE *GASTROIDEA VIRIDULA* DEG. I *GASTROIDEA POLYGONI* L. *(COL. CHRYSOMELIDAE)* NA *RUMEX CONFERTUS* WILLD. JAKO BIOLOGICZNYCH PRZEDSTAWICIELI REGULACJI POPULACJI ZACHWASZCZENIA

STRESZCZENIE

Chwasty są szkodliwymi organizmami, których nie można lekceważyć. Dominującym sposobem walki z nimi są metody chemiczne. Zbyt duże stosowanie chemikaliów powoduje jednak nierzadko skażenie środowiska, a także uaktywnianie się agrofagów dotąd nieszkodliwych. Pewną alternatywą w związku z tym wydaje się być wykorzystywanie do walki z niektórymi chwastami owadów. Jednym z takich chwastów, które mogą być poddane biologicznemu zwalczaniu jest *Rumex confertus* Willd.