EKOLOGIA POLSKA – SERIA A

Tom IX | Warszawa 1961 | Nr 13

ELIGIUSZ PIECZYŃSKI

NUMBERS, SEX RATIO, AND FECUNDITY OF SEVERAL SPECIES OF WATER MITES (*HYDRACARINA*) OF MIKOŁAJSKIE LAKE

Laboratory of Ecology, Polish Academy of Sciences, Warsaw

A possibility of application of population analysis to define the distribution and development of various species was recently perceived in ecological investigations concerning water mites. An analysis of the population of *Lebertia tuberosa* Thor occurring in the mountain spring and in the section of the brook near the spring was made by Schwoerbel (1959). It has been found that the distribution of females and males, as well as the distribution of ovigerous and non-ovigerous females was different. The author states that it results from the various responses of the particular components of population to the environmental conditions and mainly to the temperature. Bader (1959) analysed the developmental cycle of population of *Sperchon glandulosus* Koen. occurring in the mountain stream. The author made a scheme of population development of this species and defined the span of life of separate generations, exploring the moments of appearnce of ovigerous females, nymphs, young females and males. An annual cycle of several lake species of water mites was observed by Nocentini (1960), with special attention given to maximum numbers and the periods of occurrence of ovigerous females and nymphs. An approximate estimation of characteristics of development of several species based on Allee's population development theory was established in the paper on water mites of Wilkus Lake (Pieczyński 1960). Three developmental phases were found: 1. Period of positive growth, 2. Equilibrium position, 3. Period of negative growth. It was also established that the numbers of females, males and nymphs are different in the separate phases of development.

The aim of this paper was a minute analysis of the development of several species during the vegetation season. Total numbers, quantitative ratios among females, males, and nymphs, the numbers of ovigerous females and the average numbers of eggs per female were chosen as the indicators of the population condition.

The observations were carried out on Mikołajskie Lake during the vegetation season in 1959 (Olsztyn province, Mrągowo district). One littoral station was chosen in the vicinity of Pisna Kępa on this lake. It was a compact agglomeration of rushes sheltered on both its sides with wide belts of reeds and exposed tc the action of waves from one side only. The bottom was covered with sand and mud, depth – 30 to 50 cm. A dipper 15 cm. in.diameter was used for the captures and a sample consisted of 20 dippings. Every capture consisted of a series of 15 such samples. There were ten captures taken at ten days intervals starting from 3. VI. 1959. An analysis was given of 6 species most numerous in this biotope (numbers of captured specimens are given after the name of species) namely: *Hydrodroma despiciens* (Müller 1776) – 705, *Limnesia maculata* (Müller 1776) – 952, *L. undulata* (Müller 1776) – 2153, *Hygrobates longipalpis* (Hermann 1804) – 478, *Piona coccinea* (Koch 1835) – 1779, and *Brachypoda versicolor* (Müller 1776) – 2454.

FECUNDITY OF FEMALES OF SPECIES INVESTIGATED

Eggs were counted in every female of analysed species. Females of *B. versicolor* need no preparation on account of the small number of their eggs, which are easily perceivable. They were investigated by means of a microscope. The females of the remaining species were taken under a binocular, section was made, and then the eggs were counted. Although there are some reports on the numbers of eggs laid in egg-masses in literature, data on numbers of eggs when inside the body of female are still lacking. The data of numbers of eggs enclosed inside the body of females of various species obtained from the present materials, as well as Sokolow (1925), Viets (1936), and Sparing's (1959) data on numbers of eggs laid in egg-masses have been gathered in table I.

Comparison of numbers of eggs inside the body of females and in egg-masses

Porównanie ilości jaj w organizmach samic i w złożach

Tab. I

Species Gatunki	Numbers of ovigerous females Ilość samic z jajami	Numbers of eggs inside the bodies of females Ilość jaj w organizmach samic		Numbers of eggs in egg-masses Ilość jaj w złożach		
		from-to od – do	Average Średnia	acc.to Sokolov 1925 wg Sokołowa 1925	acc.to Viets 1936 wg Vietsa 1936	acc.to Sparing 1959 modified wg Sparing 1959 zmienione
Hydrodroma despiciens	154	1–293	67,7	40–200	–	–
Limnesia maculata	208	1–113	33,9	25–30	–	–
Hygrobates longipalpis	213	1–117	29,9	40	10–15,35	–
Piona coccinea	256	1–92	17,5	10–23	40–45	4–47;21,3
Limnesia undulata	417	1–36	10,5	15	–	–
Brachypoda versicolor	1208	1–4	1,5	–	–	–

The numbers of eggs, the maximum and the average numbers were the greatest in *Hydrodroma despiciens;* in *Brachypoda versicolor* they were the smallest. Of two species of genus *Limnesia, L. maculata* possesses 3 times as many eggs as *L. undulata.* In *Hygrobates longipalpis* the numbers of eggs are similar to those of *L. maculata. P. coccinea,* a representative of genus *Piona,* takes the medium position between *H. longipalpis* and *L. undulata* as far as numbers of eggs are concerned. The numbers of eggs in egg-masses are proportional to those inside the body of females. It may be an indication that they are laid in "portions".

GENERAL CHARACTERS OF POPULATION DEVELOPMENT OF THE INVESTIGATED SPECIES

1. Character of changes in numbers

In general, 3 types of changes in numbers may be distinguished. They may be defined by: a. one clearly expressed maximum, b. two distinct maxima, and c. lack of any distinct maximum (Fig. 1–6). In *L. undulata* and *P. coccinea* only one clearly expressed maximum in numbers was noted. In the first species it occurs in the end of July, and in the second in the middle of July. The trend of numbers of *L. undulata* indicates that another peak is also possible in May.

Two distinct maxima were noted in *B. versicolor* and *H. longipalpis.* In *B. versicolor* the first peak in numbers occurred at the end of June and the second at the end of July. In *H. longipalpis* the maximum levels were found at the beginning of June and of September; so the span of time between the peaks was much greater in this species than in *B. versicolor.*

Finally no distinct maximum levels were observed in *H. despiciens* and *L. maculata.* In *L. maculata* the rapid decrease in numbers at the end of August is worthy of consideration. It may be assumed that it does not result from phenological changes but is a response to the considerable action of high waves during the day of capture (It is probably migration towards the habitats which are not exposed to the waves). The corresponding decrease in numbers was noted for this species in Wilkus Lake during unfavourable weather (Pieczyński 1960).

2. Regularity of changes in ratios of females, males, and nymphs

A general regularity may be found in the majority of species in question (Fig. 1–6). At first the females predominate distinctly, a large percentage being ovigerous. During the next period both the gradual decline in numbers of the ovigerous females and an intensive increase in numbers of nymphs were noted. The nymphs gain the preponderance over their adults. Finally, at the end of

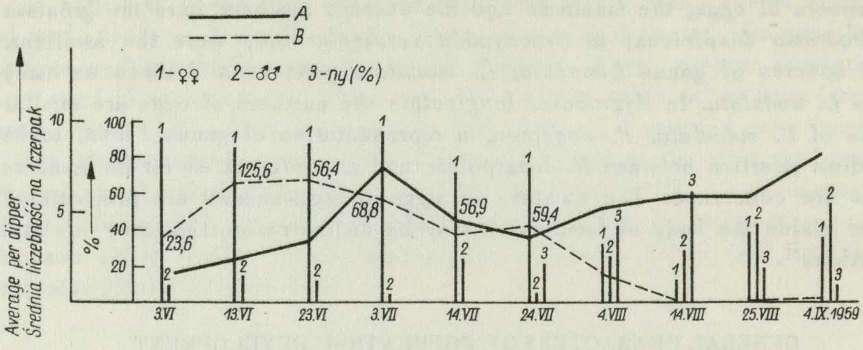

Fig. 1. Development of population of *Hydrodroma despiciens* in littoral zone of Mikołajskie Lake

A — average numbers of population; B — ovigerous females (percent of total numbers of females), numbers indicate the average of eggs per female

Rozwój populacji *Hydrodroma despiciens* w litoralu Jeziora Mikołajskiego

A — średnia liczebność populacji; B — samice z jajami (% ogólnej ilości samic); liczby wskazują średnią ilość jaj

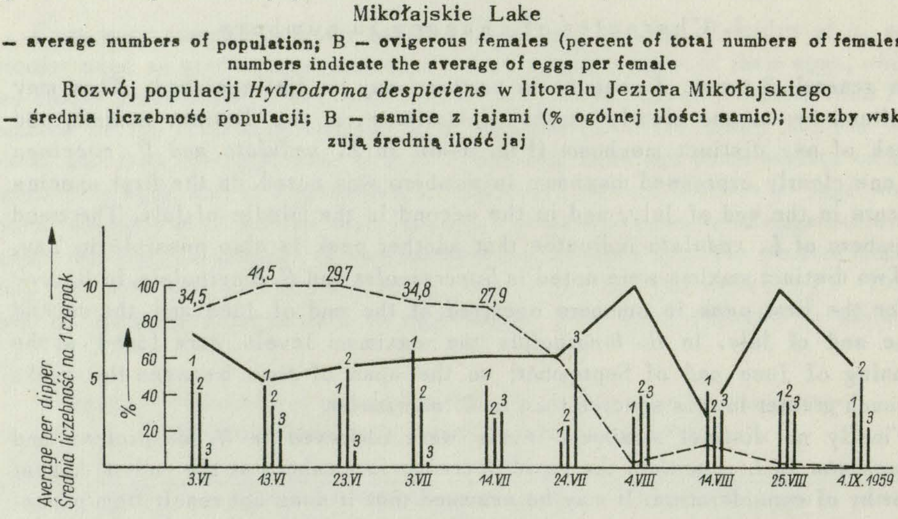

Fig. 2. Development of population of *Limnesia maculata* in littoral zone of Mikołajskie Lake

The indications such as in Fig. 1

Rozwój populacji *Limnesia maculata* w litoralu Jeziora Mikołajskiego

Oznaczenia jak na fig. 1

period investigated the nymphs disappear gradually and the adults become predominant again. The numbers of females and males equal or even the males predominate. The ovigerous females were not found or there were minimal numbers of them.

The pattern of the development of population above mentioned was observed in *H. despiciens*, *L. maculata*, *L. undulata*, *H. longipalpis*, and *B. versicolor*. An exception to this rule is *P. coccinea* where nymphs as a rule form the majority of the population, attaining their maximum level in the middle of July. The females are predominant only in the beginning of the period investigated

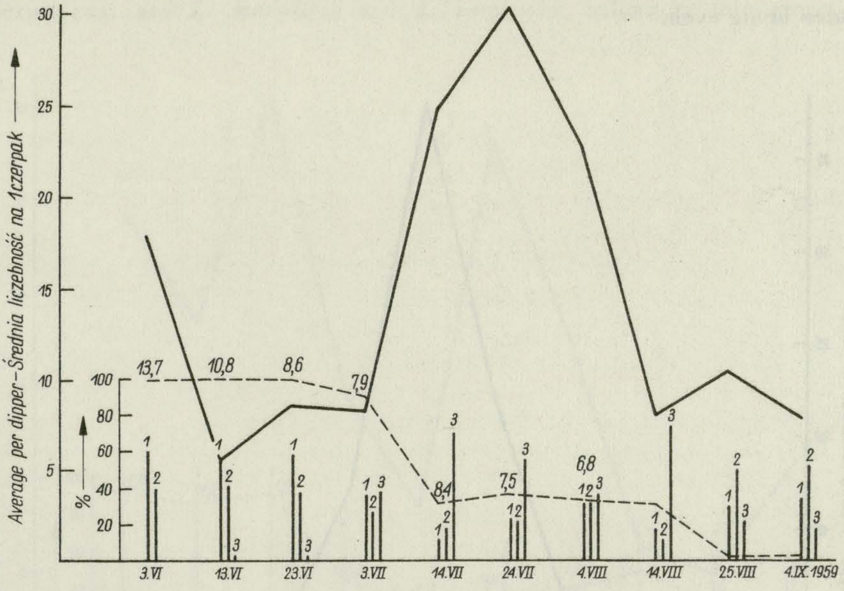

Fig. 3. Development of population of *Limnesia undulata* in littoral zone of Mikołajskie Lake

The indications such as in Fig. 1

Rozwój populacji *Limnesia undulata* w litoralu Jeziora Mikołajskiego

Oznaczenia jak na fig. 1

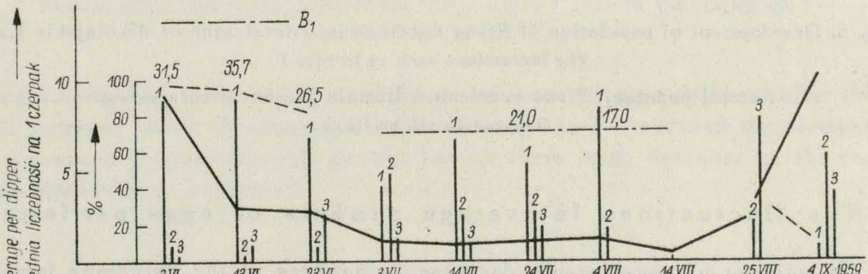

Fig. 4. Development of population of *Hygrobates longipalpis* in littoral zone of Mikołajskie Lake

B_1 – the quantitative level of ovigerous females during the period 3.VII to 14.VIII (the average values)

The further indications as in Fig. 1

Rozwój populacji *Hygrobates longipalpis* w litoralu Jeziora Mikołajskiego

B_1 – poziom ilościowy samic z jajami w okresie 3.VII – 14.VIII (wartości przeciętne)

Pozostałe oznaczenia jak na fig. 1

(June), later on the numbers of adults become smaller, the numbers of females and males being even.

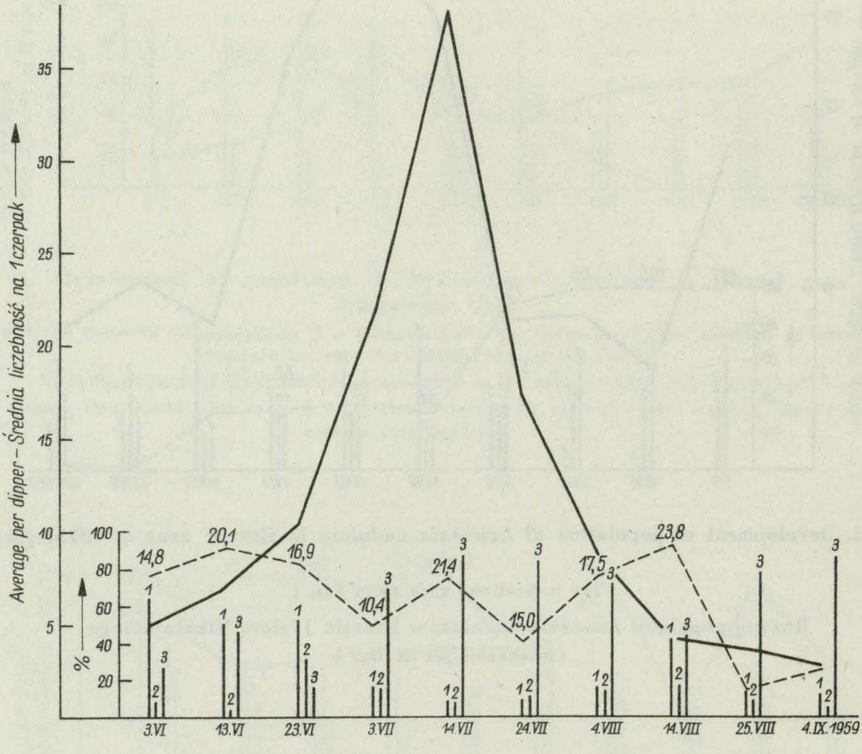

Fig. 5. Development of population of *Piona coccinea* in littoral zone of Mikołajskie Lake
The indications such as in Fig. 1

Rozwój populacji *Piona coccinea* w litoralu Jeziora Mikołajskiego
Oznaczenia jak na fig. 1

3. The fluctuations in average numbers of eggs per female

On account of considerable decrease in numbers of the ovigerous females at the beginning or in the middle of August, the average numbers of eggs can be calculated mainly in June and July. The average number of eggs decreases during the vegetation season correspondingly to the reduction in numbers of the ovigerous females. *P. coccinea* is an exception, since its eggs are the most numerous in the middle of August. The remaining species can be divided into two groups:

a. The average numbers of eggs show a constant decrease. *L. undulata* and *H. longipalpis* belong to this group but the data for the latter are not continuous.

b. The average numbers of eggs decrease but the process has a „pulsative" nature (The periods of greater and smaller numbers of eggs occur alternately). *H. despiciens*, and *L. maculata*, and *B. versicolor* belong to this group. In

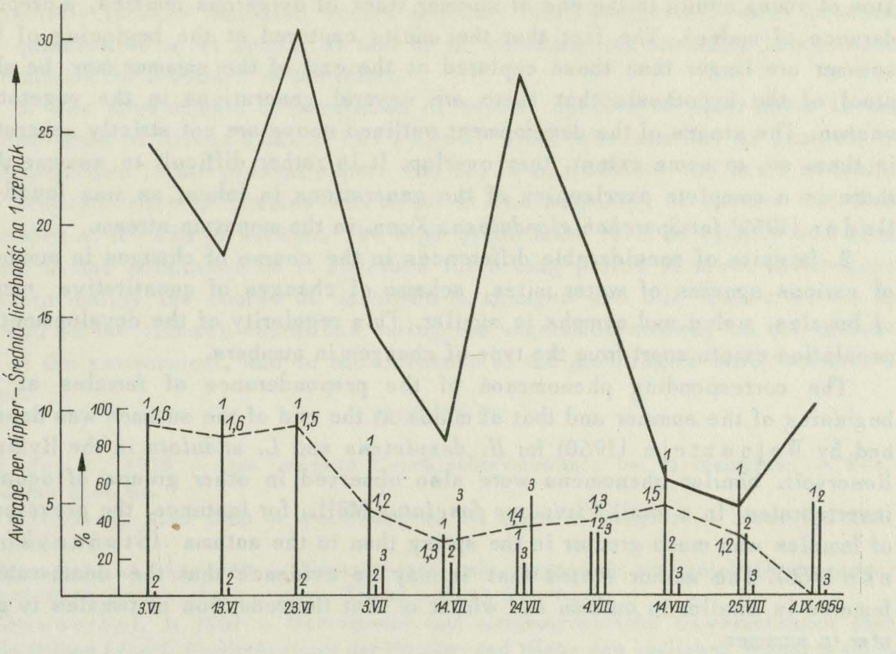

Fig. 6. Development of population of *Brachypoda versicolor* in littoral zone of Mikołajskie Lake

The indications such as in Fig. 1

Rozwój populacji *Brachypoda versicolor* w litoralu Jeziora Mikołajskiego

Oznaczenia jak na fig. 1

H. despiciens the decrease in the average numbers of eggs follows after the initial increase which is expressed very distinctly. In *P. coccinea* the changes in the average numbers of eggs are similar but there is no decrease at the end as has already been mentioned.

DISCUSSION

1. On the grounds of the data given above, it may be assumed that there is a replacement of generations of the investigated species of water mites (except for *P. coccinea*) in the lake during the summer. The adults, which were captured in the beginning of the summer, the ovigerous females being predominant among them, belonged presumably to the generation which arose either that year in the spring, or in the autumn of the previous year. This generation becomes extinct after the egg-laying. The larvae hatched from the eggs are parasites on the adults of *Chironomidae* and *Corethra* (Sparing 1959) in the

majority of the species investigated, namely: *H. despiciens*, *L. maculata*, *H. longipalpis*, and *P. coccinea*. During the course of development the larvae transform into free-living nymphs, which, in turn, give rise to the next generation of young adults in the end of summer (lack of ovigerous females, a preponderance of males). The fact that the adults captured at the beginning of the summer are larger than those captured at the end of the summer may be also proof of the hypothesis that there are several generations in the vegetation season. The stages of the development outlined above are not strictly separated in time, so, to some extent, they overlap. It is rather difficult to assume that there is a complete overlapping of the generations in lakes, as was found by Bader (1959) for *Sperchon glandulosus* Koen. in the mountain stream.

2. In spite of considerable differences in the course of changes in numbers of various species of water mites, scheme of changes of quantitative ratios of females, males and nymphs is similar. This regularity of the development of population exists apart from the type of changes in numbers.

The corresponding phenomenon of the preponderance of females at the beginning of the summer and that of males at the end of the summer was described by Wajnsztejn (1960) for *H. despiciens* and *L. undulata* in the Rybinsk Reservoir. Similar phenomena were also observed in other groups of aquatic invertebrates. In a snail *Viviparus fasciatus* Müll., for instance, the prevalence of females was much greater in the spring than in the autumn (Stańczykowska 1960). The author states that it may be evidence that the death-rate of females is smaller in autumn and winter or that the reduction of females is greater in summer.

3. In the species of water mites which were investigated in the present paper the numbers of ovigerous females decrease similarly during the season apart from the differences in the total numbers. It proves that there are no direct relations between the biological characters of water mites (the time of egg-laying) and the numbers of specimens.

4. The long period of occurrence of the ovigerous females as well as the fluctuation in the average numbers of eggs may be evidence that the females reach maturity and egg-laying ability gradually, in "portions".

5. The trend in numbers is very peculiar in the various species. The character of the reduction may be determined on the grounds of these trends. In some species distinct peaks of numbers brought about by the abundance of nymphs are found (*L. undulata* and *P. coccinea*). In these species the reduction in the nymph stage or during the metamorphosis of nymph into adult is probably greater than at other stages. In *P. coccinea*, on the contrary the high quantitative level of the nymphs is found permanently during the whole summer. It is good evidence of the permanence of the nymphal stage in this species. *B. versicolor* may be also included in the group of species with this type of reduction on account of its peak in numbers caused also by abundant development of nymphs in July. It is somewhat difficult to explain the peak in numbers in June, when the nymphs have not yet been captured. However, it may be the consequence of migration of this species from the other biotopes.

The reduction in numbers has a different course in the species with the indistinct peaks in numbers (*H. despiciens, L. maculata*). It may be assumed that reduction is most intensive during the early stages of growth (egg – larva). Especially intense reduction occurs probably in *H. despiciens*, which reaches the quantitative level similar to that of *L. maculata*, its fecundity being twice as much as the fecundity of the latter.

6. The development of population of several species of water mites in the littoral zone of Wilkus Lake (Pieczyński 1960) was similar, in general, to that described in the present paper. And so, in *L. maculata* and in *L. undulata* the preponderance of females was noted at the beginning of summer and that of males at the end of summer. The high quantitative level of nymphs had been noted in the population of *P. coccinea* for a long period of time. Differences concern mainly the course of quantitative changes and this feature seems to depend on the climatic conditions during the vegetation season, on the character of the environment, and on the influence of the grouping in which a species lives.

LITERATURE

1. Bader, C. 1959 – Das gestörte Geschlechtsverhältnis bei Hydracarinen – Rev. Suisse Zool. 66.
2. Nocentini, A.M. 1960 – *Hydrachnellae* del Lago di Mergozzo – Mem. Ist. Ital. Idrobiol. 12.
3. Pieczyński, E. 1960 – Kształtowanie się zgrupowań wodopójek (*Hydracarina*) w różnych środowiskach jeziora Wilkus – Ekol. Pol. A, 8.
4. Schwoerbel, J. 1959 – Ökologische und tiergeographische Untersuchungen über die Milben (*Acari, Hydrachnellae*) der Quellen und Bäche des südlichen Schwarzwaldes und seiner Randgebiete – Arch. Hydrobiol., suppl. 14.
5. Sokolow, I.I. 1925 – Untersuchungen über die Eiablage und den Laich der Hydracarinen II – Z. Morphol. Ökol. 4.
6. Sparing, I. 1959 – Die Larven der *Hydrachnellae*, ihre parasitische Entwicklung und ihre Systematik – Parasit. Schrift. 10.
7. Stańczykowska, A. 1960 – Obserwacje nad skupieniami *Viviparus fasciatus* Müll. na terenie łachy wiślanej Konfederatka – Ekol. Pol. A, 8.
8. Viets, K. 1936 – Spinnentiere oder *Arachnoidea*. VII. Wassermilben oder *Hydracarina* (Tierwelt Deutschlands 31–32) – Jena
9. Wajnsztejn, B.A. 1960 – Wodianyje kleszczi Rybinskogo wodochraniliszcza i prilegajuszczich wodojemow I – Biul. Inst. Biol. Wodochran. 6.

LICZEBNOŚĆ, STOSUNKI ILOŚCIOWE PŁCI ORAZ PŁODNOŚĆ KILKU GATUNKÓW WODOPÓJEK (*HYDRACARINA*) JEZIORA MIKOŁAJSKIEGO

Streszczenie

Celem pracy była analiza rozwoju populacji kilku gatunków wodopójek. Pod uwagę wzięto: ogólną liczebność, stosunki ilościowe samic, samców i nimf, ilość samic z jajami oraz średnią ilość jaj (na jedną samicę). Materiały zbierano w litoralu Jeziora Mikołajskiego w sezonie wegetacyjnym 1959 r. używając do połowów czerpaka o średnicy 15 cm.

Uzyskano i zestawiono dane dotyczące ilości jaj u samic poszczególnych gatunków (tab. I). W przebiegu zmian liczebności stwierdzono wyraźne różnice u poszczególnych

gatunków (fig. 1–6). Polegają one na występowaniu jednego szczytu, dwóch szczytów bądz też braku wyraźnych szczytów liczebności. Stosunki ilościowe samic, samców i nimf 5 gatunków, a mianowicie *Hydrodroma despiciens*, *Limnesia maculata*, *L. undulata*, *Hygrobates longipalpis* i *Brachypoda versicolor* wykazują prawidłowe zmiany w przebiegu sezonu wegetacyjnego (fig. 1–6). Początkowo przeważają samice i to w większości samice z jajami, bezpośrednio po nich pojawiają się licznie nimfy, następnie znów przeważają formy dorosłe, wśród których samce są liczniejsze bądź równe liczebnie samicom (brak samic z jajami). Można przypuszczać, że u gatunków tych następuje w ciągu lata wymiana generacji. Od powyższego schematu odbiega rozwój populacji *Piona coccinea*, której nimfy stanowią znaczny procent populacji przez całe lato.

Charakterystycznym momentem jest fakt, że podobny schemat zmian stosunków ilościowych samic, samców i nimf obserwujemy u gatunków różniących się wyraźnie przebiegiem zmian liczebności. Również ilość samic z jajami zmniejsza się u tych gatunków w sposób zbliżony. Długi okres występowania samic z jajami oraz wahania średniej ilości jaj wydają się świadczyć o tym, że samice stopniowo, pewnymi partiami osiągają dojrzałość i zdolność do składania jaj.

Można spodziewać się odmiennego przebiegu redukcji u gatunków o wyraźnych szczytach liczebności wywołanych masowym pojawieniem się nimf i u gatunków nie mających wyraźnych szczytów. U pierwszych (*L. undulata*, *P. coccinea*, *B. versicolor*) najintensywniejsza redukcja następuje przypuszczalnie w stadium nimfy bądź w trakcie metamorfozy nimfy w formę imaginalną. U drugich (*H. despiciens*, *L. maculata*) najintensywniejsza redukcja występuje we wcześniejszych stadiach rozwojowych (jajo – larwa).