PARASITISM OF WATER MITE LARVAE (*HYDRACHNELLAE*) OF THE GENUS *HYDRACHNA* ON WATER BEETLES IN POLAND

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SUMMARY: Six species of the genus *Hydrachna* parasitizing beetles were found by investigations on 35150 water beetles (six families and 244 species). *Hydrachna geographica, H. inermis,* and *H. incognita* were the most numerous and were collected from 22 species of Dytiscidae and Hydrophillidae. The infestation rate varied from 0.1 to 71.4 %. The water mite parazited several species but preferred some of them. Larvae were usually found under the elytra, but the specimens of *H. inermis* were attached on the surface of the body. The size of larvae varied from 0.15 to 5 mm. The relations between the size of larvae and the sampling suggested that the reproduction occurs from spring to summer. The investigated species of water mites chiefly colonize spring astatic waters where no typical coleopterofauna has been determined. This fact suggests that the zone of infection is separated from the zone of parasitism.

ZUSAMMENFASSUNG : 35150 Käfer aus 6 Familien und 244 Arten wurden erforscht. Die Wassermilbenlarven der Gattung Hydrachna wurden an 22 Käferarten der Familien Dytiscidae und Hydrophilidae gefunden. An diesen Käfern schmarotzten 6 Arten von der Gattung Hydrachna. Die Meisten waren: Hydrachna geographica, H. inermis, H. incognita. Die Befallsrate varüete zwischen 0,1 % und 71,4 %. Einzelne Wassermilbenarten Konnten als Parasiten an mehr als einer Wirtsart nachgewiesen werden. Zur gleichen Zeit befielen sie mehr als eine einige Käferart aber jeweils mit Präferenz fürbestimmte Arten. Diese Bevorzugung wies aufeine früher andersartige. Zusammensetzurch der Käfer-Fauna hin. Die Wassermilbenlarven aller Arten parasitierten unter den Flügeldecken von Käfern; eine Ausnahme macht H. inermis, die sich an die Oberflächen der Käfer setzte. Die larven sind von 0,15 mm bis 5 mm lang. Die Abhängigkeit der Körpergröße von dem Datum der Probeentnahme weist auf die Fortpflanzung dieser Arten in den Frühlings — und Sommermonaten hin. Die Parasiten nutzen jenachvorhardner Umgelung ihren Lebensraum zur Fortrflamsung oder zum Schmarotzen. Das ist die Folge der Tatsache, dass die erforschten Wassermilbenarten vor allem die astatischen Frühlingsgewässer, die keine für sich typische Käferfauna haben, besiedeln.

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INTRODUCTION

The current poorly advanced studies on the parasitism of water mite larvae show that the only species found on water beetles belong to *Hydrachna* and *Eylais* genera (Piatakov 1915a, Wesenberg-Lund 1918, Lundblad 1927, Brumpt 1929, Lanciani 1970, 1975, Prasad, Cook 1972, Nielsen, Davids 1975). In Poland the only available data are found in the works of CICHOCKA (1983) and BIESIADKA, CICHOCKA & ZAWAL (1989).

The parasitism of species of *Hydrachna* on water hemipterans is slightly better known. DAVIDS (1973), BIESIADKA & CICHOCKA (1994) and CICHOCKA (1995) conducted comprehensive studies concerning this problem. Owing to the work of WAINSTEIN (1980) the morphology of central-European species of the genus *Hydrachna* is sufficiently known, and permits more advanced studies on the parasitism of larvae of these species on water beetles. However, the hosts species of the genus *Hydrachna*, parasites of water bugs, are still incomplete: neither the relations "parasite-host" or the impact of the environment were thoroughly inves tigated. This study contributes to analyse the above problems on a large coleopteran material.

MATERIAL AND METHODS

The water beetles were partly collected by the author and completes by collections of Polish coleopterologists. This material included the belt of Baltic Coastland and Lake Districts, southern Great Poland, northern Mazovian and northern Podlasie Lowlands, Krakow-Czestochowa, Kielce-Sandomierz, and Przedborze Foothills, the Oswiecim Valley, Central Beskid foothills, Western and Lesisty Beskid ranges, and the entire Sudeten mountain range (fig. 1).

The 35150 adults (244 species and 6 families) were studied. The families investigated are :

Family	Number individuals	Number of species
Haliplidae	4658	18 species;
Dytiscidae	18050	119 species;
Gyrinidae	1653	9 species;
Hydraenidae	1934	25 species;
Hydrophilidae	7509	70 species;
Limnidae	1346	3 species.

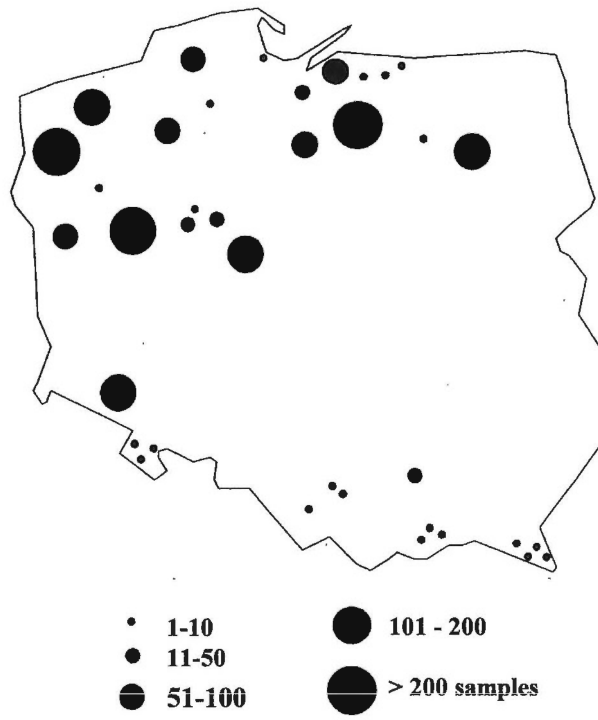

FIG. 1: Distribution collecting water beetles.

More than 90 % of species currently known to the fauna of Poland are represented and the species of greater importance in water biocenoses were studied. This collection can considered as representative and sufficient to elaborate a comprehensive diagnostic of the parasitism of water mite larvae on water beetles.

The beetles were examined under a binocular magnifying microscope. The larvae were taken off using preparatory needles and mounted on a slide. Water mites were identified using the WAINSTEIN'S key (1980).

In the descriptive analysis two indexes were used. The **infestation rate** concernes the percentage of infected individuals in the total number of the given species of water beetles. The **intensity of infection** *i.e.* the number of parasites on one individual of the given host species, was expressed by numerical intervals and averages. The correlation coefficient between the numbers of a given host species and the number of infected individuals and the correlation coefficient between the numbers of different beetle species and the number of larvae taken off from them were also computed.

Larvae were classified in three classes of body size: small (0,15–0,40 mm), medium (0,41–2,00 mm), and large (>2,00 mm). The first class (0,15–0,40 mm) include the young larvae, just after infection. The medium sized larvae were characterized by an increase in body size indicating a certain time distance from the infection, though they did not reach the size just before transformation. The larvae from the third class (>2,00 mm) are the oldest, just before moulting. The second interval is characterized by the greatest range and theoretically should contain the greatest number of larvae.

Results

The general characteristics of parasitism

Larvae of the genus *Hydrachna* were found on 22 species of water beetles, 13 species of Dytiscidae and 9 of Hydrophilidae. The number of larvae collected on the different species varied from 1 to 621. The greatest number of larvae was found on the genera *Dytiscus* and *Acilius*. The infestation rate was 5.0 % on average, varying from 0.1 to 71.4 %. *Graphoderus bilineatus, Ascilius sulcatus*, and beetles of the genus *Dytiscus* were most frequently infected. In the cases of *G. bilineatus* and *D. lapponicus* the high intensity of infection should be in a measure at least regarded as accidental. The number of *G. bilineatus* being very small, the result is highly unreliable, while *D. lapponicus* was caught in a specific environment, this increasing the infestation rate (see below) (Table 1).

Hydrachna geographica was most frequent with 1606 individuals collected on 174 water beetles (infestation rate : 3.0 %). It was followed by *H. inermis* (154 individuals, infestation rate 0.7 %) and *H. incognita* (70 individuals, infestation rate 1.1 %), *H. crassipalpis* (14 individuals, the infestation rate 0.2 %) and *H. leegei* (three individuals, the infestation rate 0.03 %) were less numerous (Table 1). The only specimen of *H. globosa,* known as parasite on *Nepa cinerea* (Hemiptera) (Biesiadka & Cichocka 1994).

Hydrachna geographica (1-96, 9.2 on average) and *H. inermis* (1-40, 3.4 on average) are water mites numerously infecting water beetles. The remaining species belong to rare parasites of beetles (Table 1).

Different species of water mites parasitized more than one host species. The greatest number of hosts was characteristic of *H. geographica,* though the number of larvae found on the different species of beetles suggested the preference for species of the genera *Dytiscus*, *Acilius* and *Graphoderus*. *Hydrachna inermis* also occurs on beetles of the genus *Dytiscus*, chiefly *D. circumcinctus* and *D. dimidiatus*. With respect to the species mentioned above the occurrence of *Hydrachna geographica* was lower. *H. incognita* chiefly occurred on *Anacena limbata* and *A. lutescens.* The remaining species of water mites were much less numerous hence it was difficult to determine their preference with respect to the hosts. In the case of *Hydrachna crassipalpis* only the most numerous occurrence of this parasite on *Coelambus impressopunctatus* and *Hydrobius fuscipes* could be recorded (Table 1).

No correlation was assessed between the number of different species of beetles and the number of infected individuals and between the numbers of the different species of beetles and the number of larvae collected from them. The respective correlation coefficients were 0.10 and –0,10. The correlation can be found, however, in analysing the different parasitic species and the host species associated with them. The correlation coefficient between the number of *Hydrachna geographica* found on the different hosts and the numbers of these beetles was 0.37 while the correlation coefficient between the numbers of the different species of beetles and the number of individuals infected by this water mite was 0.62. If in the computation of the above coefficients the beetle species most frequently infected *i.e.* preferred by *H. geographica* were only taken into consideration, the correlation coefficients amounted to 0.38 and 0.79, respectively. Then without the data concerning beetles of the species *D. lapponicus* and *G. bilineatus* (which should be regarded as accidental), the correlation coefficients raise 0.71 and 0.87. The very distinct positive correlation of this type is characteristic of *Hydrachna incognita*. The correlation coefficient between the number of larvae on the hosts and the numbers of the hosts collected is 0.98. The correlation coefficient between the numbers of the species of beetles and the number of individuals infected by this water mite is 0.98. The negative correlation was

Species of parasite	Hydrachna globosa (Deg.)			Hydrachna geographica O. Müll.			Hydrachna crassipalpis Piers.			Hydrachna leegei Koen.			Hydrachna incognita Vajn.			Hydrachna inermis Piers.		
Host species	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Coelambus impressopunctatus (Schall.)				1	1 (0,5)	1	6	5 (2,6)	1-2 (1,2)									
Ilybius obscurus (Marsh.)				1	1 (2,4)	1												
Ilybius subaeneus Er.				1	1 (5,9)	1												
Rhantus bistriatus (Bergstr.)				1	1 (11,1)	1												
Rhantus exsoletus (Forst.)				1	1 (0,7)	1												
Hydaticus transversalis (Pontopp.)				1	1 (0,5)	1												
Dytiscus circumcinctus Ahr.				37	6 (4,3)	1-12 (6,2)										114	27 (19,1)	1-40 (4,2)
Dytiscus dimidiatus Bergstr.	1	1 (0,5)	1	21	17 (8,6)	1-6 (1,2)										37	14 (7,1)	1-6 (2,6)
Dytiscus lapponicus Gyll.				621	19 (19,4)	3-96												
Dytiscus marginalis L.				557	83 (28,8)	1-51 (6,7)										3	2 (0,7)	1-2 (1,5)
Acilius sulcatus (L.)				314	32 (24,0)	1-57 (9,8)												
Graphoderus bilineatus (Deg.)				20	5 (71,4)	1-11 (4,0)												
Graphoderus cinereus (L.)				30	6 (5,3)	1-13 (5,0)												
Helophorus flavipes Fabr.										1	1 (1,1)	1						
Helophorus granularis (L.)													1	1 (0,3)	1			
Helophorus griseus Herbst													3	2 (0,6)	1-2 (1,5)			
Hydrobius fuscipes (L.)							6	6 (1,8)	1									
Anacena limbata (Fabr.)													26	22 (3,7)	1-4 (1,2)			
Anacena lutescens (Steph.)													39	36 (4,2)	1-2 (1,1)			
Laccobius minutus (L.)							1	1 (0,06)	1	2	1	2						
Helochares obscurus (O. F. Müll.)							1	1 (0,9)	1									
Enochrus melanocephalus (Oliv.)													1	1 (2,0)	1			
Total	1	1 (0,5)	1	1606	174 (11,1)	1-96 (9,2)	14	13 (0,6)	1-2 (1,1)	3	2 (0,1)	1-2 (1,5)	70	62 (2,8)	1-4 (1,2)	154	43 (6,8)	1-40 (3,4)

TABLE. 1: Infection of water beetles by *Hydrachna* : A. — number of the larvae, B. — infestation rate (in %), C. — intensity of infestation (on the average).

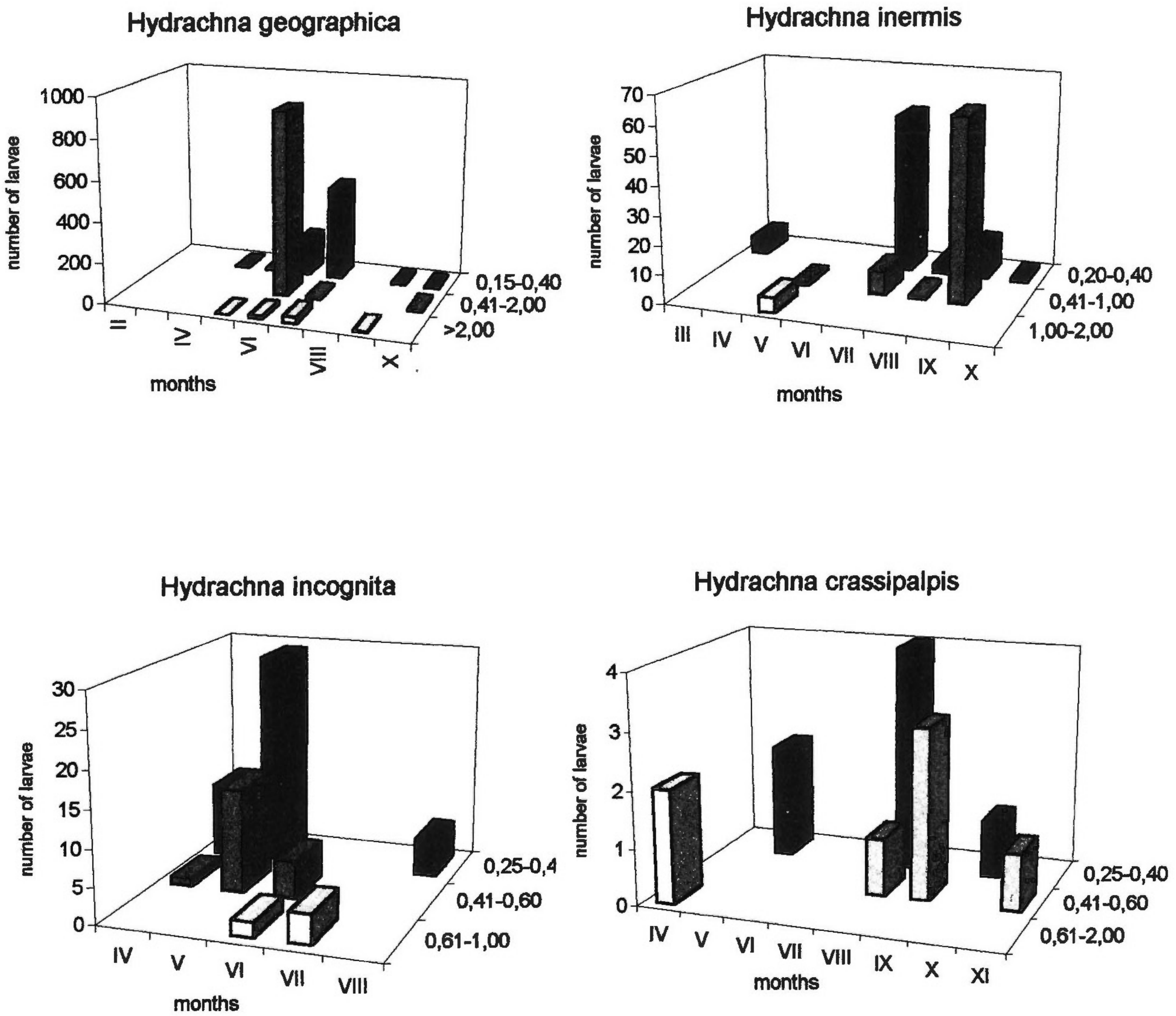

FIG. 2: Relation between the number of larvae of different sizes and date of sampling.

characteristic of *H. inermis,* the respective correlation coefficients being –0.94 and –0.99.

All the species of water mites, except *H. inermis,* were found under the elytra. Most of them (about 60 %) settled on the upper surface of the first four segments of the abdomen. Less numerous ones (about 30 %) selected lateral parts of sternites of the first four segments of the abdomen, near the stigmata. The remaining mites settled on the upper surface of further segments of the abdomen, on the upper part of the metathorax, on the second pair of wings, or on the internal side of elytra. In the case of *H. geographica* the situation was slightly different: 49.4 % of larvae were attached to the upper surface of the first four segments of the abdomen, 28.0 % to the side parts of these segments, and 22.5 % to segments V-VII. *H. inermis* was attached to the outer parts of beetle bodies. The greatest number of larvae (40.3 %) was found on the prosternum. Then on the mesosternum (20.8 %) and metasternum (19.5 %). A slightly smaller numbers of larvae were observed on the tibia of the third part of legs (13.6), one larva each being found on the lower surface of the head and the outer surface of the border of elytra.

The body size of larvae varied from 0.15 to 5 mm. *H. geographica* was characterized by the strongest increase in the stage of the parasitic larva. Larvae of this species were 0.15-5 mm in length. In the first size interval (0.15-0.40 mm) 642 larvae (40.1 %) were found, in the second (0.41-2.00 mm) 918 larvae (57.2 %) and in the third (>2.00 mm) 44 larvae (2.7 %). The body size of *H. crassipalpis* larvae varied from 0.25 to 1.05 mm. In the interval of 0.25-0.40 mm seven larvae were noted (50.0 %), in that of 0.41-0.60 mm five larvae (35.7 %) and in the interval above 0.61 two larvae (14.3 %). *H. incognita* larvae were 0.25-0.70 mm in length, most of them (44 larvae, 62.9 %) mesered 0.25-0.40 mm. In the interval of 0.41-0.60 mm 20 larvae and in that of 0.61-0.70 mm six larvae were recorded. The body size of *H. inermis* larvae was within 0.20 and 2.00 mm. In the first interval (0.20-0.40 mm) 76 larvae (49.1 %), in the second (0.41-0.60 mm) six (41.8 %) and in the third (0.61-2.00 mm) nine (5.9 %) larvae were found. A larva of *H. globosa* was 0.25 mm in length and *H. leegei* larvae one individual was 0.25 mm and two individuals 0.30 mm in length.

The dependence between the number of larvae in the different classes of size and the sampling date is illustrated by FIG.2. The occurrence of larvae of all the body sizes in spring-summer was characteristic of *H. geographica*. The larvae of large and small size were chiefly noted in June and July while these of the medium size were most numerous in June. Small numbers of medium-sized and small larvae occur in September and October and of large larvae in September. Large *H. inermis* larvae occur in May and the medium- and small-sized ones in summer-autumn. A small number of small larvae also occurred in August. Small *H. crassipalpis* larvae chiefly occurred in August, medium ones in September and large in April.

Environmental diversity of parasitism

The mostly mites larvae were found on water beetles from sphagnous peat bogs (1520 individuals). The small eutrophic water bodies released 252 individuals and small mid-forest water bodies 57; the beetles from littoral zones of lakes were rarely paratized (13 mites collected as astatic waters, and flowing waters (3 and 2 resectively).

In sphagnous peat bogs *Hydrachna geographica* was the most frequent (1507 larvae) on *D. lapponicus* (621 larvae), *D. marginalis* (538), *A. sulcatus* (313), *D. circumcinctus* (17), *G. cinereus* (17), and *D. dimidiatus* (one larva). *H. incognita* (four larvae on *Anacena lutescens*, two on *Helophorus griseus*, and one on *Enochrus melanocephalus*) and *H. inermis* (six larvae on *D. circumcinctus*) were collected . Only one site, the outskirts of a peat bog near Koscierzyna (characterized by secondary eutrophication and similarity to small eutrophic water bodies) gave us larvae.

In the small eutrophic water bodies *Hydrachna inermis* (142 larvae) occurred as the most numerous parasite of *Dytiscus (D. circumcinctus*: 106, *D. dimidiatus*: 35, and *D. marginalis*: one larva). *Hydrachna geographica* was less numerous (84 individuals), occuring on *Dytiscus (D. dimidatus*: 21, *D. circumcinctus:* 20) and *Graphoderus bilineatus* (20), *G. cinereus* (13), *Dytiscus marginalis* (5), and *Coelambus impressopunctatus, Ilybius obscurus, Rhantus bistriatus, Hydiaticus transversalis,* and *Acilius sulcatus* (one larva each). Besides the above mentioned parasites 19 larvae of *Hydrachna incognita*, three of *H. leegei*, three of *H. crassipalpis*, and one of *H. globosa* were found in the discussed environment.

In small forest water bodies *H. incognita* (23 larvae on *Anacena lutescens* and 12 on *A. limbata*), *Hydrachna geographica* (14 larvae), and *H. crassipalpis* and *H. inermis* (four larvae each) were collected.

In the lake littoral only two species of water mites (*H. crassipalpis*: 7 larvae and *H. incognita*: 6 larvae) were observed.

In astatic waters and in **flowing waters** only one species (respectively *H. incognita*, three larvae and *H. inermis*, 2 larvae) was found. These water mites parasitized the beetles of small water bodies.

DISCUSSION

General characteristics of parasitism

Larvae of water mites of the genus *Hydrachna* are parasites on Dytiscidae and Hydrophilidae. These families are frequent and numerous, occuring in astatic waters where *Hydrachna* frequently collected. Some factors explain that these mites cannot parasites othersfamilies: the Limnidae are characteristic from rapidly flowing waters (Więźlak 1986) where the genera *Hydrachna* does not occur. The Haliplidae are flightless or semi-volatile (Galewski & Tranda 1978) and they rarely colonize astatic waters, this being basically relevant to the absence water mites of the genus *Hydrachna*. Their small size also limits the occurrence of these parasites. It is difficult to determine the significance of the specific life environment (pneuston) of beetles from the family Gyrinidae, though obviously the protuberant back side of the abdomen (hardly a place under the elytra) is a factor limiting the infection of these bugs by water mites of the genus *Hydrachna*: the larvae are characterized by a significant increase in body size during the parasitic stage and hence an insufficient space under the elytra is the limiting agent. Some questions remain about the determinism of the lack of the *Hydachna* on Hydraenidae. However, the wintering of these beetles in terrestrial environment might be determinant (Galewski 1990).

The Dytiscidae and Hydrophilidae living in habitats where no water mites of the genus *Hydrachna* occur can be eliminated from the list of potential hosts (i.e. alpine species, species from flowing waters and acidiphilous habitats). The peat bog *D. lapponicus* species is an exception here, though this case should be regarded as fortuitous (see below).

The earlier authors (Piatakov 1915a, b, Brumpt 1929, Davis 1969, Cichocka 1983, Biesiadka, Cichocka & Zawal 1989) recorded the occurrence of larvae of the genus *Hydrachna* on Dytiscidae and Hydrophilidae. The genus *Cybister* was reported as the host of *H. geographica* by Piatakov (1915a,b): this observation was not confirmed. The remaining host species agree with the earlier data or have not been demonstrated until now.

The infection extensiveness is very low (Table 1) and the parasitism of the genus *Hydrachna* on the remaining species of beetles cannot be excluded. Some beetle species were represented by a too few number of individuals to eliminate them from the list of potential hosts.

The host specificity varies according to the species considered: *Hydrachna geographica* and *H. inermis* were found only on Dytiscidae, *Hydrachna leegei* and *H. incognita* only to species of Hydrophilidae whereas *Hydrachna crassipalpis* parasited of beetles belonging to the both families. The subgenus *Diplohydrachna* is only parasitic on water hemipterans. In the case of *H. geographica* and *H. inermis*, which share the same hosts, differences are noted in their preferences. *H. inermis* most intensively infests *D. circumcinctus* and *D. dimidiatus* but this genus is parasitised by *H. geographica* to the lowest degree (Table 1). The above differences probably reflect the specialization to the hosts.

The infestation rate is very low (5.0 % on average). This rate have to correlated to the natural low number of individuals of *Hydrachna*. Biesiadka & Cichocka (1994) found similarly rate of infection for the Hydrachnidae parasitic on water hemipterans. Davids (1973) reported much higher extensiveness of infection in the case of *H. conjecta* occurring on *Sigara striata*, *S. falleni*, and *Cymatia coleoptrata*. Though in this case the material was only composed of preferred hosts and sampled at only two stations, which were characterized by massive infection.

The number larvae, the intensity of infection and the infection rate were higher in Dytiscidae than in Hydrophilidae (Table 1). This was the result of the different strategy of infection. On the Dytiscidae, the highest values were regitered on the genera *Dytiscus* and *Acilius* parasitized by *H. geographica* and *H. inermis* (Table 1). The remaining infected species of beetles were determined as optional hosts.

The strategy of *H. geographica*: H. geographica characterized a highest extensity and intensity of infection (Table 1), and selects beetles with large body size as hosts. The host with a large body size and the great number of eggs produced by the female contribute to the high intensity of infection observed. The fairly high extensiveness of infection depends of the common occurrence of this species in spite of the relatively small numbers of its imagines. The discrepancy between the numbers of larvae and adult individuals suggests the high mortality of one of the preimaginal stages, most probably the stage of the parasitic larva (see below).

The strategy of *H. inermis* : the intensity of infection by *H. inermis* is relatively high (Table 1). The lower extensiveness of infection of beetles by *Hydrachna inermis* shows that this species is rare, this being confirmed by faunal studies. In this case a great discrepancy was recorded between the number of larvae and imagines, suggesting the high mortality of the larval stage.

The greatest number of collected larvae and the highest infestation rate were determined for *Anacena limbata* and *A. lutescens*. This was due to the most numerous parasite (*H. incognita*), which preferred these beetle species as hosts. In this case, the lower intensity (1-4, 1.2 on average) of infection compared with *H. geographica* and *H. inermis* is connected with the smaller body size of the hosts. The infestation rate shows the rare occurrence of adult individuals similar to that observed in *H. inermis*.

It is obvious that the intensity of infection is associated with the body size of the host. This is confirmed by earlier studies (Davids 1973, Biesiadka & Cichocka 1994) on parasitic species of water hemipterans, showing that only large species were intensively infected (*Nepa cinerea* and *Ranatra linearis*).

In natural conditions it is probable that the most available species (*i.e.* the most frequent in the given environment) are selected for hosts. No correlation or a negative one indicates changes in the numerical structure of host species, at least in relation to the environments where water mites have infected them. No such correlation was evidenced for the entire acarologic material owing to the large number of facultative hosts, characterized by the great fortuity of infection. This is chiefly due to *H. geographica* which has the largest number of facultative hosts. A strong correlation of this type occurs between the different parasitic species and the host species preferred by them. The positive correlation characteristic of *H. geographica* and *H. incognita* shows that no significant changes occur in the numerical structure of their hosts or in the plasticity of the parasite in relation to the hosts.

The negative correlation characteristic of *H. inermis* suggests the occurrence of larger numbers of *D. circumcinctus* in the past. Being less numerous than *D. dimidiatus*, it was more frequently infected by this water mite species. Biesiadka & Cichocka (1994) reported similar changes in the numerical structure of water hemipterans.

The site of attachment of the water mite larvae on the body of beetles is an other adaptable trait. Except for *H. inermis*, all the water mite species attached themselves under the elytra thus they lived in the environment of the atmospheric air. This position protects them from mechanic removal from the beetles swiming in water. The larvae were mostly attached on the upper surface of the first fourth segments of the abdomen: this central position under the elytra give them the best protection and avoid mechanical injuries even during the flight. The fairly large number of *H. geographica* found laterally on the first fourth segments (28.0 %) and on segments V-VII (22.5 %) was a consequence of the high intensity of infection. The number of larvae per beetle involved the extension of attachement sites on a larger surface. Sites attachments of *H. inermis* on the outer surface of the bodies of beetles expose the larvae to a lower protection from mechanical injuries: however, the parasite "endeavoured" to find the least exposed place and is chiefly attached to the central part of the thorax.

The analyses of the size of larvae show a distinct decrease in the number of largest larvae. This relation estimates the mortality. It was exceptionally high in the case of two species (*H. geographica* and *H. inermis*) the attachment sites of which on the beetles providing not a good protection to mechanical injuries: *H. inermis* on the outer surface and *H. geographica* on the peripheral parts of the abdomen under the elytra. *H. incognita* which almost only parasitized the upper surface of the first fourth segments of the abdomen, was characterized by a high but lower mortality than the former species.

As depending on the date of sampling, analysis of the size of larvae permits the determination of the number of generations during the year and the time of infection and of the transformation of the larvae into the deutonymph. The diversity of the material, however, makes the interpretation very difficult. The beetles originate from different years hence the probability arises that some shifts might appear in the development of generations. Additionally the unknown rate of growth of the larvae contributes to the uncertain picture of the situation.

The water mites are species associated with spring astatic waters and they are characterized by a considerable shortening of the maturation and reproduction periods. The occurrence of larvae of the smallest (the time of infection) and the largest body size (the time of transformation in deutonymphs) occur from spring to summer. In some case the reproduction may be extended to summer time: the greatest numbers of small and medium-sized larvae *H. inermis* and *H. crassipalpis* were found in summer-autumn (fig. 2). Most probably these species are connected with astatic waters of longer duration or with astatic zones of permanent water bodies, this inducing the prolongation of the reproduction period.

The occurrence of large (0.61–1.00) *H. incognita* larvae in July might indicate that this is the period of transformation of the larva into the deutonymph. Though this is in variance with the ecological characteristics of the species and much greater dimensions of imagines. The greatest size of larvae found here was one millimetre whereas that of imago reached four millimetres (Wajnstein 1976). The above discrepancy and the lack of coleopterological material from early spring months suggest that the transformations of larvae occur in that period.

The occurrence of a tiny larvae in autumn is interesting (fig. 2). It could be attributed to the second generation in year due to the reproduction in autumn astatic waters. Though, faunal records deny it as no astatic species are found in the autumn period. The probable explanation of this phenomenon is that the period of draught can be survived in the egg form. After the water bodies are refilled in autumn, the hatching larvae infect the beetles.

Environmental conditions of the parasitism

The genus *Hydrachna* parasitizing water beetles are chiefly connected with astatic waters, and the greatest number of infected larvae would be found in this environment. The investigation did not confirm the assumption. The greatest number of water mite larvae was found on beetles occurring in sphagnum peat bogs, then in small eutrophic water bodies, small forest water bodies, lake littoral, and in astatic and flowing waters. It should be mentioned that this large number of larvae found in peat bogs is accidental, since all the beetles infected by water mites were collected in one environment, a peat bog near Kościerzyna. A pronounced secondary eutrophication and certain astaticism characterized the Kościerzyna station, permitting the invasion of astatic species and these associated with small-water bodies. The above statement can be confirmed by the absence of parasitizing water mite larvae on acidophilous beetles. Here *Dytiscus lapponicus* is the only exception though the entire collection of infected individuals of this species was found in the above-mentioned peat bog at Kościerzyna. *Hydrachna geographica,* the parasite of this beetle is characterized by the optional selection of hosts, manifesting preference for large individuals of the family Dytiscidae. All the large beetles of the family Dytiscidae (chiefly of the genera *Dytiscus, Acilius,* and *Graphoderus*) occurring on this peat bog were infected by the above water mite on a mass scale. The fact that *Dytiscus lapponicus* is a flightless beetle additionally increased the extensiveness of infection of this species compared with allied beetle species since the migration of the remaining species brought about the mixing of the population in this station with the populations occurring in different neighbouring water bodies.

Since the sphagnous peat bogs were excluded from the list of environments with a mass occurrence of infected beetles, the environment from which the decisively greatest number of infected beetles was obtained, was that of small eutrophic water bodies. The ecological characteristic of infected beetles confirms this statement. Most beetle species infected by water mites of the genus *Hydrachna* are these inhabiting small-water bodies.

Species of the genus *Hydrachna* whose larvae parasitize water beetles, belong to the subgenera *Hydrachna* s. str. and *Rhabdohydrachna*. All the species of these subgenera are rare and occur in scarce numbers: it is difficult to determine exactly their ecological preferences. Nonetheless it can be assumed that all the species are to a greater or smaller degree associated with astatic water or with astatic zones of permanent water bodies. The beetles infected by the above parasites are inhabiting small-water bodies, suggesting the discrepancy between the "zone of infection" and the "zone of parasitism" owing to the lack of coleopterological fauna typically associated with the environment of astatic waters. In this connection the infected beetles are characterized by the smallest environmental specificity and by the greatest mobility. In the spring season when the shallow astatic waters are characterized by increased temperatures, the greatest numbers of these bugs colonize them. The bugs inhabiting small-water bodies correspond with the above characteristic and thus water mites of *Hydrachna* genus infect them. Such a selection of host species is the adaptability trait. Water mites from astatic waters spent a large part of their lifetime as parasitic larva. During this stage the main increase in body size is realized. The ephemerality of astatic environments necessitates the selection of such a host, which will live the main part of the year in an other environment and will be able to return to the astatic environments the next year. Some beetles of the families Dytiscidae and Hydrophilidae correspond with this characteristic. Of the family Dytiscidae *Acilius sulcatus* and bugs of the genus *Dytiscus* are most severely infected. Apart from the great mobility, the large body dimensions characterize them permitting considerable increases in body size of the parasites. Of the family Hydrophilidae *Anacena limbata* and *A. lutescens*, the species most abundantly colonizing astatic waters in spring, are most severely infected.

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