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An experimental study of the survival rate of some *Mallophaga* outside of *Columba livia dom.* body*

Badania doświadczalne nad przeżywalnością wszołów z *Columba livia dom.* poza ciałem żywiciela

Abstract

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Columbicola columbae columbae and *Campanulotes bidentatus compar* lived in the room temperature on pigeon skins up to 16 days, in test-tubes containing feathers 6–45 days, and in those without feathers 3–11 days, while *Bonomiella columbae* survived only 2–3 days. Under artificial conditions the longevity of *Mallophaga* varied according to the species, sex, developmental stage and season of the year. The viability degree and capability of reproduction in *Mallophaga* outside of the host and on the dead host are discussed.

The biology of the bird-parasitizing *Mallophaga* is still very poorly known. Experiments elucidating their life requirements are especially needed for cultivating them in vitro. The published information on the culture of *Mallophaga* from pigeon concerns *Columbicola columbae columbae* (L.) (MARTIN 1934, EICHLER 1936 a, b, 1937, CONCI 1952, 1956, STENRAM 1956), *Campanulotes bidentatus compar* (Nitz.) (CONCI 1952, NELSON and MURRAY 1971), and *Neocolpocephalum* (*Neocolpocephalum*) *turbinatum* (Denny) (NELSON 1971); other species, including *Bonomiella columbae* Emers., have not been cultivated. The cultures are reputed difficult to carry out, and this opinion is confirmed by unsuccessful attempts to pass some species, e.g. *Campanulotes bidentatus compar* (CONCI 1952, NELSON and MURRAY 1971) in vitro through their full developmental cycle. It seems, nevertheless, that mallophagan ability to survive out of the host is not so meagre, as some authors are inclined to believe. While according to BLAGOVEŠČENSKIJ 1940, 1959 mallophagans can live one to three days after the death of the host, and KÉLER 1969 considers the survival period to be several days, ZŁOTORZYCKA 1962, as well as ZŁOTORZYCKA and DANECKI 1962, have ascertained the ability of *Mallophaga* from certain birds to outlive their hosts by up to a month.

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Consequently it seems possible that direct contact with their hosts is not the indispensable condition for these parasites to shift from one bird to another. Thus, the aim of the present work is to investigate the behaviour of *Mallophaga* after the death of their host, and to examine their survival rate under nearly natural conditions.

Material and methods

The material came from 20 domestic pigeons – some of them bred in captivity, the others free-living – from Wrocław, delivered between April 1974 and February 1975. All the birds were found to be infested with *Mallophaga*, but intensity and incidence of infestation proved different in the three species recorded. The material is specified in Table I.

Table I
Mallophaga species recorded on 20 pigeons

Stages of development	*Columbicola c. columbae*	*Campanulotes b. compar*	*Bonomiella columbae*
Imagines ♀♀	297	78	18
♂♂	232	153	–
Larvae	723	97	–
Total	1252	328	18

Mallophaga were picked up with pincette from the skins of freshly killed (decapitated or suffocated) pigeons. According to the experiments planned, collecting of the material from each skin was carried out successively during several days. Some of the mallophagans were left in the plumage in order to check their survival rate in such circumstances; lignin wrapped round the skin prevented the insects from migrating out, while marking as many of them as possible with red acetone enamel allowed us to investigate their movements. The skins were left on the table and the survival of the *Mallophaga* was checked at intervals of several days.

Preliminary experiments consisted in keeping the parasites alive in thermostate (+40°C), in refrigerator (+4°C) and in test-tubes, plugged with wet pieces of cotton-wool, at room temperature. Taking the opportunity we tried also to feed them with feathers of *Turdus merula* which is the host of completely different species of *Mallophaga*.

In the actual, more rigorously controlled experiments, the parasites were placed in test-tubes 7.5 cm long and 1.4 cm in diameter and kept at room-temperature, i.e. 20–24°C (exceptionally 30°C); the humidity has not been measured. Some tubes were left empty, while the others contained feathers from different parts of pigeon's body. Survival of *Mallophaga* were checked at intervals of several (sometimes more than ten) days in summer and much more frequently – even every day – in the other seasons. At each control, dead and living insects were separated and exactly counted.

Results and discussion

Behaviour and the survival rate of *Mallophaga* on the skins stripped from pigeons

Although normally neither *Columbicola columbae columbae* occurs on the head of pigeon, nor does *Campanulotes bidentatus compar*, nevertheless shortly after skinning of the bird both the species migrate to the tips of

the head feathers. In the case of strong invasion, this well known "Drost effect" (EICHLER 1970) could be observed in our material already within two hours. EICHLER's 1970 study of *Mallophaga* from *Turdus merula* led him to suppose that the parasites leave subsequently the dead bird's head and return to their original biotopes. Our observations support this suggestion: after more than ten days some insects were still ascertained to gather on the head feathers (it is not known, whether they were the same individuals as before), the rest being found on the surface of other feathers, on the adjacent lignine, or even on the other side of the wrapping. Observation of 20 marked individuals provided us with more precise data. The *Mallophaga* have been marked the day after skinning of the dead bird, when they appeared on the surface of feathers. At the every-day controls made during two subsequent weeks, the survival rate of the marked and unmarked parasites was recorded. After 14 days, when living mallophagans were not observed any more, dead marked insects were recorded on the lignin (5 specimens) and on the surface of wing feathers (3 specimens), whereas further 10 specimens were shaken out of the deeper parts of the plumage. In the course of other experiments with unmarked material, living *Mallophaga* were still observed after 16 (in summer) or 15 (in autumn) days.

Experiments in test-tubes

In different seasons of the year, 46 experiments have been carried out in laboratory (without any attempt to stabilize temperature and humidity). In empty tubes (11 trials) the mallophagans lived 3–11 days, while in the presence of feathers (35 trials) the survival period extended from 6 to 45 days.

The experiments were executed successively as the material came in; in most cases the species were treated together (10 to 64 individuals at a time), in direct connection with different incidence and intensity of their occurrence. The most frequent and the most numerous parasite was *Columbicola columbae columbae* found (1028 specimens) on all the pigeons studies; *Campanulotes bidentatus compar* (229 specimens) occurred on most birds, while only two pigeons harboured *Bonomiella columbae* (18 females altogether).

In 93.2% of our experiments the last surviving individual was *Columbicola columbae columbae*, and in only 1.7% *Campanulotes bidentatus compar* (in 5.1% of cases both species lived equally long). On the average, the mallophagans of the genus *Columbicola* lived twice as long as those belonging to *Campanulotes*, whereas studied *Bonomiella columbae* specimens died very soon (within 2–3 days) even in tubes containing feathers.

The survival periods of *Mallophaga* were different in different seasons of the year (Fig. 1), but after one year of experiments any firm conslusion is impossible. Great differences in survival rates are possibly connected with varying temperature as recorded in the laboratory: in cooler periods it was about 20°C, while in torrid summer days it reached 30°C, approaching reported optimum for *Columbicola columbae columbae* (33–36°C, according to ZŁOTORZYCKA et al. 1974). As NELSON's 1971 observations on cultures of *Neocolpocephalum* (*Neocolpocephalum*) *turbinatum* indicate, some importance can be also attributed to the fact that less frequent summer controls caused less disturbance, than it was in the other seasons. It seems, moreover, that the biological characteristics of mallophagans can

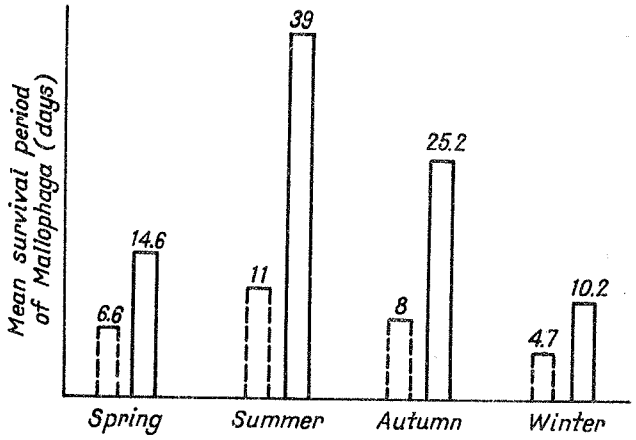

Fig. 1. Mean longevity of *Mallophaga* in test-tubes in various seasons of the year: solid line – experiments with feathers; broken line – experiments without feathers; the number of days is indicated above the columns

influence their survival while out of the host: in species under study, the intensity of infestation – which, as the experimental data shown in Fig. 1 lead to believe, may also be related to the survival rate – reached its maximum in the summer. It is also worth mentioning, that in summer the percentage ratio of females: males: larvae in *C.c. columbae* (21.5: 15.3: 63.2, respectively) was attributable to developing population (ZŁOTORZYCKA 1972**).

In the course of each experiment the mortality rate of *Mallophaga* gradually increased; the increase was very rapid during the first few days, but slackened afterwards (Fig. 2), irrespective of the initial number of individuals at the beginning of the experiment, nor of the presence or lack of feathers in the test-tube. As can be seen from Fig. 2, the longest-living parasites came usually from the most abundant samples; in our opinion, the reasons of this is not only the abundance of viable individuals that probably increases with the size of a sample: some factors conducive to survival of *Mallophaga*, e.g. those acting in summer, might also play certain role. On the other hand, excessive density possibly increased the death-rate of the insects during the first days of the experiment.

The abundance of males, females and larvae among the longest-living individuals was unequal: the maximal longevities were attained by females (35.7% in tubes containing feathers and 60.8% in the empty ones) and larvae (78.6% and 58.6%, respectively) much more frequently than by males (21.4% and 19.6%). The same rule applies as well to the mean periods of survival recorded in all seasons of the year: females and larvae lived longer than males (Fig. 3). It is interesting that at various stages of experiments – even those going on for many days – variously aged larvae were found. According to ZŁOTORZYCKA 1962 and ZŁOTORZYCKA and DANECKI

** The paper contains drawings of all the species of *Mallophaga* under present study.

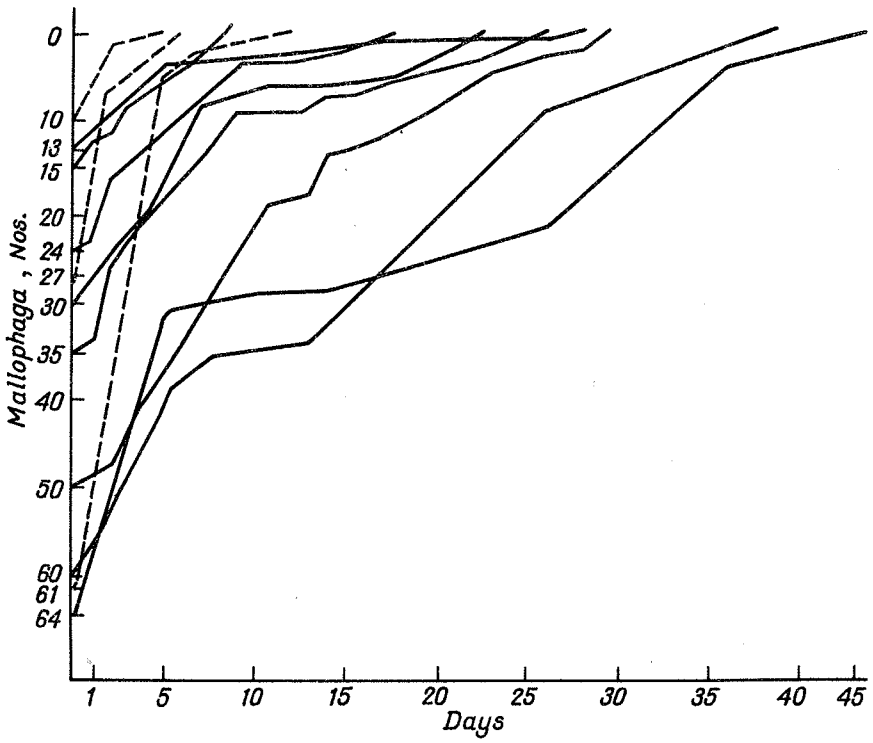

Fig. 2. Increase in mortality-rate of *Mallophaga* in 11 experiments in test-tubes: solid line – experiments with feathers; broken line – experiments without feathers

1962, the presence of mallophagan larvae (sometimes very young ones) on dead gulls and on skins of capercailyes indicates that the parasites not only survived for a long time under abnormal circumstances, but even remained capable of reproduction. According to BLAGOVEŠČENSKIJ 1959 the complete cycle of development in *Mallophaga* lasts several weeks. Consequently, ZŁOTORZYCKA and DANECKI (op.cit.) believe that in cases when very young larvae are seen on the skin of a bird killed a month ago, the eggs must have been laid after host's death.

In the course of our observations on the survival rate in *Mallophaga*, we collected also larvae (even more numerous than the adults) from pigeon skins. The larvae, at various stages of development, were found together with adults for up to 16 days. In view of EICHLER's et al. 1972 data on the duration of various stages of *Columbicola columbae columbae* (4 days for egg, 7 days for each of the three larval stages) the suggestion of ZŁOTORZYCKA and DANECKI 1962 would seem justified; it fails, however, to explain the longevity of the larvae involved in the present experiments, since the eggs have never been observed, nor have exact counts of the insects at each control demonstrated any increase of their number. Perhaps this indicates some inhibition of larval development taking place in such conditions; hence, one could suppose that prolonged life out of pigeon generates certain inhibition in the ontogenesis of *Mallophaga*.

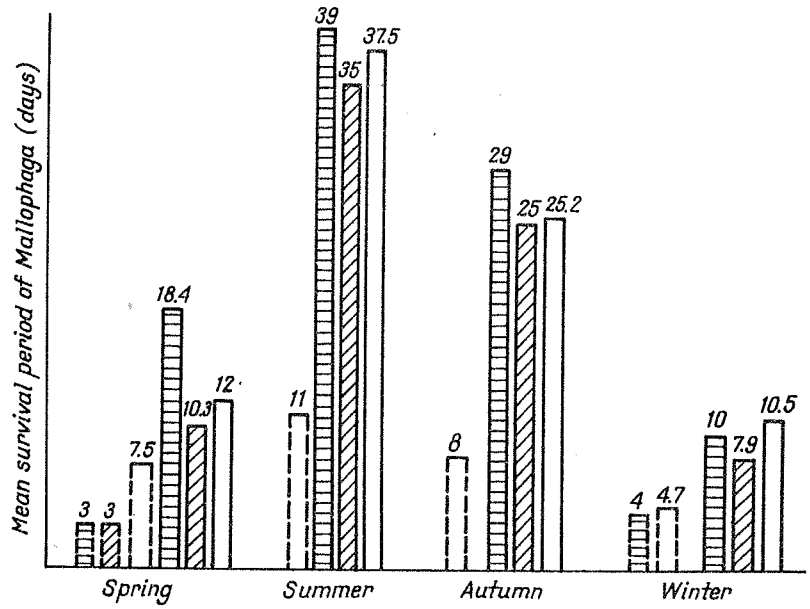

Fig. 3. Mean longevity of different developmental stages of *Mallophaga* in test-tubes in various seasons of the year: solid line – experiments with feathers; broken line – experiments without feathers; horizontal hatching – females; diagonal hatching – males; without hatching – larvae; the numbers of days indicated above the columns

Summary of conclusions

As regards the survival of *Mallophaga* while out of the host, repeated tests in room temperature proved much more effective than experiments in other conditions involving thermostate, refrigerator, humidification within the test-tubes. It is, however, worth mentioning that *Columbicola columbae columbae* kept on the feathers of blackbird survived a little longer than those starved in empty tubes (8 days and 6 days, respectively), whereas on pigeon feathers – their natural food – they lived three times as long as on those of other species of bird. While until recently there was nothing known about the biology of *Bonomiella columbae*, we availed ourselves of finding this very rare species and took observations concerning their movements (REM and ZŁOTORZYCKA 1976).

The results of our experiments seem to indicate certain degree of plasticity in life requirements of *Mallophaga*, making them capable to survive under unfavourable conditions, e.g. during the moult of their hosts, when some parasites surely lose contact with the bird; without further studies it is impossible, however, to answer the question of how long the insects living out of the host retain invasive propensity.

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STRESZCZENIE

Przeprowadzone badania nad żywotnością wszołów z gołębi *Columba livia dom.*, wykazały, że *Columbicola columbae columbae* (L.) i *Campanulotes bidentatus compar* (Nitz.) utrzymywane w temperaturze pokojowej na zdjętych skórach z gołębi, przeżywały najdłużej do 16 dni; okres ich przeżywalności w probówkach z piórami jako pokarmem wynosił 6–45 dni, zaś w probówkach bez piór przeżywały 3–11 dni. Natomiast u *Bonomiella columbae* Emers. zdolność przeżywania była bardzo mała (2–3 dni) zarówno w probówkach pustych jak i zawierających pióra. Długość życia wszołów w sztucznych warunkach była zróżnicowana w zależności od gatunku, płci, stadium rozwojowego pasożyta i od pory roku. Uzyskane wyniki potwierdzają wcześniejsze obserwacje autorek, które wskazują na możność rozmnażania się wszołów na żywicielach po ich śmierci oraz na skórach po zdjęciu ich z żywicieli.