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THE PASSAGE OF MITES THROUGH THE ALIMENTARY CANAL OF VERTEBRATES

(Ekol. Pol. 18: 741–756). It has been experimentally found that *Carpoglyphus lactis* (L.) and *Thyreophagus entomophagus* (Laboulbène) are to some extent resistant to some ecological factors, approximate to those in the alimentary canals of vertebrates (oxygen-free atmosphere, liquid habitat, 0.5% HCl and temperature + 36°C). Therefore it can be assumed that the mites consumed together with food may pass alive through the alimentary canal of stenothermic organisms. This has been proved experimentally and it was found that 1–7% of living mites passed through the alimentary canals of mice and birds. This proves the possibility of dispersion of mites also in an endozoic way by various animals, which are their vectors.

I. INTRODUCTION

The mites as pests of stored products are of great economical significance, and as they can be found in many food products the sanitary-health aspects are also not without significance. However, in literature we may come across opinions that the products affected by mites, e.g. fodder given to domestic animals, do not have a negative effect on their health (Szwabowicz, Międzobrodzki 1957, Szwabowicz, Międzobrodzki, Drzuzgiewicz 1958). But the majority of the authors of scientific papers and manuals are of the opinion that mites found in food products as well as their excrements,

setae and skins of body may cause diseases among people and also animals (Baker, Wharton 1952, Bartoš, Pulpan, Verner 1961, Beklemiševa 1949, Kiełczewski, Żółtowski 1951, Martini 1952, Młodecki 1965, Młodecki, Żurkowska 1957).

The most frequent diseases caused by mites found in food products are gastrocolitis, diarrhoea, miscarriages, nauseas, headaches and discomfort among people and animals that consumed the products affected by mites. Młodecki, Żurkowska (1957) and Młodecki (1965) observed some histopathological changes, haemorrhages and symptoms of blood stasis in some internal organs of experimental mice and rats fed with fodder containing mites. The stored products mites not only may get into alimentary canal but also to other internal organs, thus causing various indispositions.

The literature quotes cases of pulmonary acariasis (Hughes 1961), finding mites in urine of people suffering from cystitis and nephritis (Baker, Wharton 1952, Żółtowski 1954) and also in human sputum (Martini 1952).

As far as the passage of living mites through alimentary canals is concerned, similarly as in the instance of the harmfulness of products affected by mites, the opinions in literature are contradictory. Kunze (after Martini 1952) and Młodecki and Żurkowska (1957) are of the opinion that the mites and their ggs die in the alimentary canals of mice. Bulanova (1940) and Beklemíševa (1949) and her associates are of the opinion that the mites may pass alive the alimentary canal of a mouse.

The passage of living mites, undamaged, through the alimentary canals of animals apart from its sanitary aspect may also be of significance in dispersion of the harmful mites. In order to find out what is the situation I have carried out several experiments, the results of which are presented in this paper.

II. METHODICS AND THE COURSE OF EXPERIMENTS

Investigations were carried out in the years 1967–1968, at the Institute of Plant Protection, in Poznań, mainly on two species of mites: *Carpoglyphus lactis* (L.) and *Thyreophagus entomophagus* (Laboulbène) completing them with observations on *Tyrophagus putrescentiae* (Schrank), *Acarus siro* L., *Glycyphagus domesticus* (De Geer) and *Caloglyphus* sp. The mites for experiments were obtained from cultures in laboratory conditions.

In the first series of experiments the effect of several ecological factors approximate to those in conditions of alimentary canals of stenothermic organisms, on mites was investigated in vitro. The variants of experiments were as following:

A. Survival rate of mites in oxygen-free atmosphere was investigated by placing them in the atmosphere of pure nitrogen (N_2). Therefore the

test-tubes of a 100 ml capacity, out of which the air had been previously removed, were filled with pure N_2, and then under distilled water the mites were introduced into them. The test-tubes were corked and kept in a vessel under distilled water. Thus protected against the air access the mites were placed in a thermostat having constant temperature close to the temperature of human body, i.e. about +36°C. The experiment was made in 4 repetitions. In each repetition 6 test-tubes with *C. lactis* and 3 test-tubes with *T. entomophagus* were prepared. In each test-tube 25 mature mites of both sexes were placed and also eggs and individuals in other development stages, the number of which was not determined. The experiment was checked in the instance of *C. lactis* after: 4, 8, 18, 24, 40 and 64 hr, and in the instance of *T. entomophagus* after 24, 40 and 64 hr since the beginning of experiment. In order to check the survival rate of mites after a determined period of time one test-tube was taken, into which the atmospheric air was let in for a period of 2–3 hours, and the number of living and dead mites was counted. Living mites and eggs and individuals in resting form were placed in optimal conditions for the life of mites, i.e. at a temperature +25°C, at a relative air humidity 85% and in the presence of food, in order to observe their behaviour and their further development.

B. The survival rate of mites directly submerged in distilled water was investigated in a thermostat at a temperature +36°C. The test-tubes with mites, filled with distilled water were corked and submerged in a vessel under a layer of distilled water in order to avoid the access of air from the environment. The number of repetitions and of mites used in the experiment was the same as in the experiment with nitrogen. A check of experiments was also made similarly, but 2–3 hours before the control the water was removed from the test-tubes to allow the mites a contact with atmospheric air.

Parallely similar experiments with mites submerged in distilled water were carried out in open test-tubes thus having the access of atmospheric air.

C. Observations on the survival rate of mites in normal atmospheric air were made in 100 ml test-tubes, corked and containing mites without food, at a temperature +36°C. The number of repetitions and mites, and the method of checking were the same as in previous experiments.

Also mites placed at a temperature +25° C, in normal air were observed.

D. The reaction of mites to hydrochloric acid was investigated at +36°C, placing them in open test-tubes of a capacity 100 ml, filled with aqueous solution 0.5% HCl, and so in a solution with a concentration approximate to the concentration of this acid in gastric juice, i.e. 0.4–0.6% (Heller, Karpiak 1949). The number of repetitions and mites and the control of experiments were the same as in previous experiments.

Some irregular observations on the survival rate of mites were carried out in a 0.5% HCl solution without air access, and also additionally in 5% HCl solution in vessels having the access of atmospheric air.

In the second series the experiments were carried out in vivo on the passage of these same species of mites through the alimentary canal of white mouse (*Mus musculus* v. *alba* L.), domestic sparrow (*Passer domesticus* L.), domestic hen, and also one observation of the passage of mites through the alimentary canal of man. A whole and granulated wheat grain, fodder mixture DK and drinking water were given as food to the animals before the experiment. On the day preceding the experiment the animals got no food with the exception of drinking water. The following day the animals were given a diet consisting of granulated wheat grain, wheat flour and a substrate strongly affected by mites (depending on the species of mites these were: wheat germs, jam or baker's yeast). All this was moistened with water and after mixing, a substrate was obtained having the consistency of dough. After forming small pieces the food was given to the animals in their cages. The brims of glass vessels, in which the food was served, were covered with glycerine in order to decrease the possibility of escape of mites beyond the vessel. After 2–3 hours after feeding the animals were transferred to other cages and rooms in order to prevent a secondary infection of animal faeces by mites, which might find their way from the food dispersed by animals. In new cages the animals were given grain without mites and water, and the faeces were removed and analyzed within 1–3 hours or directly after defecation during the period of 8–12 hours from the moment of feeding the animals with food containing mites. Besides, it has been found that the generally accepted methods of faecal analyses on the presence of mites in the faeces such as: methods of Telemann, Fulleborn, Kalantarjan, Gorkina (Predtečensk j, Borovskaja, Margolina 1953) are of no use in determining whether the mites found in the faeces were alive or dead. This is due to the application of reagents in these methods, which kill the mites already weakened by the passage through the alimentary canal. The method of faecal analysis on the presence of mites in fresh preparations, i.e. without being previously prepared, has a weak point – the amount of analyzed material can be only very small, and because the number of living mites after their passage through the alimentary canal is also relatively small, the possibility of their finding is also slight. Therefore it was necessary to prepare a different method.

In the presented experiments a method of direct faecal analysis was applied. The faeces, the best immediately after defecation, were placed on filter paper and moistened with water for 1–3 hours, which prevented their drying and at the same allowed to regain the ability of moving by those mites that lost it during their passage through the alimentary canal. Then on to

a disk of filter paper, also moistened with distilled water, placed on a watch glass, the single portions and bits of faeces were transferred and looked at under the stereoscopic microscope, at a magnification 2 × 12.5. Dead mites and immobile forms were transferred into an embriologic vessel with distilled water, while the living individuals were placed directly in culture vessels on food in order to continue the observations. This method requires a lot of work, as the amount of analyzed material must be quite big, but allows to state the passage of living mites through the alimentary canal of vertebrates and find them in the excrements.

Apart from that, in order to find living mites, the faeces were placed in the optimal conditions for the life of mites, i.e. in conditions of increased relative humidity of air 85–95%, at a temperature +20 – +25°C and in the presence of food attractive for the mites. After several days living mites have been observed, which passed from faeces to food.

The presence of alive, moving mites can be also discovered by placing the faeces in water for a period of several hours to several days.

These two last methods of finding out the living mites in excrements are not so accurate as the method of direct faecal analysis and should be treated as auxiliary ones having an indicatory character.

As a result of the faecal analyses the number of macerated mites was determined and also of those, which died in the alimentary canal but retained their normal appearance, and the number of living mites.

A single observation on the passage of mites through the alimentary canal of man was carried out as a result of faecal analysis made in almost 15 hours after the consumption of strongly affected dried figs, raisins and plums by *C. lactis* and *T. entomophagus*, 2–3 hours after defecation.

III. RESULTS OF EXPERIMENTS AND DISCUSSION

1. Survival rate of mites in artificially created conditions

The respiratory system of mites are comparatively poorly developed and this is so mainly among some bigger species with thickened and hardened carapaces. But among many species of mites, including those from the families *Glycyphagidae* and *Acaridae*, which have thin and delicate cuticular thecae, the respiration is by the gaseous diffusion through the entire body surface. The oxygen demand of mites increases at higher temperatures, when their activity is greater and life processes proceed more intensely. Even cursory observations of these animals prove it. Extensive cultures of mites die in tightly closed containers, at a temperature +15° – +30°C not aired for several

consecutive days. But at a lower temperature 0 – +15°C, where the activity of mites is smaller, the cultures do not have to be aired so frequently, once in few or several days is enough and no harm is done.

In the experiments mainly carried on *C. lactis* and *T. entomophagus* on the effect of oxygenfree habitat on these mites, it was found that they may survive in that habitat for some time. In an atmosphere of pure nitrogen (N_2), at a temperature +36°C, after 40 hr, about 10% of *C. lactis* individuals and 5% of *T. entomophagus* individuals maintained their vitality. After 64 hr in these conditions all the mites were dead (Tab. I).

Survival rate of mites in the atmosphere of pure nitrogen (N_2), at a temperature +36°C

Tab. I

Species of mites	% of living mites, after:					
	4 hr	8 hr	18 hr	24 hr	40 hr	64 hr
Carpoglyphus lactis	85	60	25	20	10	0
Thyreophagus entomophagus	–	–	–	10	5	0

Number of examined mites – 100 individuals of both sexes in each combination.

Survival rate of mites submerged in distilled water, at +36°C

Tab. II

Species of mites		% of living mites, after:					
		4 hr	8 hr	18 hr	24 hr	40 hr	64 hr
Carpoglyphus lactis	*a*	–	90	50	45	20	0
	b	100	92	70	60	32	0
Thyreophagus entomophagus	*a*	–	–	–	20	10	0
	b	–	–	–	40	25	0

a – without the access of atmospheric air, *b* – with the access of atmospheric air.

Number of examined mites – 100 individuals of both sexes in each combination.

Investigating the survival rate of mites submerged in distilled water without the access of air, at a temperature +36°C, it was found that after 40 hr 10–20% of individuals were still alive. In distilled water with an access of air from the atmosphere, at +36°C, about 30% of mites (Tab. II) survived the period of 40 hr. Therefore the survival rate of mites in distilled water is slightly higher than in the same conditions in the atmosphere of pure nitrogen. This probably takes place due to the fact that the mites while respiring with the entire body surface use the oxygen dissolved in water.

The survival rate of mites, at a temperature +36°C, was the highest in normal atmospheric air. After 40 hr only about 10–15% of mites (Tab. III) died, which is much less than after the same period of time in the atmosphere of pure nitrogen N_2 and in H_2O.

Survival rate of mites in normal atmospheric air, at temperature +36°C

Tab. III

Species of mites	% of living mites, after:					
	4 hr	8 hr	18 hr	24 hr	40 hr	64 hr
Carpoglyphus lactis	100	99	98	93	91	89
Thyreophagus entomophagus	–	96	94	94	85	83

Number of examined mites – 100 individuals of both sexes in each combination.

Survival rate of mites submerged in 0,5% aqueos solution of hydrochloric acid (HCl), at temperature +36°C, without air access

Tab. IV

Species of mites	% of living mites, after:					
	4 hr	8 hr	18 hr	24 hr	40 hr	64 hr
Carpoglyphus lactis	–	20	8	0	0	0
Thyreophagus entomophagus	–	30	10	0	0	0

Number of examined mites – 100 individuals of both sexes in each combination.

Investigations on the effect of hydrochloric acid solution (HCl), in a concentration 0.5% approximate to the concentration of this acid in gastric juice, without air access, at a temperature +36°C, showed that after 8 hr of being submerged in the solution 20–30% of *C. lactis* and *T. entomophagus* individuals were still alive, and after 18 hr 8–10% of mites (Tab. IV) were still alive. Observations carried out on *T. putrescentiae*, *A. siro*, *G. domesticus* and Caloglyphus sp. showed that in the same conditions these mites were more sensitive than *C. lactis* and *T. entomophagus* and died in 100% already after several hours. According to Szwabowicz and Międzobrodzki (1957) *T. siro* placed in water solution of hydrochloric acid and pepsin, at a temperature +38°C, died already after 3 hr, which is connected not only with the action of, HCl but also of pepsin and slightly higher temperature.

In additional observations on *C. lactis* and *T. entomophagus* placed in a 0.5% HCl solution, at an access of atmospheric air, it was found that the mites lived longer than when without the access of air, and single individuals even longer than 70 hr. The mites placed in 5% aqueous HCl solution, that is in a concentration 10 times stronger than the concentration of acid in

gastric juice, may survive a period of 6–8 hr. In temperatures lower than the temperature of human body, e.g. +20 – +25°C, single individuals were still moving after 18 hr in 5% aqueous HCl solution.

The investigations on the effect of various temperatures on *C. lactis* (Chmielewski, in press) show that a temperature approximate to the temperature of human body, even at an optimum of the other factors forming the life conditions of mites is unfavourable for the development of this species, but still the mites may survive in these conditions for some time. E.g. mature individuals of *C. lactis* lived on the average in that temperature, at a relative air humidity 85%, 4 days without food, and 11 days with food, while at the most favourable temperatures (+15 – +25°C) – 20 and more days.

The mites, which in the experiments survived the action of artificially created, unfavourable conditions, after being transferred into optimal conditions regained their ability to move, they grazed, copulated, laid eggs and performed all life functions, similarly as mites in control cultures. Also eggs and other development stages, which survived, developed further.

In all these experiments the least susceptible to the action of unfavourable conditions was *C. lactis* and *T. entomophagus*, while *T. putrescentiae*, *A. siro*, *G. domesticus* and *Caloglyphus* sp. were more sensitive.

The survival rate of mites in artificially created habitat conditions, partly approximate to those in the alimentary canal, such as oxygen-free atmosphere, liquid habitat, action of 0.5% aqueous HCl solution and temperature +36°C, allowed to draw a hypothesis that the mites consumed, together with the food affected by them, may pass alive through the alimentary canal of vertebrates, what has been confirmed in experiments on the passage of mites through the alimentary canals of mice and birds.

2. Survival of mites after the passage through the alimentary canal

In the experiments on the passage of mites through the alimentary canal of white mouse, domestic sparrow and domestic hen it was found, that the mites consumed by these animals together with the food were excreted together with the faeces (Fig. 1). The mites stayed in the alimentary canal for 3–12 hr. Part of them (35–65%) was digested. Their bodies were deformed, strongly macerated, sometimes mechanically damaged in a visible way, totally or partly void of gut contents in such a way that sometimes only the skins were left. Part of the mites was not digested. These mites retained their normal appearance (Fig. 2, 3). The majority of them were individuals, which died in the alimentary canal as a result of suffocation or mechanical injury, or individuals in the resting form. The majority of eggs also retained their normal, healthy appearance. After placing the resting forms and eggs in the best conditions for the development of mites it was found that part

Fig. 1. Living mites *Carpoglyphus lactis* in the excrements of domestic sparrow (*Passer domesticus*), after the passage through its alimentary canal
photo W. Chmielewski

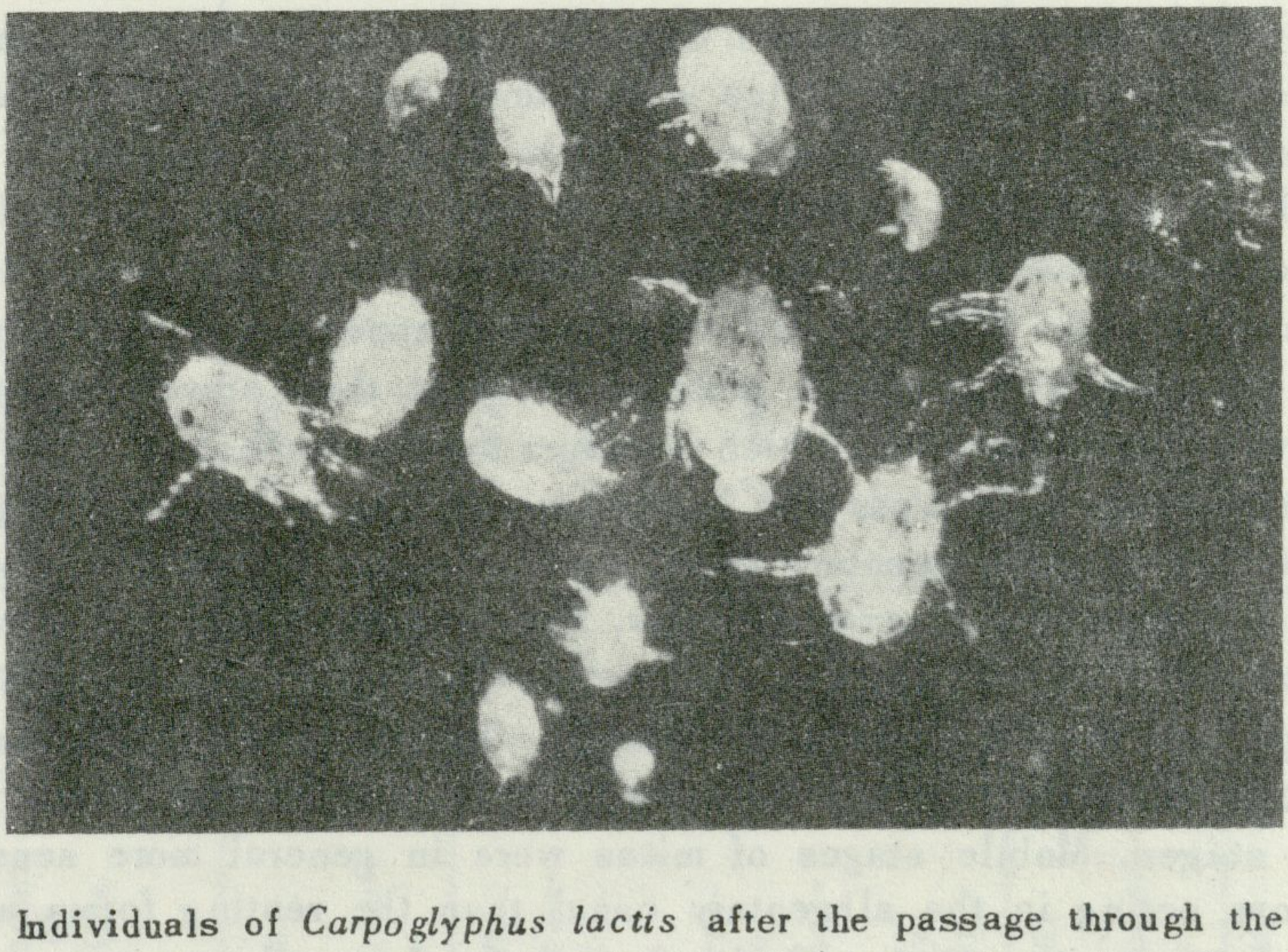

Fig. 2. Individuals of *Carpoglyphus lactis* after the passage through the alimentary canal of white mouse (*Mus musculus* v. *alba*) isolated out of the faeces
photo W. Chmielewski

of them retained their vitality and developed, and out of the eggs the larvae were hatched. About 1–7% of mites excreted with the faeces maintained, or after a short period regained their ability to move. Living mites placed

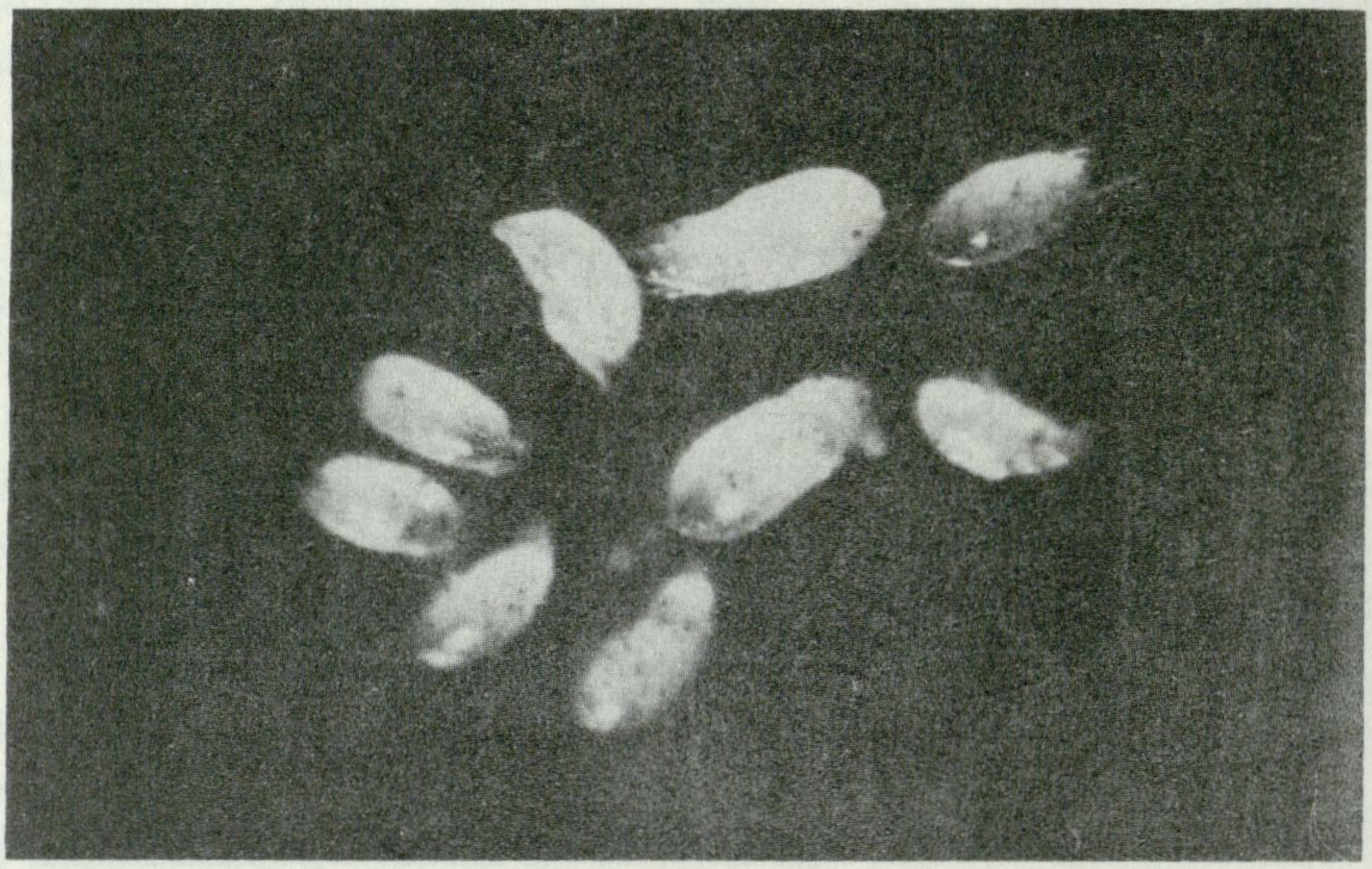

Fig. 3. Individuals of *Thyreophagus entomophagus* after the passage through the alimentary canal of domestic sparrow (*Passer domesticus*) isolated out the bird's faeces

photo W. Chmielewski

in the optimal conditions behaved normally and soon extensively increased in number. The most of living mites were found as a result of faecal analyses in the faeces of mice and sparrows, a little less in the excrements of hens (Tab. V). As the faecal analyses showed, the mites, which passed through the alimentary canal of man, were dead. About 70% of them were macerated and digested, while 30% retained their normal appearance, similarly as the majority of eggs. It should be added here, that they stayed in the human alimentary canal about 12 hr, which is longer than in animals.

In experiments with birds and in observations on mice the most resistant to the factors in the alimentary canal were, similarly as in the experiments in vitro, *C. lactis* and *T. entomophagus*. More sensitive were: *G. domesticus*, *T. putrescentiae*, *A. siro* and *Caloglyphus* sp. The least susceptible to injuries were eggs, and then the larvae and nymphs. The adult individuals were relatively less resistant to the conditions in the alimentary canal than the juvenile stages. Mobile stages of mites were in general more sensitive to the factors acting in the alimentary canal than the resting forms and eggs. Faecal analyses showed that *C. lactis* and *T. entomophagus* may pass alive in all development stages through the alimentary canal of vertebrates. Also in the faeces of sparrows observed were single, moving individuals of *C. lactis* in hypopus stage, which passed through the alimentary canal.

A considerable majority of *G. domesticus* individuals passed through the alimentary canal were macerated and digested, and only hypopi of this

Results of faecal analyses on the presence of mites in the excrements of vertebrates

Tab. V

Vertebrates	Species of mites	Number of experiments	Approximate number of mites given at one time in the food	Number of examined faeces portions*	Average number of mites, found in a faeces portion	% of mites				
						dead		living	total number	
						macerated ones	not macerated		dead	living
White mouse (2 individuals)	*C. lactis*	5	6 000	40	50	50	43	7	93	7
	T. entomophagus	5	6 000	40	50	60	38	2	98	2
Domestic sparrow (2 ind.)	*C. lactis*	5	6 000	50	50	35	59	6	94	6
	T. entomophagus	5	6 000	50	50	45	53	2	98	2
	A. siro	1	2 000	40	20	90	10	0	100	0
	T. putrescentiae	1	2 000	40	20	80	20	0	100	0
	G. domesticus	1	500	40	5	95	5	single hypopi	100	single hypopi
	Calogly-phus sp.	1	2 000	40	15	90	10	0	100	0
Domestic hen (2 ind.)	*C. lactis*	1	10 000	5	500	40	57	3	97	3
	T. entomophagus	1	10 000	5	500	50	49	1	99	1
Man (1 ind.)	*C. lactis*	1	8 000	1	1500	65	35	0	100	0
	T. entomopgahus	1	8 000	1	1500	70	30	0	100	0

* Under the word "faeces portion" the author understands the amount of faeces once excreted by the vertebrate.

species displayed some life signs. The greater part of the hypopi of *G. domesticus* after the passage through the alimentary canal lost their protonymphal skins, in which they normally rest. These hypopi were placed in the optimal conditions for the development of mites and for several weeks maintained their normal appearance, which proves that they were alive, while dead hypopuses dried up within few days. This observation is consistent with the infomation provided by Bulanova (1940), who obtained a similar result in analogous experiments with *Glycyphagus destructor* (Schrank).

Caloglyphus sp. mobile hypopi, which were given in food to sparrows, were observed later in the faeces of these birds – dead and frequently mechanically injured (e.g. lack of legs).

In the experiments *T. putrescentiae*, *A. siro* and *Caloglyphus* sp. were the least resistant to the conditions in the alimentary canal of vertebrates. The adult individuals of these species and their development stages were dead, to a considerable extent macerated, deformed, mechanically injured and digested. The eggs of these mites in a large per cent retained their normal, healthy appearance, however, after placing them in optimal conditions the larvae were not hatched out of them, as opposed to the eggs of *C. lactis* and *T. entomophagus*, which retained their vitality to a considerable extent. The results of these experiments are partly the same as the data of Bulanova (1940), who found that all stages of *T. putrescentiae* and *A. siro* die in the alimentary canal of white mice, whereas the eggs of these species retain their vitality.

The relatively high resistance of some species (*C. lactis*) to the conditions in the alimentary canal of vertebrates should be explained by the fact that natural living conditions of these mites are closer to those in the alimentary canal of vertebrates, than in the instance of other, less resistant species of mites. E.g. *C. lactis* occurs most frequently in liquid and semi-liquid habitats with great humidity and increased acidity, sometimes with a decreased oxygen content (honeys, jams, wines), and thus has greater possibilities of passing through the alimentary canal in an undamaged state than the mites living in habitats relatively drier, loose and less acidified as e.g. *T. putrescentiae* and *A. siro* which live in flours, cereals and similar products.

The structure of mites and their behaviour are also not without significance here. Slowly moving mites, such as *T. entomophagus* and *C. lactis*, the body of which is covered by a small number of relatively short setae, are to smaller extent liable to suffer a mechanical injury in the alimentary canal of vertebrates than mobile mites, quick ones, the setae of which are numerous and long as e.g. in the instance of *G. domesticus* and *T. putrescentiae*.

The chances for survival of mites in the alimentary canal of vertebrates

depend to a large extent on how long they stay inside the animal's body, which in turn is determined by the metabolism rate and the animal's state of health. Relatively fast metabolism is typical of birds and rodents, and the time between consumption and defecation is only a few hours. During that time, as it had been proved by the experiments in vitro, the mites may theoretically survive the action of many factors in the alimentary canal, and this had been practically confirmed by the experiments in vivo. In the instance of vertebrates, the metabolism of which is relatively slower, e.g. man, where since consumption a dozen or so hours pass to the moment of defecation, the possibility of survival of mites in these conditions and their excretion in an undamaged state is very small. Yet the mites are the cause of disturbances in the functioning of alimentary system, indigestion and excretion, diarrhoea, catarrhs and so on. These diseases result in frequent defecations and shorten the time during which the food remains in the alimentary canal, and thus the probability of survival of mites in these conditions and being excreted alive increases.

In literature, it is said that food products and fodders affected by mites are harmful for people and animals (Baker, Wharton 1952, Bartos, Pulpan, Verner 1961, Beklemiševa 1949, Boczek 1966, Kiełczewski, Żółtowski 1951, Martini 1952, Pulpan, Verner 1959, Młodecki, Żurkowska 1957, Zacher 1927, Zachvatkin 1941). The animals after consuming the food affected by mites were less active and had a bad appetite. Birds, usually mobile, frequently sit still and ruffle their feathers, while the mice usually stay in one place with bristled hair and are drowsy and shiver. The mice fed for several days with the fodder affected by mites become sometimes so weak that some individuals can not even crush a dry wheat grain, and when there is no other food at hand they are liable to die of starvation. But as soon as they get crushed food without mites they quickly improve. Also symptoms of diarrhoea were observed among birds, and the faeces of mice had a looser consistency than that of animals in control cultures. Frequent feeding of the animals with food strongly affected by mites may result in their poorer condition, thinning and even death.

The passage of living mites through the alimentary canal of animals, apart from its sanitary aspect is also important from the point of plant protection and protection of stored products because of transmission and extension of some harmful species. The fact of the dispersion of mites in an endozoic way, apart from other ways and means of dispersion of these arthropods, explains also to some extent their numerous and sometimes extensive appearance in the nests of rodents, sparrows and other animals. The birds and rodents are very active and mobile animals. They live and can nest

different environments, and therfore in various places they eat all possible sorts of food, frequently those affected by mites and leave their faeces. The mites excreted together with faeces may affect food products and other articles. These facts prove about the significant part of rodents, birds and other animals in the dispersion of mites, and in consequence in affecting products by these stored products pests. Therefore it is very important, in order to protect stores and warehouses,to make impossible the presence and nesting of birds, especially sparrows, and to point out the significance of controlling mice and rats (deratization), not only as of direct pests but also as vectors affecting the products by mites.

IV. CONCLUSIONS

1. The mites show a resistance to artificially created habitat conditions, approximate to those in the alimentary canal of vertebrates, such as: oxygen-free atmosphere, liquid habitat, action of 0.5% HCl solution and temperature +36°C.

2. The possibility of the passage through the alimentary canal of vertebrates should be considered for each species of mites separately, as the reaction to the conditions existing there is different in different species, and even in different development stages of mites.

3. The greatest resistance to digestion was displayed by two species of mites *Carpoglyphus lactis* and *Thyreophagus entomophagus*, which passed alive the alimentary canal of vertebrates.

4. The mites from the following species: *Tyrophagus putrescentiae*, *Acarus siro*, *Caloglyphus* sp. and *Glycyphagus domesticus* with the exception of hypopus stage of this species, die in the alimentary canal of sparrows and mice.

5. Eggs and juvenile stages of *Carpoglyphus lactis* and *Thyreophagus entomophagus* in the resting form are damaged in a lesser extent than the older development stages.

6. Probability of the passage of living mites through the alimentary canal is the greater the shorter is the time during which they stay in the alimentary canal. Therefore the chances for survival of mites in the alimentary canal of vertebrates having fast metabolism, such as birds and rodents, are greater than in the instance of vertebrates having a slower metabolism (man).

REFERENCES

1. Baker, E.W., Wharton, G.W. 1952 – An introduction to acarology – London, 475 pp.

2. Bartoš, J., Pulpan, J., Verner, P.H. 1961 – Boj proti skladištnim škůdcům – Praha, 367 pp.
3. Beklemiševa, V.N. 1949 – Učebnik medicinskoj entomologii – Moskva, 500 pp.
4. Boczek, J. 1966 – Roztocze szkodniki roślin i produktów przechowywanych – Warszawa, 246 pp.
5. Bulanova, E.M. 1940 – Endozoičeskoe rasselenie chlebnych kleščej – Učen. zap. Mosk. gosud. Univ., zool., 42: 279–283.
6. Chmielewski, W. (in press) – Morfologia, biologia i ekologia *Carpoglyphus lactis* (L., 1758) (*Glycyphagidae, Acarina*) – Ekol. Pol. voll.
7. Heller, J., Karpiak, S. 1949 – Zarys fizjologii kręgowców z podstawami biochemii. Cz. II – Wrocław, 190 pp.
8. Hughes, A.M. 1961 – The mites of stored food – London, 287 pp.
9. Kiełczewski, B., Żóltowski Z. 1951 – Zarys entomologii lekarskiej – Warszawa, 340 pp.
10. Martini, E. 1952 – Lehrbuch der medizinischen Entomologie – Jena, 694 pp.
11. Młodecki, H. 1965 – Szkody wyrządzane przez roztocze magazynowe i stosunek higienisty do środków spożywczych porażonych przez te szkodniki – Zesz. probl. Post. Nauk roln. 53: 269–282.
12. Młodecki, H., Żurkowska, T. 1957 – Materiały do higienicznej oceny żywności porażonej roztoczami magazynowymi II. – Rocz. Państw. Zakł. Hig. 8: 19–26.
13. Predtečenskij, E.V., Borovskaja, V.M., Margolina, L.T. 1950 – Laboratornye metody issledovanija – Medgiz., vyp. 4 Moskva, 838 pp.
14. Pulpàn, J., Verner, P.H. 1959 – Roztoči žijici na uskladnênèm obili a boj proti nim (*Acari*) – Boh. centr. A 1: 169–292.
15. Szwabowicz, A., Międzobrodzki, K. 1957 – Toksyczność rozkruszka mącznego – *Tyroglyphus farinae* dla zwierząt, I. Doświadczenia na białych myszkach, świnkach morskich, gołębiach i kurach – Med. Wet. 13: 475–478.
16. Szwabowicz, A., Międzobrodzki, K., Drzuzgiewicz, K. 1958 – Ocena zdrowotności pasz zakażonych rozkruszkiem mącznym, II. Doświadozenia na koniach i owcach – Med. Wet, 13: 722–724.
17. Zacher, F. 1927 – Die Vorrats-, Speicher- und Materialschädlinge und ihre Bakämpfung – Berlin, 366 pp.
18. Zachvatkin, A.A. 1941 – Tiroglifoidnye klešči (*Tyroglyphoidea*) Fauna SSSR; Paukoobraznye, t. 6, vyp. 1 – Moskva–Leningrad, 475 pp.

PRZECHODZENIE ROZTOCZY PRZEZ PRZEWÓD POKARMOWY KRĘGOWCÓW

Streszczenie

Stwierdzono eksperymentalnie, że roztocze są w pewnym stopniu odporne na działanie sztucznie stworzonych warunków, zbliżonych do panujących w przewodzie pokarmowym organizmów stałocieplnych. Mogą one przetrwać, zachowując swoją żywotność, przez kilka lub nawet kilkanaście godzin w temperaturze +36°C, zanurzone w roztworze wodnym 0,5% HCl lub w wodzie destylowanej bez dostępu powietrza, a także w atmosferze czystego N_2 (tab. I–IV). Na podstawie tych wyników wysunięta została hipoteza robocza, która znalazła praktyczne potwierdzenie w doświadczeniach nad przechodzeniem roztoczy przez przewód pokarmowy myszy białej, wróbla domowego i kury domowej.

Stwierdzono, że roztocze mogą przechodzić żywe przez przewód pokarmowy kręgowców. Nie stwierdzono natomiast przechodzenia żywych roztoczy przez przewód pokarmowy człowieka. Prawdopodobieństwo przeżycia roztoczy w przewodzie pokarmowym organizmów stałocieplnych jest tym większe, im krótszy jest czas ich przebywania w przewodzie pokarmowym. Szanse przetrwania roztoczy w przewodzie pokarmowym kręgowców o szybkiej przemianie materii, takich jak ptaki i gryzonie, są większe niż w przewodzie pokarmowym kręgowców o wolniejszej przemianie materii, np. człowieka. Badanie ekskrementów zwierząt doświadczalnych metodą bezpośredniej analizy koprologicznej wykazało, że 1–7% żywych osobników *Carpoglyphus lactis* (L.) i *Thyreophagus entomophagus* (Laboulbène), może przechodzić we wszystkich stadiach przez przewód pokarmowy (tab. V, fig. 1–3). Roztocze te, po umieszczeniu ich w optymalnych warunkach, są zdolne do podjęcia normalnych funkcji życiowych. Część jaj i form znajdujących się w stanie znieruchomienia przedwylinkowego przechodzi dalszy rozwój w warunkach optymalnych dla życia roztoczy. *Glycyphagus domesticus* (De Geer), *Tyrophagus putrescentiae* (Schrank), *Acarus siro* L. i *Caloglyphus* sp. okazały się mniej odporne na strawienie i ginęły w przewodzie pokarmowym zwierząt. Hypopusy *G. domesticus* i *C. lactis* mogą przechodzić żywe przez przewód pokarmowy wróbli.

Przechodzenie żywych roztoczy przez przewód pokarmowy kręgowców ma duże znaczenie z punktu widzenia ochrony roślin i produktów przechowywanych, ze względu na możliwość rozprzestrzeniania się niektórych szkodliwych gatunków roztoczy w sposób endozoiczny, jak również z punktu widzenia medycyny i weterynarii. W ochronie magazynów przed szkodliwymi roztoczami przechowalnianymi należy zwrócić większą uwagę na uniemożliwienie przebywania i gnieżdżenia się ptaków w pomieszczeniach magazynowych oraz na zwalczanie gryzoni (deratyzacja), jako wektorów porażenia produktów przez roztocze.

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