THE YEARLY CYCLE OF SOME HELMINTHOSES OF GAME ANIMALS FROM TWO ECOLOGICALLY DIFFERENT AREAS

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Abstract. On the basis of postmortem examination of 186 Cervus elaphus and 610 Capreolus capreolus we studied the seasonal dynamics of these nematode species: Bicaulus sagittatus, Capreocaulus capreoli, Dictyocaulus viviparus, Haemonchus contortus, Spiculopteragia boehmi, Ostertagia circumcincta and Chabertia ovina.

Our interest in this problem was instigated not only by our exceptionally rich collection of postmortem material from game animals, but also by the fact that the problem of the yearly cycles of helminthoses of game animals is of the same importance as that of domestic animals. Earlier studies (e.g. Dogel 1949, 1955, 1957, Ulyanov 1960, Boyev 1957, Riek, Roberts, O'Sulllivan 1953, Riek 1957, Levine 1959, Gibson 1959, Hovorka and his school 1958, 1959, 1960, 1962, 1963, Erhardová 1961, 1962, Prokopič 1964 a.o.) dealt with the invasive cycles of helminthoses of domestic animals, because cattle and sheep have to be under constant control. Moreover, it is much easier to obtain material from domestic animals than material from feral ruminants. The first papers concerned with the seasonal dynamics of helminthoses of game animals were those published by Kotrlý and Erhardová (1968) and Páv and Zajíček (1969).

MATERIAL

Our investigations were performed in two ecologically different areas, the one located in the hillside, the other in the mountains. The principal dominants of the Křivokláť forest block are oak-beech, oak-fir and fir-oak communities, those of the forest block Horní Maršov are fir-beech and ash-spruce communities. Our investigations lasted for several years (from 1960 to 1965), because the number of game shot each year was not sufficiently high for an evaluation of the results. In those six years we inspected in monthly postmortem examination approximately 50 specimens of roe deer and 10 specimens of red deer from both localities. The total of animals examined was 610. In addition, we examined 40 faecal samples from both localities every month, performing a total of 6,000 coprological tests.

RESULTS

1. Bicaulus sagittatus (Müller, 1890)

The most frequent parasite of the lungs of Cervus elaphus with a very high incidence. This parasite occurs practically in all vegetational zones inhabited by red deer. It
attacks also fallow deer, but its incidence in these animals is not so high as it is in the red deer (16.5%, Kotrlý 1957). The larval stages of this parasite utilize terrestrial snails as intermediate hosts, which concentrate on damp sites, where, in the spring, the first fresh grass starts to grow. The deer are attracted to these sites after the meager winter months and become infected by the migrating larvae. In the early spring, these sites constitute thus the main source of infection of the deer. The incidence of infection reaches its maximum in April as shown by the results of postmortem examination of deer from the hills. In the following months, the deer develop a natural resistance to infection, because their general conditions have greatly improved. At this time, fresh grass grows everywhere and the deer roam through the countryside. In view of the generally improved health condition of the deer, last year’s parasites die and the curve of infection decreases to 31.2%. This goes up again in the autumn, when more snails become available after increased rainfall. The autumn incidence of infection attains almost the maximum of the spring peak (in November), because the game animals have started again to concentrate and are weakened by the rut. In the mountains, infection of red deer with Bicaulus sagittatus is not so high as that

![Graphs showing incidence of infection]

**Fig. 1.** Results of postmortem and coprological examination of heminthoses of game animals in the hill and mountain area. 1—3. Course of infection with the nematode Bicaulus sagittatus. 1 — Results of postmortem examination of Cervus elaphus from the hill area; 2 — Results of coprological examination from the same area; 3 — Results of postmortem examination of Cervus elaphus from the mountain area. 4—5. Course of infection with the nematode Capreocaulus capreoli. 4 — postmortem examination in the mountain area; 5 — results of coprological examination. 6—8. Course of infection with the nematode Dictyocaulus viviparus. 6 — postmortem examination of Capreolus capreolus from the hill area; 7 — postmortem examination of C. elaphus from the same area; 8a — results of coprological examination of C. elaphus from the mountain area.
in the hills, because there are fewer snails in this habitat. The seasonal cycle, however, has also two peaks, one in April, the other in October, but the latter is lower than the spring maximum (Fig. 1).

2. *Dictyocaulus viviparus* (Bloch, 1782)

A frequent parasite of *Cervus elaphus*, *Capreolus capreolus* and *Dama dama*, occurring in all vegetational zones. The yearly incidence of this species is similar to that of the foregoing species with cyclic changes in the host animal. The incidence of infection of red and roe deer from the hills reaches its maximum in May (25% in red deer, 22% in roe deer). Early in the spring, when the snow had thawed, deer are infected by the larvae overwintering on the grass. Later in the year, the development of the helminths in the host becomes retarded, the duration of parasitisation shortened and the parasites die prematurely. The incidence of infection decreases reaching its minimum in July, August. The second maximum occurs in the autumn—in the red deer in October, in the roe deer in November—but in both instances this maximum is lower than the spring maximum. In the mountains, the highest incidence of infection occurs in the deer as late as in June, because nutritional conditions are less favourable than in the hills and some biotopes remain snowbound until April. Also in the winter climatic conditions are very hard and food is extremely scarce (especially as regards dictyocaulosis, nutritional factors are very important). Therefore, susceptibility to infection is very high. The incidence of infection decreases in December, January and February because the parasites from the spring infection are starting to die. The patent stage of *Dictyocaulus viviparus* lasts for several months (Fig. 1).

3. *Capreocaulus capreoli* (Stroh et Schmid, 1938)

A common parasite of the lungs of *Capreolus capreolus* occurring in all vegetational zones of Czechoslovakia. In the mountains, conditions are very suitable for infection of the deer and the best time for acquiring infection is the autumn. An increased incidence of infection of roe deer was observed in December, January and February and this reached its maximum in April (32% as compared with 28% in the hills). From May onwards the incidence decreased until it reached its minimum in July and August; another increase occurs from September to October (10—13%). Therefore, the yearly cycle of incidence appears to have one peak only (Fig. 1).

4. *Haemonchus contortus* Rudolphi, 1802

A common parasite of the spleen of all game animals; its incidence is highest in *Capreolus capreolus* and *Rupicapra rupicapra*. The infective larvae of this parasite overwinter on the grass, but do not survive protracted spring drought. This is reflected in the yearly cycle of occurrence of this parasite. Figure 2 illustrates the dynamics of the seasonal cycle in *Capreolus capreolus* from the hills. Postmortem examination revealed an increase of infection in May, which reached its maximum in June, when the resistance of these animals had been considerably reduced by the rut. This high incidence of infection lasted until July and then it started to decrease. This may have been due to the fact that the faeces of game animals dry up very quickly for lack of moisture during the summer and, therefore, the eggs of the parasite are retarded in their development and also first and second stage larvae die. Also infective larvae surviving the drought in the ground and migrating on the moist grass in the morning, do not survive as soon as the grass dries up during the day. Thus, the rate of infection acquired on pasture in the evening is considerably reduced and, moreover, the hosts have developed already a natural immunity. The incidence
of infection increases only slightly in the autumn and, therefore, the curve of infection seems to reach one peak only.

A very different picture is that of infection of roe deer from the mountains (Fig. 2). The curve of yearly incidence of infection shows two typical peaks, a higher one in the spring and a slightly lower one in the autumn. Ecological conditions seem to be more suitable for larval development in this area. Shaded meadows or those facing north remain moist for most of the day and the migrating larvae are not killed by lack of moisture. The incidence of infection of the red deer was higher in the autumn than in the spring due to the decreased resistance of red deer by the rut which, in these animals, occurs in the autumn, in roe deer in the spring.

5. *Chabertia ovina* (Fabricius, 1788)

A common parasite of a number of game animal species. In roe deer from the hills, the highest incidence of infection (47 %) occurs in April. It decreases in July, August and September and is minimal in October (5 % — Fig. 2). In deer from the mountains, the incidence of infection rises twice a year, once in the spring and once in the autumn, whereby the spring incidence is higher. The incidence of infection

![Graphs showing incidence of infection for different species and months]

*Fig. 2. Results of postmortem and coprological examination of helminthoses of game animals in the hill and mountain area.* 8b — results of postmortem examination of *Cervus elaphus* from the mountain area (infected with *Dictyocaulus viviparus*). 8—12. Course of infection with the nematode *Haemonchus contortus*. 9 — postmortem examination of *C. elaphus* from the mountain area; 10 — postmortem examination of *C. capreolus* from the mountain area; 11 — postmortem examination of *C. capreolus* from the hill area; 12 — results of coprological examination of *C. elaphus* from the mountain area. 13—15. Course of infection with the nematode *Chabertia ovina*. 13 — postmortem examination of *C. capreolus* from the hill area; 14 — postmortem examination of *C. capreolus* from the mountain area; 15 — postmortem examination of *C. elaphus* from the mountain area.
of red deer is similar to that of infection with *Haemonchus contortus*; the number of infected deer was highest in September (34 %), in May it was 20 % only (Fig. 2).

6. *Ostertagia circumcincta* (Stadelmann, 1894)

This species is parasitic in all ruminants. Its infective larvae are extremely resistant. This factor should be considered in an evaluation of postmortem findings in roe deer and that particularly in those from the hills, because there occurs no noticeable decrease of infection of game animals as this has been found to occur in infection with other parasites (Fig. 3). The yearly course of infection with this parasite attains two peaks.

7. *Spiculopteragia boehmi* (Gebauer, 1932)

A frequent parasite of the spleen of *Cervus elaphus*, *Capreolus capreolus* and other game animals. The curve of the yearly incidence reaches two peaks, one in the spring, the other in the autumn. In *Cervus elaphus* from both the hills and the mountains, this peak is higher in the autumn than it is in the spring (Fig. 3); in *Capreolus capreolus* from the hills, both spring and autumn maxima are the same, but in those from the mountains, the spring maximum is higher than the autumn maximum (Fig. 3).

**DISCUSSION**

Yearly changes in the incidence of helminthoses of game animals are similar to those of cattle and sheep, but experience obtained from the examination of cattle and sheep is not applicable to game animals in view of their completely different conditions of life. Deer are feeding only on natural resources and mostly without interference of man. Their food depends on the seasons, on climatic conditions etc. Various authors, e.g. Fišer and Lochtman (1969) divided the natural food of red and roe deer into several individual groups. The main components are grasses and herbs, young sprouts of trees and bushes. Group one is the most dangerous of these groups, because infective larvae migrate on the ground vegetation, when this is moistened by dew or rain, and constitute thus a dangerous source of infection. Contrary to domestic animals, deer are exposed to infection for a much longer period. In the late autumn, only an occasional fresh infection occurs, because low temperatures arrest the development of eggs and larvae. In the winter, there is no contact of deer with parasitic larvae, because only a negligible number of larvae of the genus *Ostertagia* survive in the hay. Food becomes extremely scarce and deer die from exhaustion, hunger and hard climatic conditions early in the new year. Even the lightest parasitic infection may cause the death of the deer, because their weakened organism has lost most of its natural resistance.

Our results indicate that climatic and environmental conditions influence considerably the incidence of helminthoses in game animals, affecting the development and the degree of infectivity of the larvae, causing their death or forcing them to concentrate in certain biotopes. For example, the yearly curve of infection of game animals from both areas under consideration with, e.g., *Haemonchus contortus* and *Chabertia ovina* reaches one maximum a year in deer from the hills and two maxima in deer from the mountains. Important are also the defence mechanisms of the host's organism, its natural and acquired immunity and resistance, influenced by physiological and biological processes. This complex of factors is responsible for the cyclic changes in the incidence of helminthoses.
The curve of infection of most helminthoses attains regularly two maxima a year, one in the spring (in April or May according to the locality), the other in the autumn (September, October, November). In the spring, deer are weakened from the severe living conditions of the winter and from lack of food. Moreover, they have lost their immunity against parasitic infection having had no contact with infective larvae. The first grass growing on moist sites in the early spring attracts the deer and there, the first massive contact with overwintering infective larvae is established. Also the intermediate hosts are abundant in these sites. Later in the year, the incidence of infection decreases not only because food is plentiful, but also because the host's organism has developed defence mechanism. The development of the ingested larvae is arrested, the adult parasites die prematurely. This state lasts for a certain length of time only. In the summer, droughts cause a partial sanitation of meadows and pastures, but with the commencement of wet weather, the surviving larvae reach the infective stage very quickly and attack heavily the organism of their host. The incidence of infection increases especially in red deer weakened by the rut. At this time, however, also the resistance of the host's organism increases and this is followed by a decrease in the incidence of infection. The incidence of infection with

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**Fig. 3.** Results of postmortem and coprological examination of helminthoses of game animals from the hill and mountain area. 16 — Results of coprological examination of *C. elaphus* from the mountain area (infection with *Chabertia ovina*). 17—20. Course of infection with *Ostertagia circumcincta*. 17 — postmortem examination of *C. elaphus* from the hill area; 18 — postmortem examination of *C. capreolus* from the hill area; 19 — postmortem examination of *C. capreolus* from the mountain area; 20 — coprological examination of *C. capreolus* from the mountain area. 21—23. Course of infection with *Spiculopteragia boehmi*. 21 — postmortem examination of *C. elaphus* from the hill area; 22 — postmortem examination of *C. elaphus* from the mountain area; 23 — postmortem examination of *C. capreolus* from the mountain area.
some nematodes culminates once a year only; this depends on the ecology and bionomy of these nematodes.

In conclusion it has to be mentioned that, in some instances, the results of c oprological examinations were not consistent with the results of postmortem examination. This confirms our earlier suggestion that, sometimes, c oprological inspection only is not sufficient.

CONCLUSION

The incidence of the 7 different helminthoses of game animals shows regular variation within one year. The incidence of infection with Bicaulus sagittatus, Dictyocaulus viviparus, Ostertagia circumcincta and Spiculoptera boehmi reaches two maxima a year in both red and roe deer in both areas under consideration. One maximum occurs in the spring, the other in the autumn. On the other hand, the incidence of infection of Capreolus capreolus from hilly country with the nematodes Capreolus capreolus, Haemonchus contortus and Chabertia ovina culminates only once a year (in April or even in June). In the mountains, the incidence of infection of roe deer with the latter two nematode species reaches a second maximum either in October or November.

СЕЗОНИЯ ДИНАМИКА НЕКОТОРЫХ ГЕЛЬМИНТОЗОВ ДИЧИ В ДВУХ ЭКОСИСТЕМАТИЧЕСКИ РАЗНЫХ РАЙОНАХ

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Резюме. На основании вскрытия 186 экземпляров Cereus claphus и 610 Capreolus capreolus мы изучили сесонную динамику следующих видов нематод: Bicaulus sagittatus, Capreolus capreolus, Dictyocaulus viviparus, Haemonchus contortus, Spiculoptera boehmi, Ostertagia circumcincta и Chabertia ovina.

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