FOLIA PARASITOLOGICA (PRAHA) 30: 209—222, 1983.

INCIDENCE AND SOME ECOLOGICAL ASPECTS OF AVIAN TRYPANOSOMES IN CZECHOSLOVAKIA

J. KUČERA

Institute of Parasitology, Czechoslovak Academy of Sciences, Prague

Abstract. A total of 1 874 birds belonging to 99 species was investigated on the presence of trypanosomes in Czechoslovakia, using the method of blood smears and cultivation from peripheral blood (PEN method) and autopsies with subsequent cultivation from the bone marrow. Apart from a single finding in owls, the trypanosomes were detected only in passerines which represent the majority of birds investigated (1 518 specimens belonging to 66 species). Except for sparrows, in which trypanosomes were present very rarely, they were abundant practically in all bird families represented by a sufficient number of specimens. Autopsies showed that trypanosomes occurred on the average in 23.6 % of passerines. Throughout the year their presence in peripheral blood of birds ranged from a peak in June (29 % of positive passerines after PEN method) to their absence in the winter months. There were differences in the incidence of trypanosomes in birds coming from localities with different biotopes. No essential difference was found in their incidence in migratory and non migratory birds. In birds several years old the incidence of trypanosomes was higher than in younger birds. Repeated investigations of ringed birds recaptured point out long-lasting infections with avian trypanosomes. A considerable correlation between the incidence of trypanosomes and that of *Leucocytozoon*, *Haemoproteus* and microfilariae indicates that avian trypanosomes are probably transmitted by blackflies (Simuliidae), biting midges (Ceratopogonidae) and louse flies (Hippoboscidae).

In comparison with other blood parasites of birds such as *Plasmodium*, *Haemoproteus* and *Leucocytozoon*, our knowledge on the ecology and distribution of avian trypanosomes is considerably limited (cf. Kučera 1982). In Czechoslovakia the trypanosomes were encountered earlier by Böing 1925, Černý 1933, Janda et al. 1952, Zajíček 1968 in four bird species only: *Anas acuta*, *Carduelis spinus*, *Loxia curvirostra* and *Perdix perdix*. The present paper deals with the summarized results obtained by investigating 1874 birds on the presence of avian trypanosomes in Czechoslovakia.

MATERIAL AND METHODS

Birds investigated. Domestic ducks and geese aged 2 weeks to 15 months were investigated between May and July 1977 at different farms in southern Bohemia and in June 1979 in southern Slovakia. They were birds maintained in open ponds since their age of two weeks. The investigations of wild birds were carried out between December 1972 and June 1981. Most birds were examined alive in the field. Autopsies were conducted in laboratory, using freshly killed birds or dead birds kept in refrigerator at 4—5 °C maximally for a period of 24 hours.

The wild birds investigated came from different localities in Bohemia. Some birds were investigated systematically over several years in four selected localities:

1. The Lindava locality. The basin of the Svitavka river at the confluence with the brook flowing from the Kunratice pond in the area of the Lindava settlement, district of Česká Lípa, about 320 m above sea level.

2. The Botič locality. The basin of the Botič stream at the confluence with the Pitkovický brook in Prague 10, about 300 m above sea level.

3. The Šárka locality. The basin of Tichá Šárka nad Jenerálkou in Prague 6, about 290 m above sea level.

All three localities are very similar in biotopes. They are shallow, sunny basins of meandering brooks with well developed growths of trees and bushes along their banks. The localities represented favourable breeding sites of blackflies, biting midges as well as mosquitoes, and on the birds captured louse flies were often found.

Table 1. Sur vey of examined and positive birds

Birds (Species, family, order)		Number of birds			
		Total	Blood smears	PEN	Autopsy with cult.
Anser anser (L.)		1/0	1/0		
Anser domesticus		60/0	60/0		
Anas domestica		279/0	254/0	25/0	
Anseriformes	Total	340/0	315/0	25/0	
Buteo buteo (L.)		1/0	1/0		
Accipiter gentilis (L)		1/0	1/0		
Falco tinnunculus L.		8/0	8/0		
Falconiformes	Total	10/0	10/0		
Phasianus colchicus L.		12/0	12/0		
Gallus domesticus		12/0	12/0		
Meleagris domestica		2/0	2/0		
Galliformes	Total	26/0	26/0		
Vanellus vanellus (L.)		1/0	1/0		
Charadrius hiaticula L.		1/0		1/0	
Charadrius dubius Scopoli		3/0		3/0	
Tringa hypoleucos L.		10/0		10/0	
Calidris minuta (Leisler)		5/0	1/0	4/0	
Calidris temminckii (Leisler)		1/0		1/0	
Calidris alpina (L.)		5/0		5/0	
Philomachus pugnax (L.)		1/0		1/0	
Charadriiformes	Total	27/0	2/0	25/0	
Larus ridibundus L.		1/0	1/0		
Lariformes	Total	1/0	1/0		
Columba domestica		3/0	3/0		
Columba palumbus L.		3/0	3/0		
Streptopelia turtur (L.)		2/0	1/0	1/0	
Streptopelia decaocto (Frivaldsky)		6/0	6/0		
Columbiformes	Total	14/0	13/0	1/0	
Tyto alba (Scopoli)		1/0	1/0		
Athene noctua (Scopoli)		1/0	1/0		
Strix aluco L.		4/1	4/1		
Asio otus (L.)		2/0	2/0		
Aegolius funereus (L.)		3/0	3/0		
Strigiformes	Total	11/1 = 9.1 %	11/1 = 9.1 %		
Apus apus (L.)		1/0			1/0
Apodiformes	Total	1/0			1/0
Alcedo atthis (L.)		18/0	15/0	2/0	1/0
Coraciiformes	Total	18/0	15/0	2/0	1/0
Picus viridis L.		2/0	1/0	1/0	
Dendrocopos major (L.)		4/0	1/0	3/0	
Dendrocopos minor (L.)		1/0		1/0	
Jynx torquilla L.		1/0	1/0		
Piciformes	Total	8/0	3/0	5/0	
Hirundo rustica L.		12/2		12/2	
Delichon urbica (L.)		3/1		2/0	1/1
Riparia riparia (L.)		62/1	51/1	10/0	1/0
Hirundinidae	Total	77/4 = 5.2 %	51/1 = 2 %	24/2 = 8.3 %	2/1 = 50 %
Corvus corax L.		2/1	2/0		
Corvus frugilegus L.		4/1	2/0		2/1
Corvus monedula L.		2/0	2/0		
Pica pica (L.)		3/0	3/0		
Garrulus glandarius (L.)		8/2	4/1	4/1	
Corvidae	Total	19/3 = 15.8 %	13/1 = 7.7 %	4/1 = 25 %	2/1 = 50 %
Parus major L.		99/4	45/0	51/4	3/0
Parus caeruleus L.		47/3	21/0	25/2	1/1
Parus ater L.		9/0	6/0	3/0	
Parus cristatus L.		4/2	1/0	3/2	
Parus palustris L.		12/0	3/0	9/0	
Parus montanus (Baldenstein)		35/1	18/0	16/1	1/0
Paridae	Total	206/10 = 4.8 %	94/0	107/9 = 8.4 %	5/1 = 20 %
Aegithalos caudatus (L.)		21/0	15/0	6/0	
Aegithalidae	Total	21/0	15/0	6/0	
Certhia familiaris L.		11/1	6/0	5/1	
Certhia brachydactyla C. L. Brehm		4/0	3/0	1/0	
Certhiidae	Total	15/1 = 6.7 %	9/0	6/1 = 16.7 %	

Table 1. (continued 1)

Birds (Species, family, order)		Number of birds			
		Total	Blood smears	PEN	Autopsy with cult.
Sitta europaea L.		20/2	7/0	13/2	
Sittidae	Total	20/2 = 10 %	7/0	13/2 = 15.4 %	
Cinclus cinclus (L.)		4/1	4/1		
Cinclidae	Total	4/1 = 25 %	4/1 = 25 %		
Troglodytes troglodytes (L.)		22/2	18/1	3/0	1/1
Troglodytidae	Total	22/2 = 9.5 %	18/1 = 5.9 %	3/0	1/1 = 100 %
Turdus philomelos C. L. Brehm		50/6	29/0	17/4	4/2
Turdus merula L.		106/22	41/1	49/15	16/6
Phoenicurus phoenicurus (L.)		3/0	3/0		
Phoenicurus ochruros (Gmelin)		6/2	2/0	4/2	
Erithacus rubecula (L.)		65/6	37/0	21/2	7/4
Turdidae	Total	230/36 = 15.6 %	112/1 = 0.9 %	91/23 = 25.3 %	27/12 = 44.4 %
Locustella luscinioides (Savi)		5/0		5/0	
Locustella naevia (Boddaert)		3/1	1/1	2/0	
Acrocephalus arundinaceus (L.)		1/0	1/0		
Acrocephalus scirpaceus (Hermann)		2/0	2/0		
Acrocephalus palustris (Bechstein)		22/2	6/1	16/1	
Acrocephalus schoenobaenus (L.)		10/0	2/0	8/0	
Hippolais icterina (Vieillot)		5/0		5/0	
Sylvia borin (Boddaert)		44/0	11/0	32/0	1/0
Sylvia atricapilla (L.)		44/4	18/0	25/3	1/1
Sylvia communis Latham		17/0	4/0	13/0	
Sylvia curruca (L.)		25/5	13/1	12/4	
Phylloscopus collybita (Vieillot)		29/1	23/0	5/0	1/1
Phylloscopus trochilus (L.)		11/2	6/1	5/1	
Phylloscopus sibilatrix (Bechstein)		1/0		1/0	
Phylloscopus bonelli (Vieillot)		1/1		1/1	
Sylviidae	Total	220/16 = 7.3 %	87/4 = 4.6 %	130/10 = 7.7 %	3/2 = 66.7 %
Regulus regulus (L.)		6/0	6/0		
Regulus ignicapillus (Temminck)		2/0	2/0		
Regulidae	Total	8/0	8/0		
Muscicapa striata (Pallas)		4/1	1/0	3/1	
Ficedula hypoleuca (Pallas)		2/0	1/0	1/0	
Ficedula albicollis Temminck		8/0		8/0	
Muscicapidae	Total	14/1 = 7.1 %	2/0	12/1 = 8.3 %	
Prunella modularis (L.)		72/8	28/2	44/6	
Prunellidae	Total	72/8 = 11.1 %	28/2 = 7.1 %	44/6 = 13.6 %	
Anthus trivialis (L.)		8/3	4/1	4/2	
Anthus pratensis (L.)		3/0	1/0	2/0	
Anthus spinoletta (L.)		8/0	2/0	6/0	
Motacilla cinerea Tunstall		44/4	28/0	14/3	2/1
Motacilla alba L.		10/1	6/0	3/1	1/0
Motacillidae	Total	73/8 = 10.8 %	41/1 = 2.4 %	29/6 = 20.7 %	3/1 = 33.3 %
Lanius collurio L.		16/1	10/1	6/0	
Laniidae		16/1 = 6.2 %	10/1 = 10 %	6/0	
Sturnus vulgaris L.		8/0	2/0	5/0	1/0
Sturnidae	Total	8/0	2/0	5/0	1/0
Coccothraustes coccothraustes (L.)		2/1		2/1	
Carduelis chloris (L.)		49/3	31/0	17/3	1/0
Carduelis carduelis (L.)		1/0	1/0		
Carduelis spinus (L.)		32/2	17/0	15/2	
Acanthis flammea (L.)		14/3	8/1	6/2	
Pyrrhula pyrrhula (L.)		28/15	6/0	22/15	
Loxia curvirostra L.		37/3	11/0	25/3	1/0
Fringilla coelebs L.		137/28	56/3	78/23	3/2
Fringilla montifringilla L.		1/0	1/0		
Fringillidae	Total	301/55 = 18.3 %	131/4 = 3 %	165/49 = 29.7 %	5/2 = 40 %
Emberiza citrinella L.		21/0	12/0	1/0	8/0
Emberiza schoeniclus L.		5/0	3/0	2/0	
Emberizidae	Total	26/0	15/0	3/0	8/0
Passer domesticus (L.)		112/1	65/0	32/1	15/0
Passer montanus (L.)		54/0	35/0	2/0	17/0
Ploceidae	Total	166/1 = 0.6 %	100/0	34/1 = 2.9 %	32/0
Passeriformes	Total	1518/149 = 9.8 %	747/17 = 2.3 %	682/111 = 16.3 %	89/21 = 23.6 %
Total of birds		1874/150	1043/18	740/111	91/21

Note. The numerator indicates number of birds examined, the determinator — the number of positive birds investigated after different diagnostic methods. % — percentage of infected birds. The group of birds investigated by means of blood smears does not include the birds simultaneously investigated by PEN method or autopsy because they are listed under the last mentioned two methods. Likewise, the birds investigated simultaneously by autopsy and PEN method, are listed under autopsies. Total number of birds examined is consequently equal to the sum total of birds investigated by particular methods.

4. The Sokolka locality. The site below the mountain chalet Sokolka near the border line with the nature reserve Na Rýchorách in the Krkonoše Mts., between 960 and 990 m above sea level. It is a steep mountain side with disconnected, predominantly low mixed growths, with abundant herb and shrub undergrowths. There is a water spring running down the slope, in some places creating bog (possible breeding site of blackflies and other blood-sucking insects).

Diagnostic methods. The birds were investigated by three different diagnostic methods: by examination of blood smears, by peripheral blood culture (PEN method) and autopsies with cultivation from the bone marrow. Two blood smears from each bird were made after Bennett's method (1970a). Blood smears stained with Giemsa were examined minimally for 10 minutes under microscope with oil immersion objective (total magnification 1 000×) and the remaining part of the blood smear was thereafter examined at a small enlargement of objective 8 times (total magnification 80 times). The cultivation method PEN used was described in detail in previous paper (Kučera 1979).

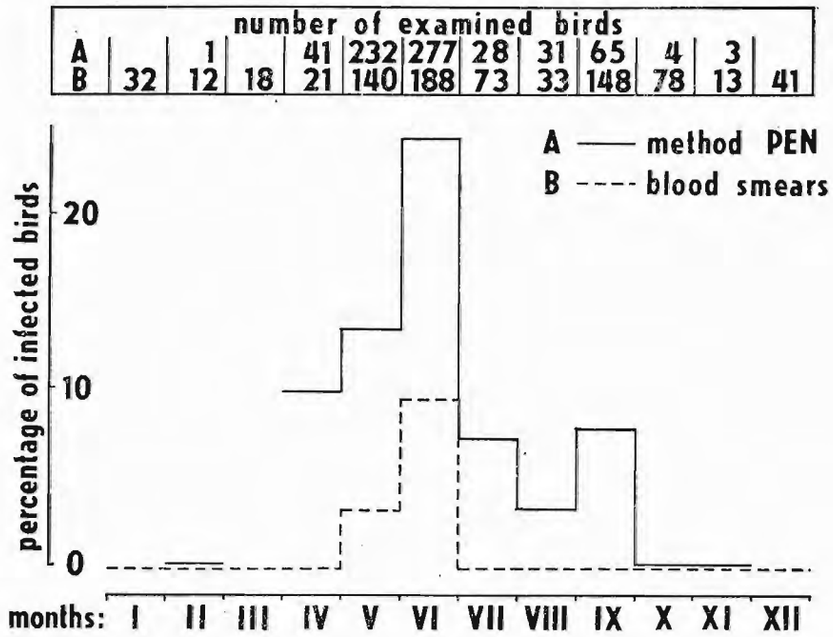

Fig. 1. Graph of seasonal dynamics of the trypanosome incidence in peripheral blood of passerines after PEN method and blood smears.

At autopsy of birds a piece of tibiotarsus approximately 1 cm long was removed and transferred together with the bone marrow into a test tube with cultivation medium SNB-9 (Diamond and Herman 1954). From each bird two samples were taken, adding antibiotics to one test tube. In the majority of dissected birds also heart blood was inoculated in SNB-9 medium. The media inoculated were examined under microscope following a 14-day incubation at 25 °C. The test tubes contaminated with other microorganisms were excluded from the results. Moreover, peripheral and heart blood and some viscera of dissected birds (heart muscles, lungs, liver, spleen, bone marrow, kidneys and brain) were examined under microscope, both in native and dry smears and impressions stained with Giemsa.

RESULTS

Total results are presented in Table 1. A total of 1 874 birds belonging to 99 species was investigated. Apart from a single finding in *Strix aluco* the trypanosomes were detected in 38 species of passerines only. A total of 1 518 specimens of passerines belonging to 66 species was examined. The results were different according to the method used. Blood smears revealed only 2.3 % of positive passerines (i. e. 17 out of 747), while the PEN method yielded 16.3 % of positive passerines (i. e. 111 out of 682); autopsies with subsequent cultivation of the bone marrow showed as many as 23.6 % of passerines positive on trypanosomes (i. e. 21 out of 89). Among the groups of passerines where a large number of specimens (more than 50) was investigated, the trypanosomes were most abundant in Turdidae, Fringillidae and Motacillidae (more than 20 % of positive birds, using PEN method); they were also relatively numerous in Prunellidae, Paridae, Hirundinidae and Sylviidae (7 to 14 % positive findings by PEN method).

Table 2. Incidence of trypanosomes in passerines in four different localities

Locality	Number of birds		i. e. %
	examined	infected	
Botič	87	8	9.2
Šárka	67	6	9.0
Lindava	246	30	12.2
Sokolka	147	58	39.5

Note. The table summarizes the results obtained by PEN method in passerines examined from April to July between 1978 and 1981.

Table 3. Comparison of the incidence of trypanosomes in passerines divided according to migratory abilities

Birds	Total number of birds examined	Number of birds examined/infected		
		by blood smears	by PEN	autopsy
migratory	272	119/7 = 5.9 %	150/14 = 9.3 %	3/1 = 33.3 %
semi-migratory	983	481/9 = 1.9 %	449/89 = 19.8 %	53/20 = 37.7 %
resident	97	47/1 = 2.1 %	49/7 = 14.3 %	1/0

Note. The table summarizes the results obtained by particular method in passerines from April to July between 1972 and 1981. The total number does not include sparrows due to low incidence of trypanosomes. % — percentage of infected birds.

The trypanosomes were also frequently found in Corvidae, Sittidae, Cinclidae, Troglodytidae, Muscicapidae and Laniidae. In these groups, however, a small number of specimens was examined. In sparrows, on the contrary, the trypanosomes were detected only in one bird out of 166 examined. In Table 2 the incidence of trypanosomes is compared in passerines captured in four different localities. The table shows that in the first three localities characterized by similar biotopes the trypanosomes are present in approximately the same percentage, while in the mountain locality Sokolka they are three times more abundant.

Fig. 1 depicts the seasonal dynamics of the incidence of trypanosomes in the peripheral blood of passerines as revealed by PEN method and blood smears examined. The trypanosomes were detected by blood smears only in May and June. The maximum of their incidence was revealed both by blood smears and by PEN method in June. Though the PEN method was not used in winter months, the results obtained by it

indicate a decrease of the incidence of trypanosomes in the peripheral blood of passerines in the autumn and repeated increase in the spring months. Autopsies with subsequent cultivation from the bone marrow were mostly conducted in the spring and summer seasons. The trypanosomes were also found by this method in the bone marrow of three birds examined in December, while the blood smears in these birds were negative.

Table 4. Incidence of trypanosomes in birds of different age

Age of birds	Total number of birds examined	Number of birds examined/infected		
		by blood smears	by PEN	by post-mortem
adult	853	361/18 = 5 %	459/102 = 22.2 %	33/14 = 42.4 %
(first-year birds)	369	227/0	113/9 = 8 %	29/7 = 24.1 %
nestlings	21	21/0		

Note. The table includes only data concerning those species of passerines, in which trypanosomes were detected at least once. Adults = older than one year.

Table 5. Survey of repeatedly captured birds examined, at least once positive on trypanosomes

Number and species of bird	Examined			Number of days
	once	twice	thrice	
1. *Erith. rubecula*	8V79*	21VII79	4VIII79*	88
2. *Turdus merula*	21VII79*	2V80*		316
3. *Turdus merula*	15IV80*	6V80*		21
4. *Turdus merula*	10V80*	31V80*		21
5. *Parus major*	2V80	10V80*	1VI80	
6. *Parus major*	11V80*	27IX80		
7. *Turdus philomelos*	27V80*	27VI80*		31
8. *Parus montanus*	8V79*	21VII79		
9. *Acroc. palustris*	27V80*	27VI80		
10. *Sylvia curruca*	10V80*	30V80		

Note. Positive finding is marked by asterisk, negative finding is accompanied by date only. Number of days indicates the maximum interval between two positive findings of trypanosomes

In Table 3 the incidence of trypanosomes is compared in passerines divided according to their migrating abilities. The table shows that after PEN method trypanosomes are more abundant in resident and semi-migratory birds in contrast to migratory birds.

Table 4 shows the comparison of incidence of trypanosomes in birds of different age. A very small number of nestlings was examined, mostly by blood smears. (In the table only those passerine species are listed in which trypanosomes were detected at least once. In species negative on the presence of trypanosomes also some nestlings were investigated by PEN method and autopsies). Once, however, trypanosomes were detected in the bone marrow of *T. troglodytes* which was a fledgling about 20 days old, shortly before leaving the nest. After comparing the first-year birds and those several years old the trypanosomes seem to be more abundant in older birds.

Some ringed birds were recaptured several times, ten of them harbouring trypanosomes. A list of these birds is given in Table 5. In two cases the trypanosomes were repeatedly detected in the same birds examined after a longer period, namely after 88 and 316 days.

In Table 6 the incidence of trypanosomes was compared with the incidence of other avian blood parasites. The table shows that there is a considerable correlation between the incidence of avian trypanosomes and the incidence of *Leucocytozoon*, microfilariae and *Haemoproteus*. The percentage of incidence of these parasites in the group of passerines positive on the presence of trypanosomes is many times higher than in the group of passerines free from trypanosomes and in all passerines together. This correlation was statistically verified by χ^2 test (Table 7).

Table 6. Comparison of the incidence of trypanosomes with the incidence of other blood parasites

Birds	Total number of birds examined and infected (%)		Number of birds infected with parasites of the genus					
			P	H	L	A	M	T
positive on T	138	95	5	71	60	3	13	138
% inf.		68.8	3.6	51.4	43.5	2.2	9.4	100
negative on T	692	231	17	188	72	21	6	—
% inf.		33.4	2.5	27.2	10.4	3	0.9	
total	830	326	22	259	132	24	19	138
% inf.		39.3	2.6	31.2	15.2	2.4	2.3	16.6

Note. The table includes only those passerine species, in which trypanosomes were detected at least once. In order to eliminate the influence of parasite fluctuation in peripheral blood throughout the year only results from the April—July period between 1972 and 1981 are given. P = *Plasmodium*, H = *Haemoproteus*, L = *Leucocytozoon*, A = *„Atoxoplasma"*, M = microfilariae, T = *Trypanosoma*

Table 7. Statistical analysis of results given in Table 6 by χ^2

	Combination of parasites				
	P—T	H—T	L—T	A—T	M—T
Anticipated incidence	3.6	43	21.9	4	3.2
True incidence	5	71	60	3	13
Value χ^2	0.544	18.232	66.284	0.25	30.012
Probability of agreement	0.5—0.3	< 0.001	< 0.001	0.7—0.5	< 0.001

Note. P = *Plasmodium*, H = *Haemoproteus*, L = *Leucocytozoon*, A = *"Atoxoplasma"*, M = microfilariae, T = *Trypanosoma*.
Anticipated incidence indicates theoretical incidence of the given combination of parasites in 830 birds provided that the incidence of parasites is independent. True incidence indicates the actual number of birds infected with the given combination of parasites in those 830 birds examined (cf. Table 6). Probability of agreement means probability of agreement of anticipated and true incidence of the given combination according to the calculated value χ^2.
In combinations P—T and A—T this probability is high, so that the T incidence is most probably not dependent on P and A incidence. Conversely, in combinations H—T, L—T and M—T this probability between the anticipated and true incidence is lower than 0.001. Consequently, there is a correlation of H, L and M incidence with T incidence.

DISCUSSION

It may be seen from Table 1 that the results in other bird groups than passerines are not very conclusive due to a small number of birds examined. Only a larger number of negative domestic ducks and geese investigated indicates that trypanosomes are either absent or are very rare in them. The largest number of investigated birds belonged to the order of Passeriformes. Our results show that trypanosomes are abundant in practically all families of passerines represented by a sufficient number of specimens examined, except for sparrows in which trypanosomes seem to be rare. This is in good agreement with the summarized results obtained by other authors from Central Europe (see Kučera 1981a, 1982). According to our results trypanosomes are most abundant in Fringillidae, Turdidae and Motacillidae. According to the results of other authors from Central Europe trypanosomes are most abundant in Corvidae. Our results also seem to indicate the abundance of trypanosomes in Corvidae, but we investigated only a small number of these birds.

Table 1 also offers a comparison of the effectiveness of diagnostic methods used. The most effective are autopsies with cultivations from the bone marrow, because trypanosomes concentrate in the bone marrow of birds and may be detected there even in the winter period, when they vanish from the peripheral blood (Danilevsky 1888, Baker 1976 etc., see also below). Blood smears reveal trypanosomes only accidentally, while the PEN method, being seven times more effective, yields comparable results.

In Table 2 the incidence of avian trypanosomes was compared in four selected localities. The differences in the incidence of trypanosomes in the Sokolka locality in comparison with the remaining three localities are probably caused by the different character of biotopes and consequently by the different occurrence of insect vectors. A more abundant incidence of trypanosomes in the Sokolka locality is probably caused by the fact that this locality is situated in a protected territory where neither insecticides nor other pesticides reducing the number of insect vectors, are applied. On the other hand, the same incidence of trypanosomes in the Lindava, Botič and Šárka localities may be explained by the fact that probably in all three localities characterized by very similar biotopes the occurrence of vectors of avian trypanosomes is more or less similar.

The seasonal changes in the incidence of trypanosomes in the peripheral blood of birds were already observed by Danilevsky (1888) in Kharkov and afterwards by other authors (e. g. in Europe by Minchin and Woodcock, 1911, Baker 1956a, in Canada by Bennett and Fallis 1960 and in Colorado (USA) by Stabler 1961). According to our results (Fig. 1) the maximum of the incidence of trypanosomes in the peripheral blood of passerines is in May and June, namely at the peak of nesting activity of birds. The active transmission to uninfected birds thus takes place mostly in this period. However, the results yielded by the PEN method, virtually simulating the probability with which the vector is infected, show that the transmission of avian trypanosomes is possible practically throughout the warm half of the year. In the winter season, as far as overwintering birds are concerned, trypanosomes survive in their internal organs, mainly in the bone marrow (cf. our results, Danilevsky 1888, Minchin and Woodcock 1911, Diamond and Herman 1954, Baker 1956b etc.). This type of seasonal dynamics, when the parasites occur in the peripheral blood during a warmer season, while in the winter season they survive in the internal organs of birds, is roughly similar to the incidence of *Plasmodium*, *Haemoproteus* and *Leucocytozoon* in birds living in the moderate zone (cf. Kučera 1981 b, c,). This has evidently resulted from the adaptation of ecology of avian blood parasites to the seasonal dynamics of the occurrence of insect vectors due to the change of seasons in the moderate zone. In this respect interesting is the paper by Manwell (1933) who ascertained that natural infections with trypanosomes in canaries kept in cages do not manifest any seasonal dependance. These trypanosomes are transmitted by the mites *Dermanyssus gallinae* which occur in the canary colonies throughout the year.

In connection with the seasonal incidence of trypanosomes it is of interest what influence is exerted on the incidence of trypanosomes by the annual migration of a portion of bird population to warmer regions. The comparison of the incidence of trypanosomes

in migratory, semi-migratory and resident passerines does not show any distinct dependence of the incidence of trypanosomes on the migratory ability of birds (Table 3). It is evident mainly from the results obtained by the PEN method used in the warmer season. The low incidence of trypanosomes in resident birds as revealed by blood smears is apparently caused by the fact that these birds were also examined in the winter season, when the detection of trypanosomes by this method is practically improbable, while the migratory birds were investigated only in the period when trypanosomes are present in peripheral blood. In this respect, the incidence of avian trypanosomes in Central Europe summarized after different authors, did not show any difference between the migratory and non-migratory birds (Kučera 1978). A similar fact was also revealed by Bennett and Fallis (1960) and Bennett et al. (1976, 1978) in the incidence of trypanosomes in migratory and non migratory birds in North America and Zeyniev (1975) in Azerbaijan. These results, along with the seasonal dynamics found in the peripheral blood, indicate that the transmission of trypanosomes by insect vectors to birds in this country takes place mainly in nesting localities and that the presence of birds in warmer regions during the winter season does not significantly affect the incidence of trypanosomes. Bennett et al. (1976, 1978) drew a similar conclusion with reference to the incidence of avian blood parasites, including trypanosomes, in North America. It remains to be seen, however, whether the migrations of birds are involved at least in the expansion and maintenance of areas of individual strains or species of avian trypanosomes (cf. Peirce and Mead 1978).

Table 4 indicates that trypanosomes are likely to occur more frequently in older than in younger passerines. Bennett and Fallis (1960), Baker (1956a, 1975), Stabler (1961), Stabler et al. (1977) and Williams et al. (1980) also found in different birds a higher infection rate in adult birds than in those younger than one year. On the other hand, Geigy et al. (1962) detected trypanosomes in 8.8 % of first-year and 7.8 % of adult birds in Switzerland. Danilevsky (1888) found trypanosomes in the bone marrow of the three-day-old chicks of *Coracias garrulus*, and Lovrics (1967) also revealed trypanosomes in a few nestlings. In one case the author of this communication also found trypanosomes in the bone marrow of a bird about 20 days old. The above mentioned results show that birds may be infected in nature practically since their hatching. The majority of authors as well as the author of this paper revealed, however, that trypanosomes are mostly present in adult birds several years old, less frequent in birds hatched in the year when they were examined and rarely in nestlings. This finding well corresponds with the concept of chronic and long-term course of trypanosome infection in birds. The long-term infections with avian trypanosomes were experimentally ascertained by many authors (Novy and McNeal 1905, Woodcock 1910, David and Nair 1955, Baker 1956b, Bennett 1970b, Molyneux and Gordon 1975). This fact was confirmed by our results obtained from repeated examinations of recaptured birds (Table 5), when the longest interval between two positive examinations was 316 days.

Some authors (Lyubinsky et al. 1937, Bennett and Fallis 1960, Williams et al. 1980) have noted earlier that the blood of birds markedly often contains combinations of trypanosomes with some other blood parasites. The connection between the trypanosome incidence and the incidence of *Haemoproteus*, *Leucocytozoon* and microfilariae (Table 6), in agreement with the findings of the above-mentioned authors, may be clarified by the fact that these parasites are transmitted by similar vectors. The probable vectors of avian trypanosomes in Czechoslovakia are Ceratopogonidae, Simuliidae and Hippoboscidae because they also simultaneously transmit some species of *Haemoproteus*, *Leucocytozoon* and microfilariae (Fallis and Desser 1974, 1977, Atchley and Wirth 1975, Sonin 1975 etc.). Apparently mosquitoes are not implicated in Czechoslovakia, indicating that trypanosome incidence is not dependent on the incidence of *Plasmodium* which is transmitted by ornithophilic Culicidae (Huff 1965).

In conslusion, we may outline the basic ecological features of avian trypanosomes as seen from the above discussion. So far as parasites of passerines are concerned, trypanosomes are very abundant in Czechoslovakia. The reservoirs of the trypanosome infection are birds which remain to be infected practically throughout their life span. Trypanosomes survive the unfavourable winter season in the bone marrow of birds. The presence of migratory birds in overwintering sites does not significantly affect the incidence of trypanosomes because the transmission by insect vectors to uninfected birds mainly takes place in nesting localities during the nesting period of the birds. In view of the non-pathogenicity (Baker 1976 etc) and long-term character of trypanosome infections, the infection rate in avian populations increases with the increasing age of birds. So far, no studies on the vectors of avian trypanosomes have been carried out in Czechoslovakia. According to indirect proofs, however, it is very probable that avian trypanosomes are transmitted in this country by some species of biting midges (Ceratopogonidae), blackflies (Simuliidae) and louse flies (Hippoboscidae).

Acknowledgement. I would like to thank RNDr. J. Lom, D. Sc. for valuable advice and assistance during my studies. Thanks are also due to all friends and associates who rendered assistance in collecting the material for these studies, primarily to Ing. J. Červený who helped examine domestic birds and to RNDr P. Miles, C. Sc. who made it possible to obtain birds captured in the Krkonoše Mts. during the ornithological expedition Balt. Last but not least I am grateful to my wife Zuzana for her patience and much help regarding the capture and examination of the birds.

НАЛИЧИЕ И НЕКОТОРЫЕ АСПЕКТЫ ЭКОЛОГИИ ПТИЧЬИХ ТРИПАНОСОМ В ЧЕХОСЛОВАКИИ

Я. Кучера

Резюме. С помощью мазков и выращивания из периферической крови, (метод PEN) и вскрытий с последующей культивацией из костного мозга на наличие трипаносом всего исследовано 1 874 птицы, относящиеся к 99 видам в Чехословакии. Кроме одного случая у сов трипаносомы обнаружены лишь у певчих, которые составляли большинство обследованных птиц (1 518 особей, относящихся к 66 видам). За исключением воробьев, у которых трипаносомы обнаружены редко, их находили практически у всех семейств певчих, из которых исследовали достаточное количество особей. Результаты вскрытий показали, что трипаносомы находились в среднем у 23,6 % певчих. Наличие трипаносом в периферической крови птиц колебалось в течение года. Максимум паразитов встречали в июне (29 % положительных находок у певчих по методу PEN). В зимний период трипаносом не обнаружили. В наличии трипаносом нашли разницы у птиц из местностей с разными биотопами. Не обнаружена существенная разница в наличии трипаносом у перелетных и неперелетных птиц. У птиц старших одного года наличие трипаносом выше чем у птиц моложе этого возраста. Повторные исследования окольцованных, снова отловленных птиц указывают на длительность инфекций птичьими трипаносомами. Значительная корреляция наличия трипаносом с наличием *Leucocytozoon*, *Haemoproteus* и микрофилярий указывает, что птичьи трипаносомы передаются по всей вероятности мошками (Simuliidae), мокрецами (Ceratopogonidae) и кровососками (Hippoboscidae).

REFERENCES

ATCHLEY W. R., WIRTH W., W., On a new western *Culicoides* (Diptera: Ceratopogonidae) which are vectors of filaria in the California valley quail. Can. J. Zool. 53: 1421—1423, 1975.

BAKER J. R., Studies on *Trypanosoma avium* Danilewsky 1885. Incidence in some birds of Hertfordshire. Parasitology 46: 308—319, 1956a.

—, Studies on *Trypanosoma avium* Danilewsky 1885. III. Life cycle in vertebrate and invertebrate hosts. Parasitology 46: 335—352, 1956b.

—, Epizootiology of some haematozoic protozoa of English birds. J. nat. Hist. 9: 601—609, 1975.

—, Biology of the trypanosomes of birds. In: W. H. R. Lumsden (Ed.), Biology of the Kinetoplastida. Academic Press, London—New York 1: 131—174, 1976.

BENNETT G. F., Simple techniques for making avian blood smears. Can. J. Zool. 48: 585—586, 1970a.

—, *Trypanosoma avium* Danilewsky in the avian host. Can. J. Zool. 48: 803—807, 1970b.

—, FALLIS A. M., Blood parasites of birds in Algonquin Park, Canada, and a discussion of their transmission. Can. J. Zool. 38: 261—273, 1960.

—, GREINER E. C., CAMERON M. F., HERMAN C. M., Hematozoos de aves passeriformes silvestres muestradas en años succecivos. Bol. Dir. Malariol. San. Amb. 16: 313—319, 1976.

—, —, —, —, Haematozoa of wild Passeriformes sampled in successive years in eastern Canada. In: Transcontinental connections of migratory birds and their role in the distribution of arboviruses. Nauka, Novosibirsk: 290—295, 1978.

BÖING W., Untersuchungen über Blutschmarotzer bei einheimischem Vogelwild. Zentralbl. Bakteriol. Parasitenkd. Infektionskr. Hyg. Abt. I, Orig. 95: 312—327, 1925.

ČERNÝ W., Studien an einigen Blutprotozoen aus Vögeln. Arch. Protistenkd. 81: 318—342, 1933.

DANILEWSKY V. Ya. Researches on the comparative parasitology of the blood. I. Zooparasites of the blood of birds. 146 pp., 1888 (In Russian.)

DAVID A., NAIR C. P., Observations on a natural (cryptic) infection of trypanosomes in sparrows (*Passer domesticus* Linnaeus). Part I. Susceptibility of birds and mammals to the trypanosomes. Indian J. Malariol. 9: 95—98, 1955.

DIAMOND L. S., HERMAN C. M., Incidence of trypanosomes in the Canada goose as revealed by the bone marrow culture. J. Parasitol. 40: 195—202, 1954.

FALLIS A. M., DESSER S. S., On species of *Leucocytozoon*. In: B. Dawes (Ed.), Advances in parasitology. Academic Press, London—New York 12: 1—67, 1974.

—, —, On species of *Leucocytozoon*, *Haemoproteus* and *Hepatocystis*. In: J. P. Kreier (Ed.), Parasitic protozoa. Academic Press, San Francisco—London 3: 239—266, 1977.

GEIGY R., HÄUSERMANN W., KAUFFMANN M., Beobachtungen über Blutparasiten-Befall bei in der Schweiz zum Beringen gefangenen Vögeln. Acta Trop. 19: 159—166, 1962.

HUFF C. G., Susceptibility of mosquitoes to avian malaria. Exp. Parasitol. 16: 107—132, 1965.

JANDA J., NOVÁKOVÁ E., PUJMAN V., VOJTĚCHOVSKÁ-MAJEROVÁ M., ZIMA L., ZVONAŘ V., Results of the studies on the partridge. Stráž myslivosti 30: 111 to 124, 1952. (In Czech.)

KUČERA J., Blood parasites of our birds with special regard to blood protozoa. Thesis. Fac. Nat. Sci., Charles' Univ., Praha, 180 pp., 1978. (In Czech.)

—, A simple cultivation method for field diagnosis of avian trypanosomes. Folia parasit. (Praha) 26: 289—293, 1979.

—, Blood parasites of birds in Central Europe. 1. Survey of literature, the incidence in domestic birds and general remarks to the incidence in wild birds. Folia parasit. (Praha) 28: 13—22, 1981a.

—, Blood parasites of birds in Central Europe. 2. *Leucocytozoon*. Folia parasit. (Praha) 28: 193—203, 1981b.

—, Blood parasites of birds in Central Europe. 3. *Plasmodium* and *Haemoproteus*. Folia parasit. (Praha) 28: 303—312, 1981c.

—, Blood parasites of birds in Central Europe. 4. *Trypanosoma*, "*Atoxoplasma*", microfilariae and other rare haematozoa. Folia parasit. (Praha) 29: 107—113, 1982.

LOVRICS V., Studien über Blutparasiten verschiedener schweizerischer Vogelarten. Acta Trop. 24: 19—58, 1967.

LYUBINSKY G. A., GRINSHPON K. L., LEVIT M. S., Trypanosomes and leucocytozoa in mountain finches. Med. parazitol. i paraz. bolezni 6: 578—579, 1937. (In Russian.)

MANWELL R. D., Further studies on trypanosomes of the canary. Anat. Rec. 57 (Suppl.): 99, 1933.

MINCHIN E. A., WOODCOCK H. M., Observations on the trypanosomes of the little owl (*Athene noctua*), with remarks on the other protozoan blood-parasites occurring in this bird. Quart. J. Micr. Sci. 57: 141—185, 1911.

MOLYNEUX D. H., GORDON E., Studies on immunity with three species of avian trypanosomes. Parasitology 70: 181—187, 1975.

NOVY F. G., McNEAL W. J., On the trypanosomes of birds. J. Infect. Dis. 2: 256—308, 1905.

PEIRCE M. A., MEAD C. J., Haematozoa of British birds. III. Spring incidence of blood parasites of birds from Hertfordshire, especially returning migrants. J. nat. Hist. 12: 337—340, 1978.

SONIN M. D., Filariata of animals and man and the diseases they cause. 3. Filariidae, Onchocercinae. In: Osnovy nematodologii. Nauka, Moskva 24: 396 pp., 1975. (In Russian.)

STABLER R. M., Comparison of trypanosome incidence in blood and bone marrow from 79 Colorado birds. J. Protozool. 8: 122—123, 1961.

—, KITZMILLER N. J., BRAUN C. E., Blood parasites from bandtailed pigeons. J. Wildl. Manag. 41: 128—130, 1977.

WILLAMS N. A., MAHRT J. L., ZWICKEL F. C., The ecology of blood parasites in blue

grouse from Vancouver Island, British Columbia. Can. J. Zool. 58: 2175—2186, 1980.
WOODCOCK H. M., Studies on avian Haemoprotozoa. I. On certain parasites of the chaffinch (*Fringilla coelebs*) and the redpoll (*Linota rufescens*). Q. J. Microsc. Sci. 55: 641—740, 1910.
ZAJÍČEK D., *Trypanosoma dafilae* sp. n. and *Leucocytozoon anatis* Wickware, 1915 in the northern pintail (*Dafila acuta acuta* L.). Folia parasit. (Praha) 15: 169—172, 1968.
ZEYNIEV N. R., Parasitic protozoa in the blood of birds from northeastern Azerbaijan. Izv. Akad. nauk AzSSR, ser. biol. nauk 4: 86—89, 1975. (In Russian.)

Received 7 June 1982.
Translated by: E. Bělyjová

Present address:
J. K., Ústav pro biofaktory a veterin. léčiva, 254 49 Pohoří Chotouň, Jílové, ČSSR

FOLIA PARASITOLOGICA (PRAHA) 30: 222, 1983.

The meeting of FAO/UNEP/WHO Working group on guidelines for surveillance, prevention and control of taeniasis/cysticercosis

The meeting of the WHO Working group on the problems of human taeniasis and cysticercosis of farm animals (*T. saginata*, *T. solium*) took place at the Institute of Hygiene and Epidemiology in Prague from 27 September to 1 October 1982. The meeting was held on the invitation of Prof. J. Prokopec, D.Sc., the ČSR Minister of Health and organized by the World Health Organization (Prof. Dr. Z. Matyáš, D.Sc., Veterinary Public Health), FAO, UNEP and the Institute of Hygiene and Epidemiology. This meeting was motivated by the generally increasing interest in the problems of taeniasis/cysticercosis throughout the world. The meeting set up as its goal to work out globally uniform and valid directives for the control of this zoonosis causing considerable socio-economic losses in many countries. The problems of taeniasis/cysticercosis has lately become topical not only in developing countries, but also in the economically well-developed countries including most countries of Europe. The sessions of the working group were attended by 14 outstanding world specialists from Mexico, New Zealand, Kenya, Great Britain, Poland and Czechoslovakia. On the first day of sessions Academician B. Rosický, the Director of the Institute of Hygiene and Epidemiology was elected chairman of the WHO working group. The proceedings of the group took place in four sections. The material worked out by them comprises 14 chapters: 1. Systematics, biology and pathology; 2. Geographic distribution, epizootology and epidemiology; 3. The dynamics of transmission with emphasis on the stability of the system; 4. Surveys and surveillance in monitoring control programmes; 5. Immunodiagnosis; 5a. Costs and benefits of surveillance, prevention and control; 6. Review of control programmes; 7. Health education; 8. Sewage disposal and upgrading of sanitation; 9. Chemotherapy; 10. Meat inspection, meat treatment and development of safe animal slaughtering facilities; 11. Biology; 12. Present state of development of larvicides; 13. Immunity and immunization; 14. Recommended tactics and strategy of control. While compiling this material the latest data were taken into consideration, mainly from the fields of serodiagnostics, immunology, therapy and epidemiology-epizootology relating to taeniasis/cysticercosis.

Indeed, the new directives will also find application in our conditions and will serve as a basis for the improvement of measures for the liquidation of taeniasis/cysticercosis in Czechoslovakia.

PhMr. M. Zástěra and *RNDr. J. Jirouš*