Ectoparasites (Insecta: Anoplura and Siphonaptera. Acari: Mesostigmata, Ixodoidea) on small mammals in Draved Forest, Denmark

PER BRINCK, GUNVOR BRINCK-LINDROTH, ANDERS EDLER, LARS LUNDQVIST AND ANDERS NILSSON

Per Brinck et al.: Ectoparasites (Insecta: Anoplura and Siphonaptera. Acari: Mesostigmata, Ixodoidea) on small mammals in Draved Forest, Denmark. Ent. Meddr 51: 103-111. Copenhagen, Denmark 1984. ISSN 0013-8851.

The relations between hosts and ectoparasites are described from material from a Danish forest having been relatively undisturbed during the last 3-4000 years. 16 new Danish ectoparasitic species are recorded. It is concluded, however, that Draved Forest can not be regarded a reserve for rare small mammals and their parasites.

Per Brinck et al., Lund University, Ecology Building, Helgonavägen 5, S-223 62 Lund, Sweden.

Introduction

The ectoparasites of small mammals in Scandinavia are wellknown faunistically (Brinck-Lindroth et al. 1975). But the relationship between small mammals and their ectoparasites needs further investigation. The aim of the present paper is to examine the ectoparasites of the small mammals in an old forest which is situated in an area not covered by ice during the last glaciation and which in early medieval period was in contact with Central European deciduous forests.

Collecting area

In Draved Forest, 10 km NE of Tønder, South Jutland, Denmark, small mammals and their ectoparasites were collected from 30 October till 4 November, 1971. The mixed forest is at places predominated by birch *(Betula),* oak *(Quercus)* and beech *(Fagus).* Arable land surrounds the forest except to the west, where there is a large peatbog (Iversen, 1969).

Draved Forest can be traced back to the early Post-glacial period. During the Atlantic period it formed a mixed oak forest which started to deteriorate at the transition between Boreal and Atlantic time, subsequently, bogs transgressed over wide areas of the forest. Not until about 700 years B.C. did interference by man start, but the forest was not cleared. Detailed analysis by Iversen (1964) showed that the composition of the forest has been surprisingly stable during the last 3000-4000 years. In this respect Draved Forest seems to be unique in Denmark and southern Scandinavia.

Material and methods

The small mammals were handled in accordance with Edler & Nilsson (1973). 1244 trapnights yielded 753 small mammals comprising 9 species. 4346 (4328 parasitic) Anoplura, Siphonaptera, Ixodoidea and mesostigmatic mites were collected in the pelage of 654 hosts (prevalence 86,9%). Of the ectoparasites 16 species were not previously recorded from Denmark (Tab. 1).

The hosts

The sex and reproductive stage of each host individual were examined (Hansson et al., 1978), i.e. animals with at least remains of their first pelage: *juveniles;* animals with at least their second pelage: *subadults* (with immature gonads), *reproductive* (fully developed gonads) and *postreproductive* (regressed gonads) (Tab. 3).

Table 1. The infestation of small mammal species from the Draved Forest. – 7/4 means 7 parasite specimens on 4 host specimens.

Tabel 1. Parasiteringen af småpattedyr i Draved Skov. – 7/4 betyder, at der er fundet 7 parasitter på 4 værter.

	Sorex minutus	*Sorex araneus*	*Clethrio-nomys glareolus*	*Microtus agrestis*
% infested hosts	58%	68%	84.1%	100%
Number of hosts	12	31	389	12
ANOPLURA *Polyplax gracilis* Fahrenholz	0/0	0/0	0/0	0/0
P. serrata (Burmeister)	0/0	0/0	0/0	0/0
Hoplopleura acanthopus (Burmeister)	0/0	0/0	10/2	20/2
H. longula (Neumann)	0/0	0/0	0/0	0/0
SIPHONAPTERA *Hystrichopsylla talpae* (Curtis)	0/0	2/2	27/22	5/3
Doratopsylla d. dasycnema (Rothsch.)	0/0	7/5	2/2	3/1
Palaeopsylla s. soricis (Dale)	0/0	28/9	7/3	4/1
Ctenophthalmus a. agyrtes (Heller)	1/1	0/0	199/126	4/4
Peromyscopsylla b. bidentata (Kol.)	0/0	0/0	12/9	22/9
P. silvatica (Meinert)	0/0	0/0	70/48	7/2
Amalaraeus p. mustelae (Dale)	0/0	0/0	136/77	1/1
Megabothris turbidus (Rothsch.)	0/0	0/0	28/21	1/1
M. walkeri (Rothsch.)	0/0	0/0	5/4	0/0

Microtus arvalis	*Micromys minutus*	*Apodemus flavicollis*	*Apodemus sylvaticus*	
82% 11	100% 19	96.3% 80	92.4% 197	85.8% 751
0/0	4/1	0/0	0/0	4/1
0/0	0/0	0/0	33/14	33/14
14/6	0/0	0/0	2/2	46/12
0/0	21/3	0/0	0/0	21/3
0/0	0/0	2/2	3/3	39/32
0/0	1/1	0/0	0/0	13/9
0/0	0/0	0/0	1/1	40/14
2/1	1/1	36/28	47/33	290/194
5/4	17/7	3/3	19/12	78/44
2/2	0/0	0/0	0/0	79/52
11/3	0/0	0/0	0/0	148/81
0/0	2/2	2/2	6/4	39/30
0/0	0/0	0/0	1/1	6/5

ACARI	*Sorex minutus*	*Sorex araneus*	*Clethrio-nomys glareolus*	*Microtus agrestis*
Ixodes ricinus L.	1/1	23/11	258/147	7/5
I. trianguliceps Birula	47/6	20/9	186/114	35/6
Euryparasitus emarginatus (C.L. Koch)	0/0	2/2	5/5	1/1
Laelaps hilaris C.L. Koch	0/0	1/1	7/3	7/5
L. agilis C.L. Koch	0/0	2/2	7/7	0/0
L. micromydis Zachvatkin	0/0	0/0	0/0	0/0
Hyperlaelaps microti (Ewing)	0/0	0/0	2/1	62/10
Eulaelaps stabularis (C.L. Koch)	0/0	0/0	90/67	1/1
Haemogamasus horridus Michael	0/0	2/1	4/4	0/0
H. nidi Michael	0/0	0/0	402/119	5/3
H. hirsutus Berlese	0/0	5/5	18/14	4/1
H. hirsutusimilis Willmann	0/0	0/0	0/0	0/0
Myonyssus ingricus Bregetova	0/0	0/0	1/1	0/0
Hirstionyssus isabellinus (Oudemans)	0/0	0/0	46/15	0/0
H. latiscutatis (de Meillon & Lavoipierre)	0/0	0/0	0/0	0/0
TOTAL	49/7	92/21	1522/327	189/12

Microtus arvalis	*Micromys minutus*	*Apodemus flavicollis*	*Apodemus sylvaticus*	
0/0	20/11	66/33	353/106	728/314
6/2	196/14	32/18	235/96	757/265
0/0	0/0	3/3	10/9	21/20
29/9	0/0	0/0	0/0	44/18
0/0	1/1	538/66	533/118	1081/194
0/0	14/8	0/0	0/0	14/8
29/6	0/0	0/0	1/1	94/18
2/1	2/2	8/7	68/38	171/116
0/0	1/1	4/3	3/3	14/12
3/3	4/3	12/9	55/31	481/168
0/0	2/2	5/3	3/3	37/28
0/0	0/0	1/1	0/0	1/1
0/0	0/0	0/0	0/0	1/1
0/0	0/0	0/0	1/1	47/16
0/0	0/0	0/0	1/1	1/1
103/19	286/19	712/77	1375/182	4328/644

The ectoparasites

The ectoparasites were removed in the laboratory and preserved in 80% ethanol or mounted on slides for identification (Edler & Nilsson, 1973). The parasites were tabulated according to host species (Tab. 1). For the most frequent host–parasite relations the following three figures were calculated, i.e. 1) prevalence, 2) mean number of parasites on all hosts and 3) variance (Tab. 2).

Results

89% of the rodents were sexually inactive, comprising 11% juveniles (1-15% according to species), 33% subadults (32-58%) and 45% postreproductive (32-60%), while 11% were still reproductive (0-16%) (Tab. 3). Although *Apodemus sylvaticus* and *A. flavicollis* still showed signs of sexual activity, only *Clethrionomys glareolus* females were pregnant.

Host	*C.glar.*	*C.glar.*	*A.flav.*	*A.flav.*	*A.sylv.*	*A.sylv.*
sex	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
N	190	199	37	43	122	75
	46.3%	29.6%	35.1%	46.5%	56.6%	49.3%
I. ricinus	0.88	0.64	0.89	0.84	1.92	1.63
	1.87	0.75	2.43	1.19	7.35	5.45
	30.0%	28.6%	18.9%	25.6%	51.6%	44.0%
I. trianguliceps	0.55	0.41	0.46	0.35	1.21	1.23
	1.59	0.74	1.48	0.42	4.61	4.72
	20.0%	14.6%				
E. stabularis	0.30	0.18				
	0.65	0.21				
	34.7%	27.1%				
H. nidi	1.40	0.69				
	23.18	5.19				
			94.6%	72.1%	62.1%	54.7%
L. agilis			9.19	4.61	2.62	2.83
			164.77	44.77	15.78	20.28
	36.3%	28.6%	45.9%	25.6%	18.0%	16.0%
C. a. agyrtes	0.57	0.45	0.68	0.26	0.25	0.24
	0.87	1.00	1.17	0.19	0.40	0.43
	11.1%	13.6%				
P. silvatica	0.19	0.17				
	0.52	0.22				
	21.1%	18.6%				
A. p. mustelae	0.36	0.34				
	0.80	1.07				

Table 2. Prevalence, mean no. of parasites on collected hosts and variance of the most important relations between hosts and parasites from Draved Forest.

Tabel 2. Hyppigheden, det gennemsnitlige antal parasitter pr. vært og variationen af de vigtigste relationer mellem værter og parasitter i Draved Skov.

Only subadult shrews were found.

The material is interesting also from a faunistic point of view. All the parasitic mites, listed in Tab. 1, are here recorded from Denmark for the first time and the following five free-living species of mites are new to Denmark (Hallas, 1978): *Pergamasus robustus* Oudemans, *Cyrtolaelaps mucronatus* (G. & R. Canestrini), *Proctolaelaps pygmaeus* (Müller), *Hypoaspis sardoa* (Berlese), and *Androlaelaps fahrenholzi* (Berlese).

Among the lice, only a few specimens of *Polyplax gracilis* Fahrenholz were previously known. This species is new to Scandinavia (Beaucournu, 1968). Among the fleas *Palaeopsylla soricis soricis* (Dale) is probably reaching the limit of its north-eastern distribution on the European continent at Draved. The nominate form was previously recorded from Northern Germany (Schleswig-Holstein) (Artz, 1975). New to Denmark are also the vole fleas *Peromyscopsylla bidentata bidentata* (Kolenati), a widespread winter species, and *Amalaraeus penicilliger mustelae* (Dale) (Brinck-Lindroth, 1974).

Discussion

Of the two pregnant females of *C. glareolus*, none was lactating. This indicates that they were bearing their first litter. In one case only *(A. flavicollis)*, a postreproductive female had two series of placental scars, while the rest had only one series and thus had had only one litter. This means that all females probably were born the same year, and that older females, and possibly also males, had died. Due to the young age of the females it was not possible to calculate the number of young born during the year on basis of embryos or placental scars.

Since only subadult shrews were found, their season of reproduction was probably over. Shrews leave their place of birth relatively late, and juveniles therefore are rarely caught. In northern countries shrews probably do not become reproductive the first summer in contrast to rodents.

The small mammals were too few in number to permit a detailed analysis of the influence of their reproductive stage on the infestation rates. Only one uninfested specimen of *Mus musculus* was caught. All the remaining eight species were infested. The infestation degree of the shrews *Sorex minutus* and *S. araneus* was fairly low (Tab. 1). No lice or mesostigmatic laelapid mites (i.e. *Hirstionyssus soricis* and *H. talpae)* were found. Two species of fleas were, however, present: *Doratopsylla d. dasycnema* and *Palaeopsylla s. soricis.* Both are common parasites on Soricidae.

The voles *C. glareolus, Microtus agrestis* and *M. arvalis* were heavily infested, although no single parasite species predomi-

	JUVENILE			SUBADULT			REPRODUCTIVE			POSTREPRODUCTIVE			
	♂	♀	Σ	♂	♀	Σ	♂	♀	Σ	♂	♀	Σ	Total
S. minutus	–	–	–	7	5	13*	–	–	–	–	–	–	13
S. araneus	–	–	–	23	8	31	–	–	–	–	–	–	31
C. glareolus	23	36	59	52	71	123	29	35	64	86	57	143	389
M. agrestis	–	–	–	3	3	6	–	–	–	3	3	6	12
M. arvalis	1	–	1	2	2	4	–	–	–	4	2	6	11
M. minutus	2	–	2	2	9	11	–	–	–	4	2	6	19
A. flavicollis	–	1	1	1	21	22	7	2	9	29	19	48	80
A. sylvaticus	10	7	17	20	44	64	6	1	7	86	23	109	197
M. musculus	–	–	–	–	1	1	–	–	–	–	–	–	1
Σ	36	44	80	110	164	275	42	38	80	212	106	318	753

Table 3. Species, sex and age distribution of host animals from Draved Forest. *)Including one animal of unknown sex.

*Tabel 3. Arts-, køns- og aldersfordelingen af værtsarter i Draved Skov. *)Indeholdende et eksemplar af ubestemt køn.*

nated. All flea species collected in Draved Forest occurred on *C. glareolus* (Tab. 1) (shrew fleas as accidental records), while *Peromyscopsylla silvatica, Amalaraeus penicilliger mustelae* and *Megabothris walkeri* were found only on the vole species. These flea species are not host specific: they are regularly found on various vole species.

Disregarding two specimens, *Hyperlaelaps microti* was found only on *Microtus* spp. *Haemogamasus nidi* was the predominant mite on *C. glareolus,* which was the most important host for this parasite.

Micromys minutus is the most interesting host species in the present material, due to its specific and rare species of lice *(Polyplax gracilis* and *Hoplopleura longula)* and the mite *Laelaps micromydis.* The nest is placed above the ground and the host problably does not share runways and burrows with other small mammal species. Not much is known about the flea fauna of *M. minutus.* According to Peus (1970) the nests are too dry for successful development of flea larvae, while George (1973) reported many flea-positive nests. The presence of *P. b. bidentata* on *M. minutus* in the Draved material is no doubt associated with the season (Brinck-Lindroth, 1968).

The parasite fauna of the two *Apodemus*-species was predominated by *Laelaps agilis. A. flavicollis* was the more heavily infested (Tab. 2), which is in accordance with Edler (1973). *C. a. agyrtes* was the predominant flea species on *Apodemus* (Smit, 1969).

The two tick species infest nearly all potential host species in Draved Forest, with the exception of *Ixodes ricinus* on *Microtus arvalis* (Tab. 2). *A. sylvaticus* is the most infested host in Draved Forest both for *I. ricinus* and *I. trianguliceps.* This might be explained by the habits of the parasite and the hosts. *A. sylvaticus* prefers shrubby forest biotopes as do the two *Ixodes*-species. On the other hand *I. ricinus* is not likely to occur in bogs, the typical habitat of *M. arvalis.*

The distribution of parasites within a host population can be described by three parameters, viz. 1) prevalence (percentage of infested hosts), 2) mean number of parasites either on infested specimens or on the total number of hosts, and 3) the variance of the number of parasites on host individuals (Mitchell, 1975) (Tab. 2). The mean number of parasites on the total number of hosts and the variance elucidate the clustering in the parasite distribution. When the variance equals the mean the population is dispersed at random, while a variance greater than the mean indicates a clumped distribution. Biologically a random distribution means that the occurrence of one parasite does not influence the distribution of the next parasite individual. This is, however, not the case in a clumped distribution.

In this material the variance is notably high in a few cases (Tab. 2), e.g. *L. agilis* especially on *A. flavicollis* males (but also females) and on *A. sylvaticus.* It is also interesting to note the differences in the two nest-dwelling mites *E. stabularis* and *H. nidi* on *C. glareolus.* These differences cannot be explained without a greater knowledge of the life cycles of the parasites.

Finally it should be pointed out that in spite of its age and unique stability, the forest apparently is not a reserve for rare small mammals and their parasites. The fauna agrees well with the fauna of other more or less isolated old forests and remains of forests in adjacent areas. The same was found to be the case with the soil fauna. The cause might be hydrographic and pedological conditions and that the small-sized forest gives rise to a fairly high extinction rate of biota.

Sammendrag

Ektoparasitter (Insekter: Anoplura og Siphonaptera, Acari: Mesostigmata og Ixodoidea) på småpattedyr i Draved Skov.

Formålet med artiklen er at belyse forholdene mellem værter og parasitter i et nordisk område, der ikke var isdækket under sidste istid, og derfor havde forbindelse til skovområder i mellemeuropa. Draved Skov er enestående i denne sammenhæng. Vegetationssammensætningen har stort set været uændret gennem de sidste 3-4000 år.

Blandt de fundne parasitter er 16 arter ikke tidligere kendt fra Danmark (Tab. 1). Det indsamlede materiale omfatter 753 eksemplarer (9 arter) af småpattedyr, hvorpå 4328 lus, lopper og parasitiske mider blev fundet. De følgende arter af fritlevende arter af mider er nye for den danske fauna: *Pergamasus robustus* Oudemans, *Cyrtolaelaps mucronatus* (G. & R. Canestrini), *Proctolaelaps pygmaeus* (Müller), *Hypoaspis sardoa* (Berlese) og *Androlaelaps fahrenholzi* (Berlese). *Polyplax gracilis* Fahrenholz (Anoplura), *Peromyscopsylla bi-*

dentata bidentata (Kolenati) og *Amalaraeus penicilliger mustelae* (Dale) (Siphonaptera) er ligeledes nye for den danske fauna. De øvrige, for Danmark nye ektoparasitiske mider er nævnt efter *Ixodes trianguliceps* i Tab. 1.

Spidsmus (Soricidae) er i langt mindre omfang end mus værter for parasitter (Tab. 1). Dværgmusen *(Micromys minutus)* er interessant ved at være den eneste vært for *Polyplax gracilis* Fahrenholz og *Hoplopleura longula* (Neumann) (Anoplura) og *Laelaps micromydis* Zachvatkin (Acari).

Forholdene mellem vært og parasit relateres til: procentuel infestation, hyppighed og disses variation.

Konklusionen bliver, at Draved Skov, med hensyn til småpattedyrene og deres parasitter, ikke kan betragtes som et »reservat« for disse arter.

References

Artz, V. 1975. Zur Synökologie der Ektoparasiten von Kleinsäugern in Norddeutschland. (Siphonaptera, Phthiraptera, Acarina, Coleoptera: Leptinidae). – Ent. Germ. 1: 105-143.

Beaucournu, J.-C. 1968. Les Anoplures de Lagomorphes, Rongeurs et Insectivores dans la region Palearctique Occidentale et en particulier en France. – Ann. Parasitol. 43: 201-271.

Brinck-Lindroth, G. 1968. Host spectra and distribution of fleas of small mammals in Swedish Lapland. – Opusc. Ent. 33: 327-358.

– 1974. Differentiation and distribution of the flea *Amalaraeus penicilliger* (Grube, 1851) in Western and Central Europe. Ent. Scand. 5: 265-276.

Brinck-Lindroth, G., Edler, A., Lundqvist, L. & Nilsson, A. 1975. Small mammals and ectoparasites in Scandinavia. – *In:* Hansson, L. & Nilsson, B. (Eds) Biocontrol of Rodents. Ecological Bulletins No. 19. Swedish Natural Science Research Council. 73-98.

Edler, A. 1973. Seasonal changes and host relationships of mites on small mammals in southern Sweden. – Folia parasitol. (Praha) 20: 75-87.

Edler, A. & Nilsson, A. 1973. Numerical relations between groups of ectoparasites infesting small mammals. – Ent. Scand. 4: 274-282.

George, R.S. 1973. Fleas of the harvest mouse *(Micromys minutus).* – Bedfordshire Naturalist 28: 41-44.

Hallas, T.E. 1978. Fortegnelse over danske mider. (Acari). – Ent. Meddr 46: 27-45.

Hansson, L., Löfqvist, J. & Nilsson, A. 1978. Population fluctuations in insectivores and small rodents in northernmost Fennoscandia. – Z. Säugtierkunde 43: 75-92.

Iversen, J. 1964. Retrogressive vegetational succession in the Postglacial. – British Ecol. Soc. Jub. Symp. (J. Ecol. 52 Suppl.): 59-70.

– 1969. Retrogressive development of a forest ecosystem demonstrated by pollen diagrams from fossil mor. – Oikos Suppl. 12: 35-49.

Mitchell, R. 1975. Models for parasite populations. – *In:* Price, P.W. Evolutionary strategies of parasitic insects and mites. – Plenum Press. New York and London.

Peus, F. 1972. Zur Kenntnis der Flöhe Deutschlands (Insecta, Siphonaptera). IV. Faunistik und Ökologie der Säugetierflöhe. – Zool. Jb. Syst. 99: 408-504.

Skuratowicz, W. 1972. Notes on *Hystricopsylla talpae* (Curtis) (Siphonaptera) in Poland. – Bull. Acad. Pol. Scien. II. XX. 5: 321-324.

Smit, F.G.A.M. 1969. A catalogue of the Siphonaptera of Finland with distribution maps of all Fennoscandian species. – Ann. Zool. Fenn. 6: 47-86.