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Skrjabingylus nasicola (Nematoda) in skulls of *Mustela erminea* and *Mustela nivalis* (Mammalia) from the Netherlands

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Abstract

The occurrence of the skull parasite *Skrjabingylus nasicola* (Leuckart, 1842) in Stoats and Weasels from the Netherlands has been studied extensively. A redescription is given of certain morphological characters of the parasite, which includes the discovery of hitherto unknown peribuccal papillae. The genus *Skrjabingylus* is discussed. The extent of infection and the damage caused by the parasite in Stoats and Weasels has been assessed by studying collections of preserved skulls. Detailed comparisons are made between the infection percentages in both species of mustelids in different areas of the Netherlands and in different European countries. Also the relation between infection and age and sex has been studied. In the discussion an attempt is made to explain at least some of the observed differences in extent of infection in the studied material.

Introduction

Several parasitic worms (the trematode *Troglotrema acutum* and nematodes of the genus *Skrjabingylus*) occur in the frontal sinuses of Mustelidae. Often they cause swellings and perforations of the skull in the supraorbital region, so that even preserved skulls may show that parasites have been present. Because of these evident effects the parasites have attracted unusual attention. The extensive literature on the subject, especially on *Skrjabingylus*, is well covered by Hansson (1967-1970); for references to the literature on *Troglotrema* we refer to the Index Catalogue of Medical and Veterinary Zoology.

In the present paper information is given on the occurrence of parasites in the frontal sinuses of mustelids, particularly of the Stoat (*Mustela erminea* Linnaeus, 1758) and the Weasel (*Mustela nivalis* Linnaeus, 1758) from the Netherlands.

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The presence of damaged mustelid skulls has been recorded several times in the Netherlands mammalogical literature, but actual finds of worms have been reported only twice, viz., by Weijenbergh (1868) who published an extensive description of "*Filaroides mustelarum*" from a *Mustela erminea*, and by Swierstra (1948) who obtained some specimens of *Skrjabingylus nasicola* from a *M. erminea*.

We examined preserved skulls from the Rijksmuseum van Natuurlijke Historie, Leiden, the Zoölogisch Museum, Amsterdam, and from the private collection of Mr. B. Hoekstra, Almelo. We also studied a considerable number of nematodes, present in the Leiden museum and collected for a large part by Mr. B. Hoekstra (part of these are from *Mustela putorius*).

THE IDENTITY OF THE PARASITES

In preserved skulls the parasites are usually not present anymore, so in principle damage to the frontal bones might have been caused by any of the parasites mentioned above. However, we have several reasons to believe that *Mustela erminea* and *M. nivalis* in the Netherlands are only infected by the nematode *Skrjabingylus nasicola* (Leuckart, 1842).

Haltenorth (1937) claims to be able to recognize the parasite by the shape of the perforations of the frontal bones, but the reliability of this method seems doubtful (see also Hansson, 1968 and Kotlán, 1960).

The trematode *Troglotrema acutum* has never been found in the Netherlands and it probably does not occur here. This parasite seems to have a restricted distribution in central Europe, where it is known to occur in Switzerland, France, Germany and Hungary. Occasionally it has been reported from other countries, but these records all refer to parasites of captive animals that had been imported or had been kept on farms. There is not even a single record from countries where hundreds of mustelids have been dissected, e.g. Sweden (Hansson, 1968) and Russia (Kontrimavičus, 1966). Moreover, *Troglotrema* has never been reported from *Mustela nivalis* and *M. erminea*, apart from the somewhat doubtful record of Vásárhelyi (1941). In the great number of mustelids from Hungary that he investigated he only found "*Distoma acutum*", which is unbelievable; apparently he did not even know of the existence of *Skrjabingylus* and considered all parasites to be trematodes.

Remnants of nematodes have been found in several of the dry skulls and from several other specimens nematodes have been collected (localities in fig. 8) which in all cases could be identified as *Skrjabingylus nasicola*. Not all the known species of the genus *Skrjabingylus* have been described very well, but *S. nasicola* differs from all other species in that the spicules are very short. Their length varies from about 150 μ to about 250 μ, while this measurement is at least 450 μ in the other species (up to 1330 μ!). There seem to be no differences between the species in the morphology of the bursa. In all species the bursa consists of two lobate structures (pl. I, f), with usually six papillae: two pairs and two single papillae (figs. 2—4). Sometimes one papilla of a pair is lacking (fig. 3).

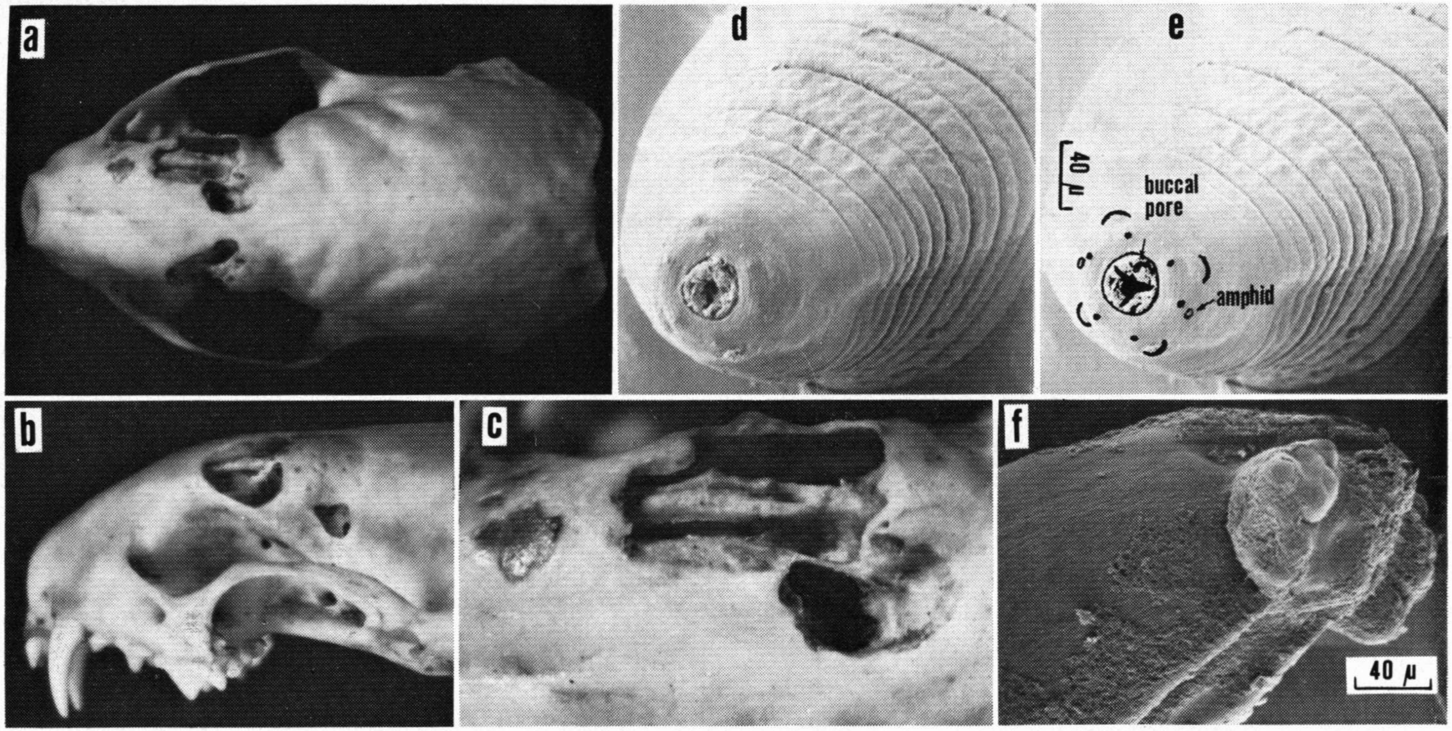

PLATE I. a—c, skull of *Mustela nivalis* L. (Epse, RMNH no. 10980) showing perforations of the frontal bones; nine ♂♂ and ten ♀♀ of *Skrjabingylus nasicola* (Leuckart) were recovered from the frontal sinuses. d—f, *S. nasicola*, scanning electron micrographs; d—e, antero-dorsal view of head; f, lateroventral view of hind end of ♂.

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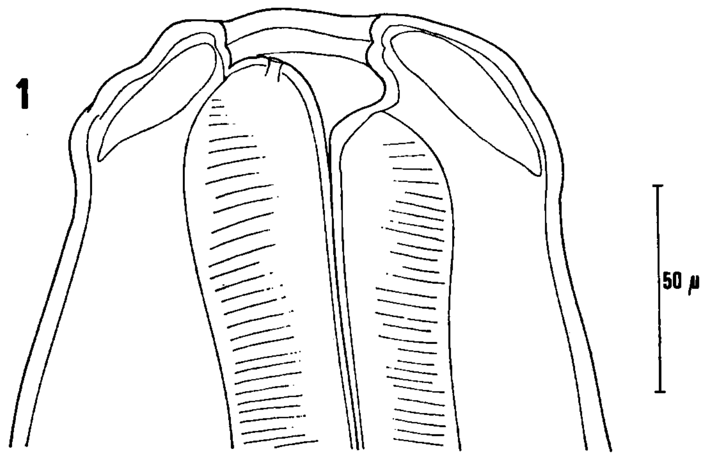

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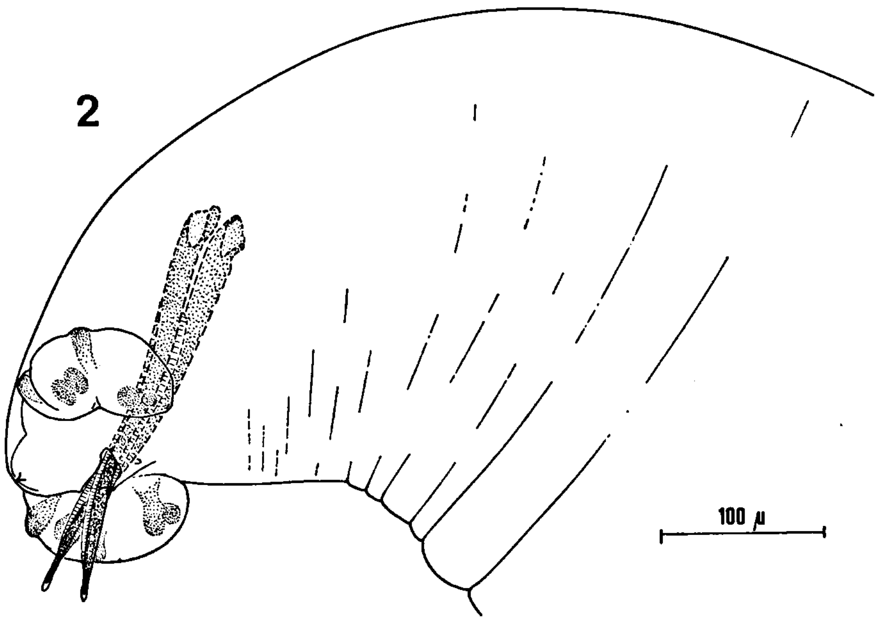
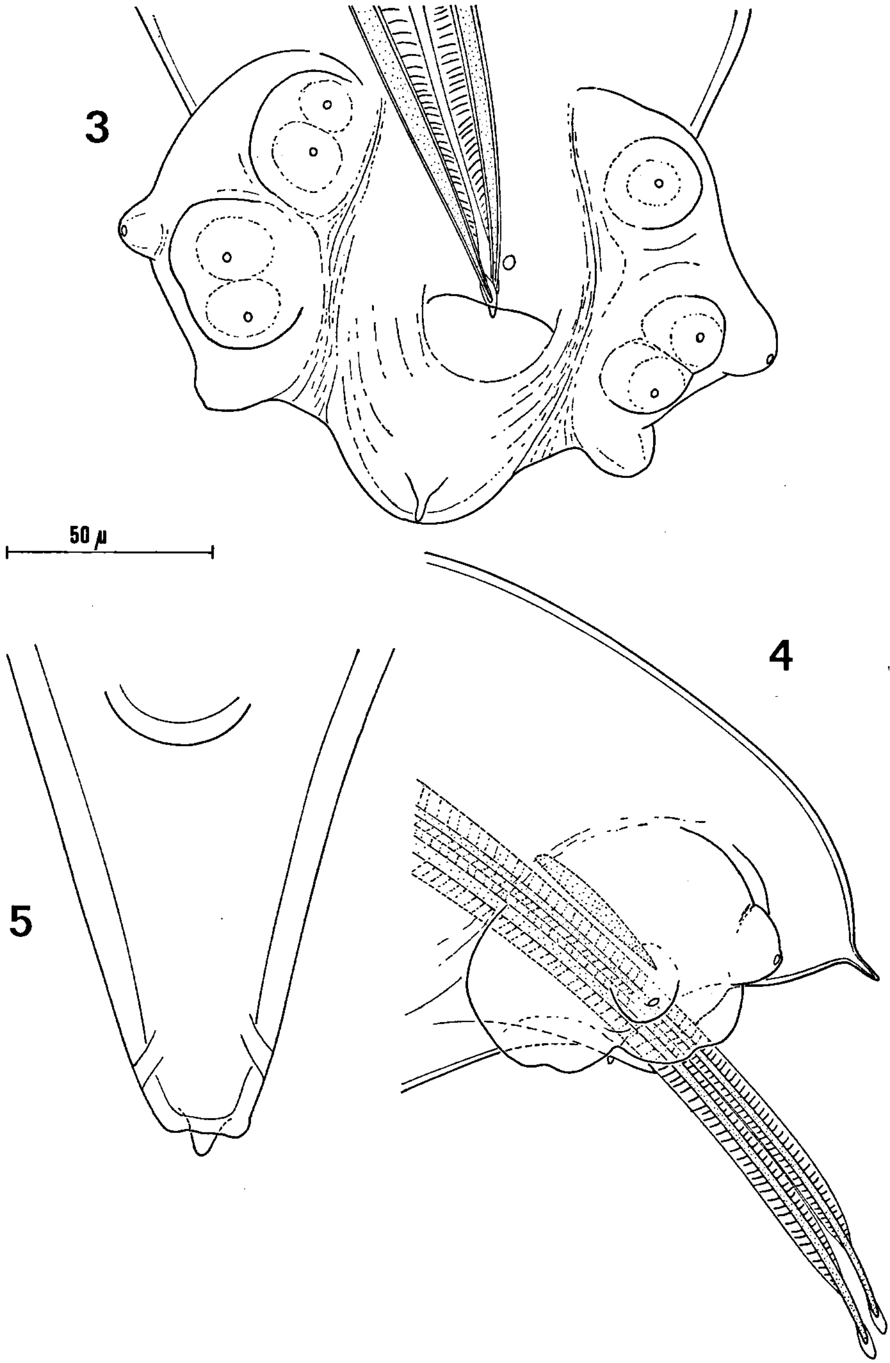


FIGS. 1—2. *Skrjabingylus nasicola*; 1, head of ♀, lateral view (Wilp, RMNH no. 3002); 2, hind end of ♂, lateral view (Twello, RMNH no. 3004).

There are differences between the species in the presence and arrangement of the pericloacal papillae. There are one median precloacal papilla and three pairs of postcloacal papillae in *S. chitwoodorum* (Hill, 1939). In *S. magnus* Webster, 1965 there are one median precloacal papilla and one pair of post-cloacal papillae (the posterior two pairs may have been overlooked because they seem to be extremely small). Both species are known only from the



FIGS. 3—5. *Skrjabingylus nasicola*, (Wilp, RMNH no. 3002); 3, bursa, ventral view; 4, bursa, lateral view; 5, hind end of ♀, ventral view.

skunk (*Mephites mephites*) and probably *S. magnus* is only a synonym of *S. chitwoodorum*. *S. ryjikovi* Kontrimavičus, 1961 and *S. petrowi* Bageanov in Petrow, 1941 are only known from *Martes* species; nothing is known about the presence of pericloacal papillae in these species. Hitherto they have never been described for *S. nasicola* either (for descriptions of this species see Baer, 1931, Fahmy, 1964, and Hansson, 1968) but we found one small precloacal papilla (figs. 3—4). There may be differences in the relative position of the organs of the posterior part of the body in females (fig. 5), but sufficiently detailed descriptions are lacking.

As in most nematodes the peribuccal organs must be of systematic significance, but hitherto only the head of *S. chitwoodorum* has been described well (Hill, 1939). The mouth is surrounded by 16 minute papillae in this species, arranged in an internal circle with three pairs and an external circle with five pairs. *S. nasicola* is a much smaller species and it proved to be impossible to find the minute papillae as described by Hill with a light microscope. Only four bulbous structures could be seen. However, with a scanning electron microscope six minute papillae could be made visible. In this species there are the following peribuccal organs (pl. I, d—e): an inner circle of six small papillae, an outer circle of four bulbous papillae and the two amphids on the same level as the outer circle. There is a buccal pore in the upper lip, probably connected with a gland in the oesophageal musculature (fig. 1). This pore is also present in *S. chitwoodorum*.

Study of the preserved skulls

In the present investigation only a distinct swelling or perforations of the skull were taken as clear evidence of *Skrjabingylus* infections. This means that the figures given below are minimum values, because doubtless a certain number of undamaged and normal looking skulls were infected also, but could not be pinpointed as such. This is also the reason why mustelids with bigger skulls as Polecats (*Mustela putorius* Linnaeus, 1758) and Martens (*Martes* spp.) were not included in the present investigation: their thick skull bones prevent recognition of infection in too many cases.

In addition to examining the skulls for parasite-caused damage also the condylobasal lengths of the skulls of all Stoats were measured in order to investigate whether the skulls of infected animals showed any retarded growth. For comparison of the results from the Netherlands with those of other countries also a collection of skulls of Stoats from Oxfordshire, Berkshire and Sussex, England, was available, kindly presented to the Zoological Museum of Amsterdam by Miss Dr. C. M. King formerly attached to the Animal Ecology Research Group of Oxford, for which the authors are very grateful. Thanks are also due to Dr. A. M. Husson of the Rijksmuseum van Natuurlijke Historie at Leiden for giving the opportunity to study the skulls preserved at Leiden.

Results

Stoats

The Stoat material consisted of 345 skulls from all parts of the Netherlands. Of these a total of 139 specimens showed skull damages in more or less advanced stages, comprising thus 40.6 % of the available specimens. Regional differences in the Netherlands: In order to investigate whether Stoats of different parts of the Netherlands showed any

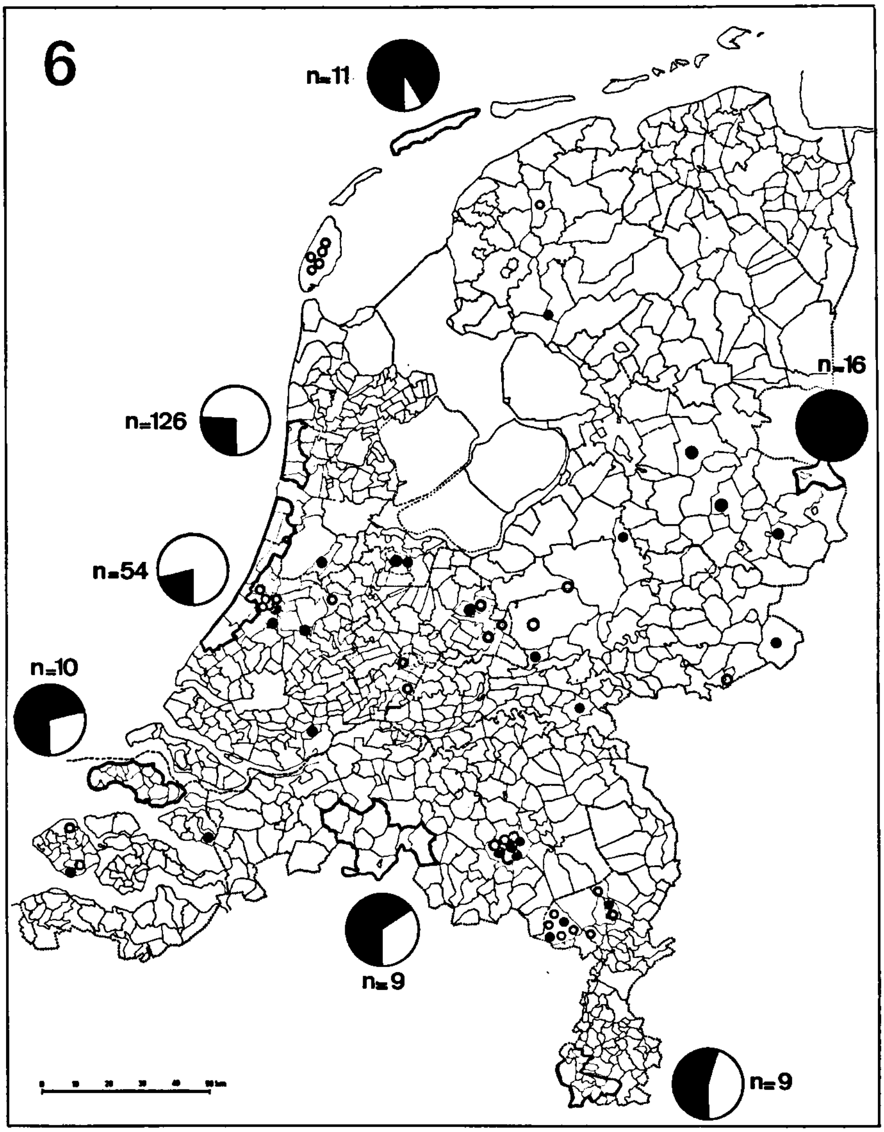


FIG. 6. Origin of infected (dots and black areas) and non-infected (circles and white areas) skulls of *Mustela erminea*.

discrepancies in the extent of infection with *Skrjabingylus*, part of the material was grouped according to the area from which it originated. The areas were chosen on the basis of a more or less uniform environment. In this way, for example, the Stoats from the northern dune region (above the Noordzeekanaal) were considered together. Part of the material, however, originated from localities too dispersed to enable a grouping in regions. The results of the subdivision of the material are represented in fig. 6 and table I. The

TABLE I. Percentages of infected Stoats (*Mustela erminea* L.) in different parts of the Netherlands:

Terschelling	91 % (n = 11)
Denekamp (Overijssel)	100 % (n = 16)
Northern dune region	26 % (n = 126)
Southern dune region	17 % (n = 54)
Both dune regions	23 % (n = 180)
Southern Limburg	55 % (n = 9)
Southern Noord-Brabant	67 % (n = 9)
Schouwen-Duiveland	70 % (n = 10)

black part in the big circles in fig. 6 represents the proportions of infected animals in the area considered (bordered by a thick black line). Small circles indicate single specimens, open ones not infected, black ones infected. While *Skrjabingylus*-infected Stoats are found all over the Netherlands, the extent of the infections is by no means the same for all parts. Infection rate is high in the northeastern part of Overijssel (the estate Singraven at Denekamp: 100 %!), and on the island of Terschelling (91 %), but low in both dune areas (23 %, when considered together).

Comparison with other countries: Infection percentages of Scandinavian countries (after Hansson, 1970), England, and the Netherlands are given in table II. Apparently Danish and British Stoats are least affected.

TABLE II. Percentages of infected Stoats (*M. erminea*) and Weasels (*M. nivalis*) in some European countries (mainly based on preserved skulls):

	M. erminea	*M. nivalis*
Netherlands	41 % (n = 345)	56 % (n = 203)
England	30.5 % (n = 46)	35 % (n = 147; Lewis, 1967)
Denmark (Hansson, 1970)	28 % (n = 221)	27 % (n = 171)
Sweden (Hansson, 1970)	41 % (n = 386)	35 % (n = 137)
Finland (Hansson, 1970)	50 % (n = 82)	52 % (n = 25)
Norway (Vik, 1955)	30 % (n = 88)	42 % (n = 48)

Sex differences: Male Stoats from the Netherlands were somewhat less frequently infected than females (viz. 33 % (n = 196) and 48 % (n = 130)). The same appeared to be true for British Stoats (viz. 30 % (n = 30) and 36 % (n = 14)). No significant sex differences were found in the extent of infection of Scandinavian Stoats (Hansson, 1970).

Age differences: The age of the examined specimens was estimated on the basis of previously tested characteristics (see van Soest & van Bree, 1970). Juvenile and subadult (less than one year old) animals were considered together against adult (over one year old) specimens. This distinction probably more or less covers age groups I—III and IV respectively of Hansson (1970), so comparison with Scandinavian results in this respect is possible. Young (juvenile-subadult) Stoats from the Netherlands were less infected than adult ones (viz. 37 % (n = 86) and 49.5 % (n = 49)). The same holds true for British animals (viz. 30 % (n = 20) and 36 % (n = 22)) and Scandinavian (age group I—III: 23.5 % (n = 293)); age group IV: 50 % (n = 385)).

Condylobasal length: For the comparison of the condylobasal length of the skull of infected animals with those of not infected ones. only fully grown skulls were used, which include all animals over 4 months old (van Soest & van Bree, 1970). Males and females are considered separately because of sexual differences in skull length. The average condylobasal length of 60 infected male Stoats from the Netherlands was 48.00 mm (range: 45.5—51.3 mm), that of 96 not infected ones 48.88 mm (46.4—54.0 mm). 57 infected female Stoats from the Netherlands had an average CB-length of 44.38 mm (40.5—46.5 mm), 59 not infected ones 45.27 mm (43.7—47.5 mm). British Stoats showed pretty much the same results: infected ♂♂ 49.46 mm (range: 47.0—51.3 mm, n = 8). not infected ♂♂ 50.26 mm (46.0—52.1 mm, n = 18); infected ♀♀ 45.58 mm (44.5—46.5 mm, n = 4), not infected ♀♀ 45.93 mm (44.9—46.8 mm, n = 6). Differences are slight, but infected animals mostly have smaller skulls than not infected ones. In areas with a high incidence of infection, such as Terschelling and Denekamp. the average CB-length is considerably smaller than elsewhere: Terschelling, ♂♂ 45.95 (n = 5). ♀♀ 44.70 mm (n = 5); Denekamp, ♂♂ 47.08 mm (n = 12), ♀♀ 42.68 mm (n = 5).

Weasels

The material consisted of 203 skulls of Weasels from the Netherlands of which 56.1 % was infected.

Regional differences: In the same way as with the Stoats the Weasel material was subdivided, as far as possible, into regional groups

TABLE III. Percentages of infected Weasels (*Mustela nivalis* L.) in different parts of the Netherlands:

Northern dune region	77 % (n = 13)
Southern dune region	67 % (n = 30)
Both dune regions	70 % (n = 43)
Braakman (Zeeuws Vlaanderen)	33 % (n = 6)
Denekamp (Overijssel)	71 % (n = 7)
Middle Limburg	56.5 % (n = 23)
Southern Limburg	33 % (n = 24)

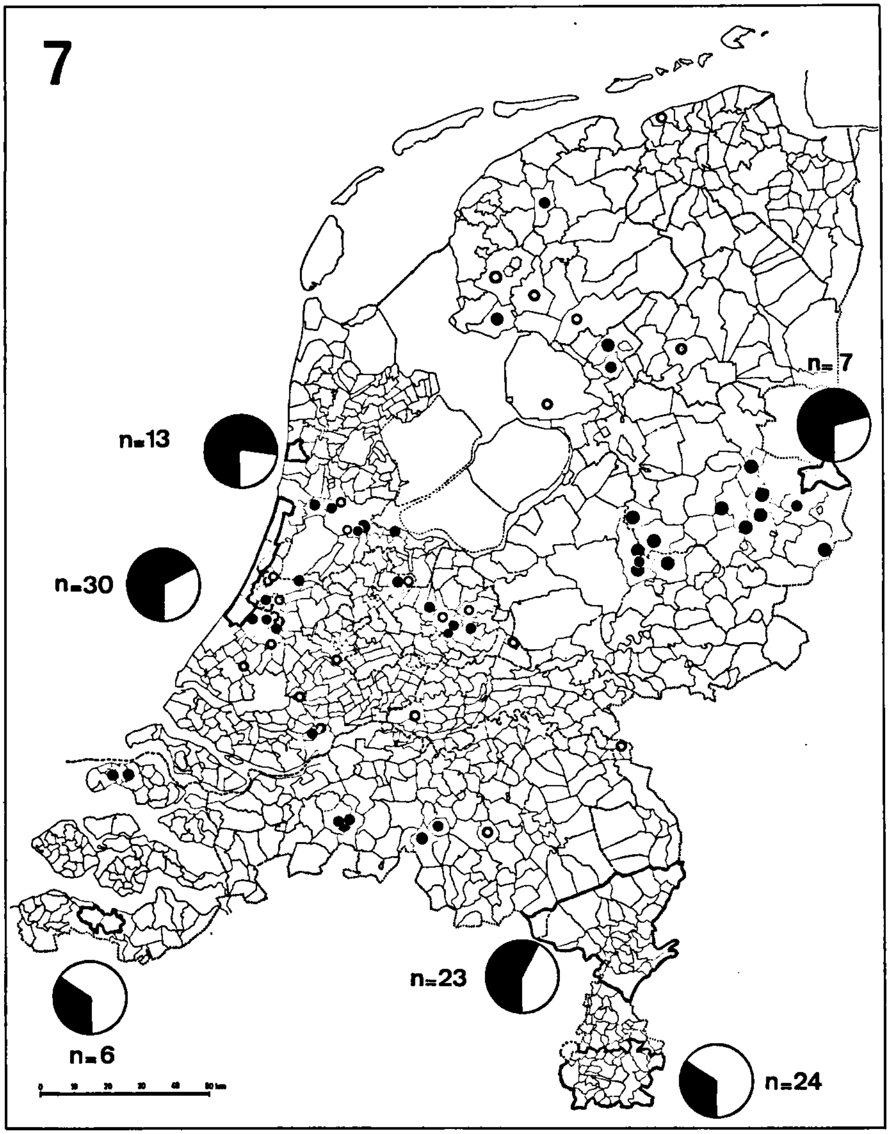


FIG. 7. Origin of infected (dots and black areas) and non-infected (circles and white areas) skulls of *Mustela nivalis*.

(fig. 7, table III). In contrast to the results obtained with Stoats, Weasels from the dune region were infected most.

Comparison with other countries (table II): The extent of infection of Weasels with *Skrjabingylus* in the Netherlands is high when compared to Denmark (27 %, n = 171), Sweden (35 %, n = 137), and England (35 %, n = 147); it equals that of Finland (52 %, n = 25) (Hansson, 1970 and Lewis, 1967).

Discussion

Part of the studies of Hansson (1967, 1970) were concerned with the transmission of the parasites from intermediate hosts to the mustelids. Earlier experiments by Dubnitsky (1956, after Hansson, 1967) showed that infected terrestrial molluscs fed to mustelids could transmit the parasite *Skrjabingylus nasicola* (Leuckart) to its predator. However, as Hansson correctly observed, Stoats and Weasels do not normally prey upon terrestrial molluscs, so another

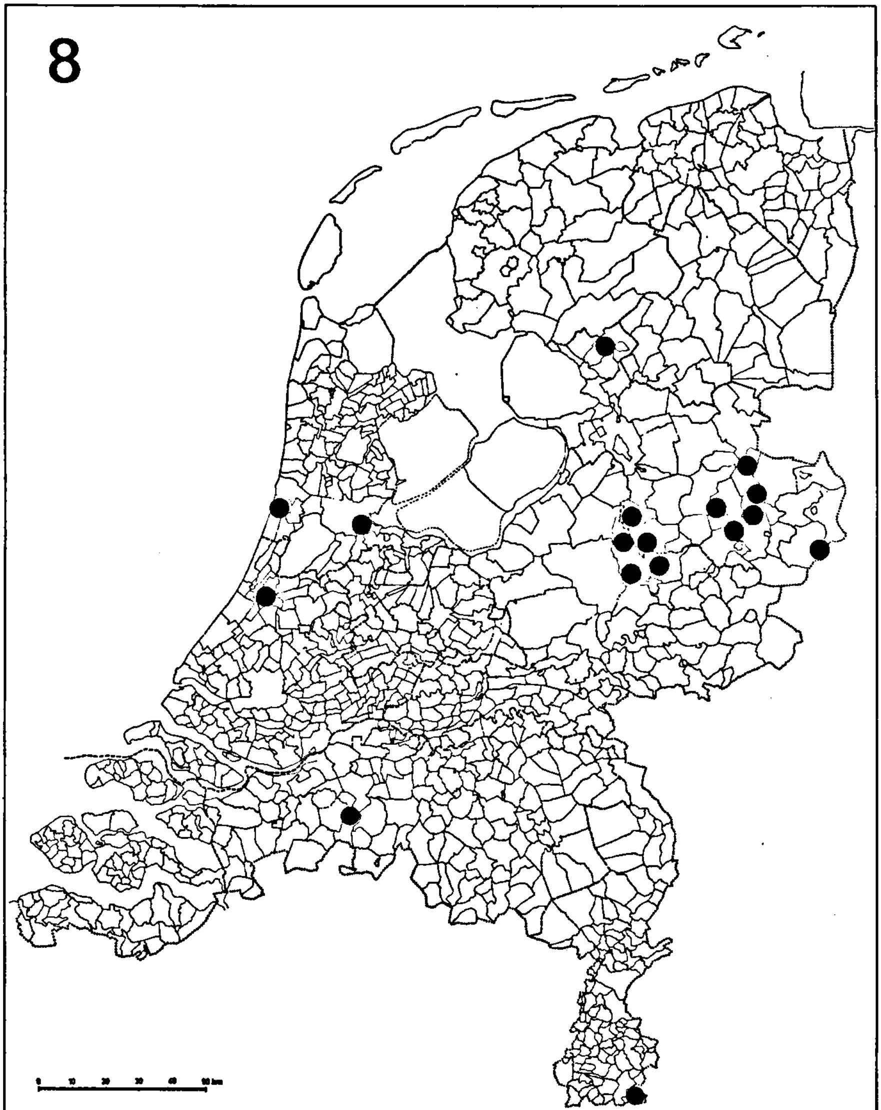


Fig. 8. Localities where *Skrjabingylus nasicola* has actually been found.

intermediate host had to be found. In an experimental situation Hansson fed Stoats and Weasels with freshly killed shrews, *Sorex araneus* (L.), which resulted after some time in Skrjabingylosis of the mustelids. Further evidence for the possibility, that at least partly shrews are the transmitting agents of the parasite, is the fact, pointed out by Hansson (1970), that in areas of the world in which shrews are absent from the fauna (for instance North East Canada and Greenland) no *Skrjabingylus*-infected Stoats are found (Hansson, 1970: 591). Shrews being the intermediate hosts could also explain why the infection rate on the island of Terschelling is so high. On Terschelling the diversity of prey for Stoats is greatly limited: only Long-tailed Field Mice (*Apodemus sylvaticus* (L.)), Shrews (*Sorex araneus* L. and *Sorex minutus* L.) and to a lesser extent Rabbits and birds are available. When it is assumed that soricids are the parasite transmitting animals, then it is clear that sooner or later nearly every Stoat on the island is going to be infected by eating Shrews. In other parts of the Netherlands, for instance in the dune region, a very important part of the food will be Voles, thus the chance of eating infected food will be greatly reduced.

However, this leaves the question why Weasels from the dune region are so much heavier infected than Stoats. It is interesting to compare the infection rate of young and adult Stoats and Weasels, taken only from both dune regions. Of the young Stoats 21.3 % were infected (n = 141), of the young Weasels 29.4 % (n = 17). Of the adult Stoats 28.3 % were infected (n = 53), of the adult Weasels 92.3 % (n = 26). The difference in total infection percentage is apparently caused by the high percentage of adult Weasels that are infected. One is tempted to draw the conclusion that adult Stoats stand a lesser chance of being infected by generally eating more (not *Skrjabingylus*-infected) prey animals like Rabbits and Voles, than Weasels.

No possible explanation for the high percentage of infected Stoats in the Denekamp region (100 %) can be offered.

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