

Scent-marking in the pine marten (*Martes martes*) in Finnish Forest Lapland in winter

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Abstract

Studied were scent-markings used by pine martens (*Martes martes*) in an uninhabited region of Finnish Forest Lapland, northern Europe, by tracking individuals of the species for a total of 2481 km over two successive winters. The frequency of defaecation decreased during the course of the winter (from 0.8 times/km in late October to 0.3/km in March), but increases were found in urination (from 0.9/km in late October-December to 1.6/km in January-March) and rubbing secretion from the anal glands (from 0.8/km to 5.4/km respectively). The last mentioned activity varied considerably even from night to night. The pine martens scent-marked throughout their home ranges. Orientation (taking place even in conditions when vision is inoperative), familiarity with a locality and individual recognition are regarded as the primary functions of these scent-markings, whereas the „reading“ of each other's scent-marks, and thereby the maintaining of *martelism*, is regarded as one of the effects of this practice under unpredictable northern conditions in which the home range of a pine marten may amount to almost 100 km².

Introduction

The pine marten of northern Fennoscandia (*Martes martes*) is active at night in winter, only about 1 % of observations being achieved at day (PULLIAINEN 1981b). THIESSEN and RICE (1976) and STODDART (1980c) have recently emphasized that nocturnalism provides a selective encouragement to the development of olfactory communication. The pine marten scent-marks its home range by urination, defaecation and rubbing secretion from the anal glands on conspicuous objects (EWER 1968; PULLIAINEN 1981b). JOHNSON (1973) proposed six functions for such scent-marking, namely as an alarm signal, epideictic display or sex attractant, or for individual recognition, orientation or familiarity in a location, or for warning conspecifics away from occupied territory. RALLS (1971) suggested that it may also be used to indicate dominance to a conspecific (see also STODDART 1980a, b).

The purpose of the present paper is to provide records on the scent-marking behaviour of the pine marten in Finnish Forest Lapland, northern Europe, in winter.

Material and methods

The study area, of approx. 250 km², lies in eastern Itäkaira, Finnish Forest Lapland. The eastern part of the area includes two fell ridges (Pulkkatunturi-Sautunturi and Värriötunturi) running in a north-south direction about 5 km apart. Ravines are typical of the fell terrain. The area is in a virgin state, with the following proportions of natural habitats: spruce forests (*Picea abies*) 26.5 %. Scots pine forests (*Pinus sylvestris*) 18.5 %, birch forests (*Betula spp.*) 3.0 %, mixed forests 22.0 %, open bogs 13.5 %, mountain birch forests (*Betula pubescens ssp. tortuosa*) 7.0 % and treeless fell summits 9.5 %. The forests are old and mature, including a large number of standing and fallen dead trunks. The density of trees is generally very low, and in some places there are young spruce and pine saplings among the very old trees. Some of the lowland birch forests were killed by larvae of the geometrid *Epirrita autumnata* in 1965-1966 (see PULLIAINEN 1976).

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Table 1

Distances covered in tracking pine martens during each of the ten-day study periods during the winters of 1979/80 and 1980/81

Period	Distance skied, in km	Period	Distance skied, in km
21–30 October	272.12	10–19 January	113.57
1–10 November	86.27	20–29 January	157.01
11–20 November	114.26	30 January–8 February	233.90
21–30 November	76.74	9–18 February	192.06
1–10 December	120.07	19–28 February	155.30
11–20 December	158.35	1–10 March	141.20
21–30 December	104.67	11–20 March	224.97
31 December–9 January	65.99	21–30 March	264.76

The field studies were carried out during two successive winters, 1979/80 and 1980/81. Four males and two females during the former winter and three males and two females (identified on the basis of the size of the footprints and urination patterns) during the latter were tracked by skiing, giving a total distance skied of 2481 km (Table 1). In 1979/80 a male and a female were tracked simultaneously for 67 days, and in 1980/81 a male and a female in the same part of the study area were also tracked simultaneously for 50 days. The animals were not disturbed in any way when tracked through the snow. All events of urination, defaecation, and rubbing secretion from the anal glands were recorded. In the majority of the cases included in this paper the pine marten was tracked from one resting site to another. All cases, in which the snow had covered the tracks or had otherwise made it difficult to interpret the activities of the animals were omitted.

Results

Pine martens employ a scent-marking technique which involves rubbing secretion from the scent anal glands onto various objects or urinating and defaecating at conspicuous locations (PULLIAINEN 1981b). Faeces are usually left singly throughout the home range. Middens were seldom found, and only in the immediate vicinity of frequently used resting sites. The largest midden consisted of 6 faeces. Faeces were often found on the roots or trunks of fallen trees, on stumps or at other places where the surface of the snow was higher than elsewhere in the vicinity.

Defaecation was the least frequent and least variable of the three scent-marking techniques (Fig. 1). In late October, however, when the pine martens ate large quantities of berries and mushrooms (PULLIAINEN 1981a), the faeces were left at the average distances of 1.3 km, while in March, when small rodents, carcasses, etc. comprised the majority of the diet (PULLIAINEN 1981a), the corresponding figure was 3.6 km. The average defaecation frequency of the two males (or one male in two successive winters) was 0.36 times/km, and the corresponding mean for the female(s) in the two successive winters (in late January–March) 0.33. This difference is not statistically significant ($t = 0.815$, $p < 0.5$, d.f. 12). When travelling, the pine martens visited faeces left earlier by themselves or other martens at conspicuous locations.

The pine martens frequently urinated at places where the surface of the snow was higher than elsewhere in the vicinity, or on their own trails of those of other animals (including empty snow cavities of tetraonids) or on ski tracks, on carcasses, in trees which they were climbing, etc. Urination occurred throughout the home range. Its average frequency was 0.9 times/km before the turn of the year, but clearly higher in January–March (1.7 times/km) (Fig. 1). Interestingly, this urination frequency was at its minimum (0.7 times/km) in late October, when the pine martens were eating wet berries and mushrooms, although the faeces were very wet at this time. Urination was the second most frequent scent-marking

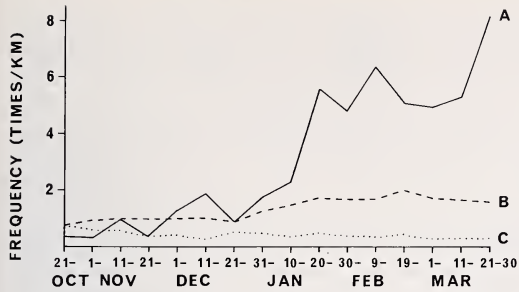


Fig. 1. Frequencies (n/1 km) of rubbing secretion from the anal glands (A), urination (B) and defaecation (C) in pine martens in the period 21 October–30 March during the winters of 1979/80 and 1980/81

activity, with average frequencies in late January–March of 1.6 times/km in the male(s) (see above) and 2.1 times/km in the female(s). This difference is statistically significant ($t = -3.508$, $p < 0.01$, d.f. 12).

The pine martens rubbed secretion from their anal glands on the snow surface, sticks, branches of bushes or trees, etc. This was the most frequent and most changeable of the scent-marking activities (Fig. 1), varying considerably even from night to night and from one individual to another, although a certain trend can also be seen, in that the mean frequency was only 0.8 times/km before the turn of the year, while in January–March it was 5.4 times/km (Fig. 1).

The male and female rubbed secretion from their anal glands with almost similar frequency (4.6 and 3.9 times/km, respectively) in January–March 1980, but in February–

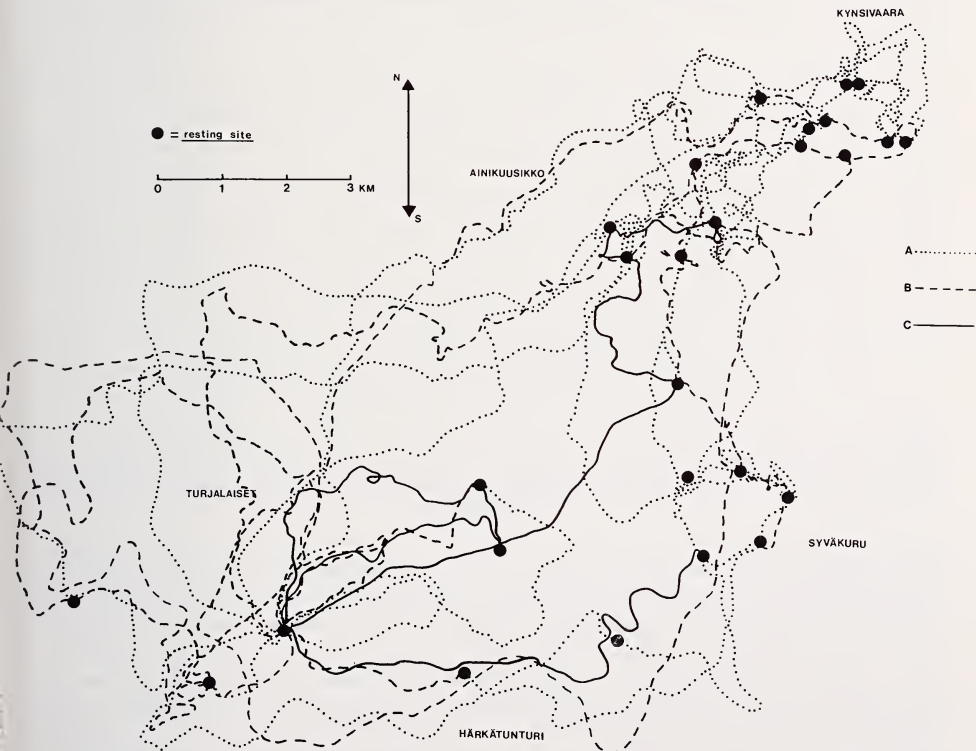


Fig. 2. Movements of a male pine marten in the study area on 2 February to 31 March 1981 and frequencies of rubbing secretion from the anal glands between the resting sites. Frequencies: A = 0–10 times/km; B = 11–20 times/km; C = over 20 times/km

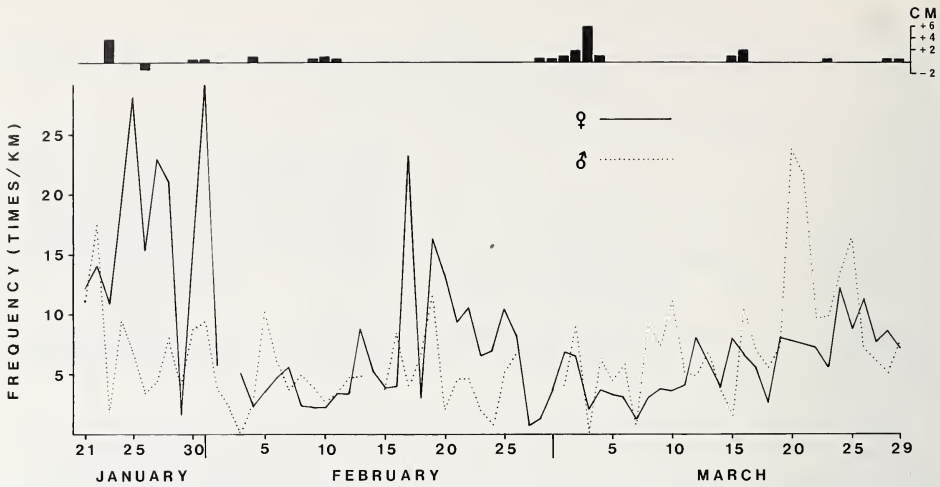


Fig. 3. Frequency of scent-marking in a male and a female pine marten and changes in the thickness of the snow cover at a meteorological screen located in the middle of the study area on 21 January to 29 March 1980

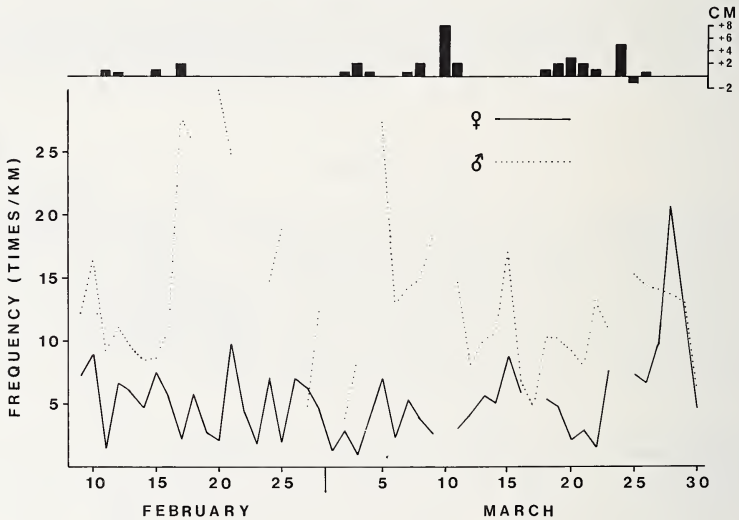


Fig. 4. Frequency of scent-marking in a male and a female pine marten and changes in the thickness of the snow cover at a meteorological screen located in the middle of the study area on 9 February to 30 March 1981

March 1981 the corresponding frequency for the male was considerably higher than that of the female. Thus when the two sets of data are combined, the average frequency for the male(s) is 7.5 and that for the female(s) 3.6 times/km. This difference is statistically highly significant ($t = 4.787$, $p < 0.001$, d.f. 12).

In order to understand any possible territorial behaviour in the pine marten it is important to know whether it scent-marks along the borders of its home range or throughout it. Fig. 2 shows that the male marten tracked on 2 February–31 March 1981 had rubbed secretion from its anal glands onto various objects throughout its home range, the highest marking intensities being recorded both near the boundaries and in the inner parts. Other long trackings gave the same result.

Figure 3 shows the scent-marking frequencies (defaecation, urination and rubbing secretion from the anal glands calculated together) of the male and female pine marten, the home ranges of which (areas of 34 and 14 km² respectively) totally overlapped, during the period 21 January–29 March 1980. The female had peaks in this activity in the beginning and in the middle of the period, while the male had similar peaks at the end of the period. Altogether, however, there was no significant difference in scent-marking frequency between the sexes.

A male and a female pine marten were tracked in the same part of the study area on 9 February–30 March 1981, the areas of their home ranges being 93 and 38 km² respectively. Again these totally overlapped. It is possible that the martens were the same individuals as during the previous winter. In this case, however, scent-marking was much more frequent in the male than in the female (Fig. 4). Here again a considerable variation in scent-marking frequency is visible from night to night.

Discussion

The present pine martens did not throw their odorous secretion (in the urine and faeces and from the anal glands) to the winds, but directed it at conspicuous locations. PETERS and MECH (1975), studying scent-marking in wolves (*Canis lupus*), point out that the elevated locations of raised leg urination 1. facilitates wind dispersal of the odour, 2. increases the evaporation surface as the urine trickles down, 3. minimizes the chances of the mark being covered by snow, and 4. produces a visual contrast against the snow which is visible from several metres away. The present study describes the behaviour of the pine marten, also in snow conditions. The first three points are probably relevant here, too, while the fourth is scarcely of any great importance in view of the darkness of the night in mid-winter.

The term "territorial marking" implies that the marks serve to identify a territory, that is, a fixed space which the individual will defend against rivals of the same species (RALLS 1971). If scent-marks acted as a means of territorial defence they might be expected to occur most frequently at the territorial boundaries (JOHNSON 1973). PETERS and MECH (1975) found that wolves leave urine markings more frequently near their territorial borders, and they are also known to mark more frequently on trails than off them, irrespective of the availability of suitable prominent sites. CAMENZIND (1978) describes similar behavior in the coyote (*Canis latrans*) and MACDONALD (1980) in the red fox (*Vulpes vulpes*). Red foxes also leave urine marks specifically on visually conspicuous objects (MACDONALD 1980), as also do coyotes (LINHART and KNOWLTON 1975).

KRUUK (1978) found that European badgers (*Meles meles*) demarcate their territory borders with middens, which were found to be located near certain landmarks more often than could be predicted by chance. MACDONALD and LINDSAY (cit. in MACDONALD 1980) also found middens along territory borders, although some long sections of the boundaries had none. KRUUK and HEWSON (1978) discovered that the middens of a population of coastal otters (*Lutra lutra*) were more than twice as numerous within 100 m of the holts than elsewhere. These otters had linear territories along the coast, and so their middens were well away from this. ERLINGE (1968), studying otters in inland waterways, found these to be territorial, their middens being associated with home range boundaries, whereas the scats of otters around certain Scottish lochs were not associated with territorial borders (GORMAN 1980). Solitary moving mustelids such as *Mustela frenata* and *M. nivalis* (QUICK 1951), and the pine marten (LOCKIE 1966; the present study), may also use middens.

Red foxes (MACDONALD 1980) and wolves (SETON 1909; PETERS and MECH 1975; DANILOV et al. 1978) often travel along well-used trails and leave their scent-marks on these routes and at junctions between them. The pine martens of the present study area avoid

openings and clearly prefer forests where spruce is growing as their moving and resting habitats (PULLIAINEN 1981b). Partly due to the local habitat structure and partly to the location of favourite resting sites and scent-marked routes leading to them, the pine martens of the area also have routes (see PULLIAINEN 1981b; Fig. 2), but these are not the same game trails as are used by the semi-domestic reindeer (*Rangifer tarandus tarandus*) in the same area. Martens only occasionally use the ski trails of trackers, but regularly scent-mark the junctions between these and their own trails.

Thus the present pine martens practised scent-marking throughout their home ranges and did not defend their ranges against rivals of the same species during the non-breeding season (PULLIAINEN 1981b). MOORS (1980) also draws attention to the same point, and emphasizes that "actual conflict has not been observed between male mustelids establishing territories" and that these are "maintained more by deposition of scent than by direct aggression". JOHNSON (1973) writes that "although scent marks do not cause avoidance, they may signal that an animal is in foreign territory and predispose withdrawal in the presence of the resident animal". STODDART (1980a: 160) states that "mammals very obviously distribute scent around their territories, but such odours do not prevent intruders from entering occupied territories" (see also THIESSEN and RICE 1976).

STODDART (1980a: 151) classifies mammals for which there is clear evidence of territory marking into two categories, arranged according to whether the marks are principally placed at the territory boundary or scattered throughout the hinterland (in both categories there may be a concentration of marks in the immediate environs of the home site). The boundary markers' group (STODDART 1980a) includes *Vulpes vulpes*, *Canis familiaris*, *Canis lupus* (pack), *Meles meles*, *Lutra lutra* (riverine habitat), *Crocuta crocuta*, *Canis aureus*, *Felis tigris*, *Vombatus ursinus*, *Galago alleni* and the domestic cat, and the category of hinterland markers the following species/groups: *Herpestes auropunctatus*, *Hyaena brunnea*, *Lutra lutra* (marine habitat), *Diceros bicornis*, *Oryctolagus cuniculus*, most ungulates and most primates.

STODDART (1980a) stresses that environmental conditions exert a strong influence on territorial demarcation, and this is particularly well seen in northern temperate species which must be catholic feeders in order to survive, while in predictable environments a rather constant pattern of territoriality occurs, and with it a constant demarcation procedure. The present pine martens are opportunistic feeders which utilize a wide variety of food sources, from berries and mushrooms to small mammals, birds and all kinds of carcasses, depending on availability (see PULLIAINEN 1981a).

On the basis of his own research and the work carried out by HAWLEY and NEWBY (1957) and MECH and ROGERS (1977), PULLIAINEN (1981b) states that the resource-space use pattern of *Martes martes* and *M. americana* includes all the alternatives from overlapping of the home ranges of two adult males or a male and one or more females to partial or no overlapping of home ranges among neighbouring males or a male and a female. Home ranges may or may not be extended into vacated areas (WECKWERTH and HAWLEY 1962; PULLIAINEN 1981b). This pattern even allows for the possibility of three or four individuals feeding on the same cervid-sized carcass during one night (NASIMOVIC 1948; PULLIAINEN 1981b). NYHOLM (1970) and POWELL (1979) use the term "territory" in the case of the pine marten, whereas in his earlier paper (PULLIAINEN 1981b) the present author was reluctant to do so for the reasons mentioned above.

The author also suggested (PULLIAINEN 1981b) that scent-marking plays an important role in the pine marten's-spatial orientation, so that it "reads" other individuals' tracks, and soon learns whether it is worth hunting in the area or not. EATON (1970) suggests that cheetahs (*Acinonyx jubatus*) avoid each other's hunting trails by "reading" fresh urine marks. MACDONALD (1980) has correctly emphasized that there is a need to distinguish the functions and the effects of scent-marks, and in this respect the pine marten's reading of another's scent-marks belongs to the latter category. The author termed the resource-space

use pattern of the pine marten *martelism* (PULLIAINEN 1981b), a feature which probably also occurs in the wolverine (*Gulo gulo*) (PULLIAINEN 1981b; see also KOEHLER et al. 1980; cf. PULLIAINEN and OVASKAINEN 1975), which also lives in the unpredictable environments of the northern taiga.

Scent-marking in the pine marten almost certainly also has self-centred primary functions in the life of the marker. It evidently plays a role in orientation and familiarity with a locality (PULLIAINEN 1981b). Pine martens are very familiar with their home ranges, using the same resting sites on successive days and finding their way almost directly to their resting sites at night, when vision is of no avail (PULLIAINEN 1981b). The same favourite resting sites are known to have been used by the same and/or different individuals during successive winters.

CAMENZIND (1978) found that coyotes had a seasonal pattern in urine marking, with a minimum during September and October. PETERS and MECH (1975) recorded a peak in the frequency of raised leg urination of wolves in February (3.5 times/km), falling to 1 per km in March. On the basis of this data and his own observations on red foxes, MACDONALD (1980) states that in many cases the peak coincides with the period of pair formation and courtship, and also, perhaps fortuitously, with the dispersal of non-resident juveniles.

The present data on the pine marten covers only the snowy season. Since copulation takes place in June (DANILOV and TUMANOV 1976), one interesting season, in the light of the above-mentioned studies, lies outside the scope of the present investigations. During the present work it was found that the frequency of defaecation decreased almost to one third during the course of the winter, while that of urination almost doubled and that of rubbing secretion from the anal glands multiplied many times over (Fig. 1), thus partly confirming the results of the preliminary study (PULLIAINEN and HEIKKINEN 1980). There was a considerable night-to-night variation in these frequencies, however, especially in that of rubbing secretion from the anal glands (see also PULLIAINEN 1981b).

In most mammals the males use scent-marking more frequently than females (see review in JOHNSON 1973; THIESSEN and RICE 1976; STODDART 1980a). At an earlier stage in the present work (PULLIAINEN 1981b) no differences were recorded between the sexes in this respect, but the present data suggest a difference corresponding to the usual pattern. The interindividual variation is so great, however, that further studies are needed before any final conclusions can be reached.

At the same stage (PULLIAINEN 1981b) the author also draws attention to some cases in which the rubbing of secretion from the anal glands was especially frequent after snowfalls. A more detailed study nevertheless revealed that this is not always the case (see Figs. 3 and 4). There are probably many factors which affect the scent-marking frequency of a pine marten. In early winter, when the snow cover is thin, odours from the summer can still be detected, but gradually their concentration decreases. The increase in the depth of the snow also acts in the same direction, but the scent-marks left by the pine martens similarly become weaker during long spells with no snowfall, and the spots must be re-marked. In the field it often seems that the faeces left on the tops of long stumps act in the orientation of martens like the buoys and beacons for ships on the sea. Thus the relatively numerous faeces left in early winter may partly explain the relative scarcity of other scent-markings. As already mentioned, external stimuli such as ski tracks or the trails of other mammals, birds, etc., may also trigger scent-marking in the pine marten.

Field studies reveal that pine martens recognize the smells of the other martens individually (PULLIAINEN 1981b), and a male marten will now and then follow the tracks of a female living in his home range. SIMMS (1979) found that *Mustela erminea* and *M. frenata* in North America have distinctly different smells, and notes that these species regularly traverse their ranges and advertise their presence by scent-marking, the degree of interference depending on population densities and the availability of refuges for the smaller

species. The present author (PULLIAINEN 1981b) has suggested that the pine marten also has its distinctive smell, which serves for interspecific recognition.

MACDONALD (1980) also warns against attempts to fit urine of faecal marking into a role which stresses only their aversive functions. It is also possible that the roles which odours play vary intraspecifically. Thus the results obtained in unpredictable northerly environments, where the area of a home range of a pine marten may be almost 100 km², are not necessarily relevant to more predictable environments. The costs of the different activities, such as defending a large space, must be taken into consideration.

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Zusammenfassung

Duftmarkierung des Baumarders (Martes martes L.) im Wald-Lappland Finnlands im Winter

Die Duftmarkierungen des Baumarders (*Martes martes*) wurden im unberührten Wald-Lappland Finnlands, in Nord-Europa, untersucht, indem Spuren von Individuen dieser Art in zwei aufeinander folgenden Wintern 2481 km lang gefolgt wurde. Die Untersuchungen haben folgendes ergeben: Die durchschnittliche Defäkationshäufigkeit sank während des Winters (von 0,8 mal/km Ende Oktober bis 0,3 mal/km im März), während die Häufigkeiten von Urinabgabe (0,9 mal/km Ende Oktober bis Dezember gegenüber 1,6 mal/km im Januar bis März) und Frottieren der Analdrüsen (entsprechend 0,8 mal/km gegenüber 5,4 mal/km) anstiegen. Die letztgenannte Handlung zeigte sogar von Nacht zu Nacht erhebliche Schwankungen. Die Marder duftmarkierten in ihrem gesamten Wohngebiet. Orientierung (sogar unter Bedingungen, bei denen das Sehvermögen versagt), Erkennen des Wohngebietes und individuelle Identifizierung werden als Primärfunktionen dieser Duftmarkierungen betrachtet. Demgegenüber wird das „Ablesen“ der Spuren anderer Artgenossen, und damit die Aufrechterhaltung des sog. *Martelismus* (PULLIAINEN 1981b) als ein praktischer Effekt dieser Handlung angesehen. Er ist erforderlich, da unter den extremen Verhältnissen des Nordens die Größe des Wohngebietes eines Marders fast 100 km² betragen kann.

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