# Distribution of *Sorex minutus* and *Sorex araneus* (Mammalia: Insectivora) within a forest area in Western Norway


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We collected shrews using pitfall traps in a forest area in Kvam, Hordaland, Western Norway in 1997-98. Altogether, 205 individuals of pygmy shrew, *Sorex minutus* and 129 individuals of common shrew, *Sorex araneus* were collected. Both shrew species occurred over a wide range of forest types. Common shrew was absent in bogs and pygmy shrew apparently was absent in alder forest. Common shrew was relatively evenly distributed among forest types while the catches of pygmy shrew was significantly lower in deciduous forest than in pine forest, and this may suggest that the pygmy shrew is partially excluded from these areas by the common shrew. Catches of shrews showed no unambiguous correlation with catches of arthropods. Shrew catches were only weakly related to variation in forest productivity, humidity and tree cover. For both species the number of animals caught was highest in June and July, with rather few specimens caught in early spring and late autumn/winter.



*Keywords*: habitat distribution, interspecific competition, pitfall traps, shrews



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## INTRODUCTION

The common shrew *Sorex araneus* and the pygmy shrew *Sorex minutus* are common, small sized insectivores which coexist over large parts of Europe (Siivonen 1976, Butterfield *et al.* 1981, Heggberget 1990). In general these species are thought to utilise the same habitats. Niche overlaps > 90 % between the two species were calculated by Churchfield *et al.* (1997) and Rychlik (2000). Shrews are aggressive and highly territorial (Ellenbroek 1980) and all fulfil their high and constant energy needs by eating invertebrates. Yet several species are frequently found together, with as many as nine occurring in the same area in some parts of Siberia (Sheftel 1989, Churchfield & Sheftel 1994, Churchfield *et al.* 1997). Coexisting shrew species tend to utilise different prey groups (Pernetta 1976, Churchfield & Sheftel 1994) and in some cases morphological character displacement has been found, different species being more dissimilar in sympatry than in allopatry (Malmquist 1985, Frafjord 1992). Several investigations have shown that the common and pygmy shrews utilise quite different food resources (Pernetta 1976, Butterfield *et al.* 1981, Churchfield 1984, Dickman 1988, Churchfield & Sheftel 1994). While the common shrew takes a wide range of prey, earthworms (Lumbricidae) are quite important (Pernetta 1976, Butterfield et al. 1981, Churchfield 1984, Denneman 1990). In contrast, earthworms are not eaten at all by the pygmy shrew (Pernetta 1976 and others). Both species eat numerous kinds of arthropods, which make up nearly the entire diet of the pygmy shrew. However, even arthropods are preyed upon differently by the two species (Pernetta 1976). Arthropods found in stomachs of pygmy shrew are mostly small-sized species such as linyphiid spiders, harvestmen of the genus *Nemastoma* and beetles in the size range 2-6 mm (Pernetta 1976). In contrast, common shrew eats mainly lycosid and clubionid spiders and larger-sized genera of harvestmen. Pernetta (1976) found that woodlice were eaten by common shrew but only infrequently by pygmy shrew, on the other hand Churchfield (1984) found that both species took about equal fractions of woodlice. Ants were found frequently in shrew droppings by Churchfield (1984), however these ants were possibly eaten because they were a nuisance to shrews trapped within live-traps. Pernetta (1976) did not mention ants as prey of these shrew species, however the frequency of occurrence of the order Hymenoptera was rather low in his survey. Churchfield & Sheftel (1994) found ants with very low frequency in the diet of common shrew, and not at all in pygmy shrew.

Pygmy shrews have been shown to avoid contact with common shrews (Dickman 1991). However, the habitat distribution of shrews in Norway has been investigated only sporadically (Linn 1954, Andersson & Hansson 1966, Frafjord 1992, Olsen 1994).

Interspecific territoriality among shrews has been found in some cases (Croin Michielsen 1966, Hawes 1977, Malmquist 1985). The common shrew is generally roughly twice the size of the pygmy shrew, with a weight range of 3.5-14 grams versus 2-6 grams for pygmy shrew (Siivonen 1976). Being much larger, common shrew could probably exclude pygmy shrew. Dickman (1991) showed that pygmy shrews avoided contact with common shrews within an enclosure, and that the presence of a common shrew reduced the foraging rate of a pygmy shrew. Ellenbroek (1980) found no difference in territory size, and thus density, in pygmy shrew between Ireland, where common shrew is absent, and the Netherlands, where common shrew is present.

During a large-scale sampling program for epigaeic invertebrates in Western Norway (Baumann & Gjerde 1998, Gjerde & Baumann 1999, Pommeresche 1999, Gjerde & Baumann 2002) using pitfall traps we found that a rather large number of shrews were collected over a wide range of forest types. This gave us the opportunity to study the distribution of the common and pygmy shrews with respect to forest type, to each other, and to the distribution of some important prey groups. In particular, we want to address the following questions:

How are the common and pygmy shrews distributed between habitat types in mixed forest in Western Norway?

Is the distribution of shrews determined by the distribution of potential prey animals?

Is there any evidence of competitive displacement between the two species? In particular, does the larger species, the common shrew, displace the smaller pygmy shrew from some habitats?

# MATERIAL AND METHODS

## Study area

The study area was situated in Kvam municipality in Hordaland, Western Norway (60º 7' N, 5º52' E), between the fjords Bjørnafjorden to the west and Hardangerfjorden to the east. Altitude varies between 100 and 300 meters above sea level. The area has a varied topography with steep ridges running through most of the area in SW-NE direction. Vegetation on the ridge tops is mainly nutrient-poor heather-pine woodlands, with some areas of bare rock. Between the ridges bilberry/pine forest alternates with bogs. Some of the south-facing slopes have broadleaf forest. Climate in the area is rather oceanic with cool summers, relatively mild winters and generally high humidity. Omastrand weather station, about 10 km to the north of the study area, has recorded mean annual temperature of 7.2º C, ranging from 0.6º C in February to 14.8º C in July, and a mean annual precipitation of 2570 mm (Data from Norwegian Meteorological Institute).

## Pitfall trap samples

We sampled each locality by the means of a trap series of eight pitfall traps. The traps were glass vats with a diameter of 6.5 cm, which were buried to the rim. The majority of the traps used were 12 cm deep, but in a few localities with very shallow soils we used traps 6 cm deep. We equipped each trap with a sheet metal roof 2-3 cm above the trap to reduce evaporation and prevent that rainwater and debris filled up the traps. The traps were half-filled with 4 % formaldehyde plus a small amount of detergent. We put out the traps in late April or early May, and emptied them four times during the season until November. The traps put out in 1997 were also operated during the winter, when some ethylene glycol was added to the traps to avoid freezing. We stored the material in alcohol, and picked out all beetles, spiders and vertebrates for identification. The shrew specimens collected, except for some which were discarded because they were in a bad condition when they were collected, have been deposited in the vertebrate collection of the Zoological Museum, University of Bergen (ZMUB).

## Dataset I

In 1997-98, we sampled 50 sites with pitfall traps. The traps were placed in a cross pattern, and the distance between traps was approximately two metres. We took care to ensure that the whole trap series were well within the boundaries of a single, relatively homogenous forest stand or bog. The traps remained operating until April 1998, thus covering a full year. We avoided sampling certain parts of the study area with traps to avoid unintended killing of crested newts (*Triturus cristatus*), which were locally abundant in the area but are endangered. Further details on the localities sampled are given by Pommeresche (1999).

We sampled seven bog localities. Five of these were oligotrophic *Sphagnum*-dominated bogs, with bog myrtle (*Myrica gale*) and bog bilberry (*Vaccinium uliginosum*), two were more nutrient-rich bogs with a vegetation of predominantly sedges (*Carex* spp.). Within the nutrient-poor, heather / pine woodlands we sampled 15 localities. These localities had a tree layer (often sparse) of almost exclusively scots pine (*Pinus sylvestris*), with a field layer of bog bilberry (*Vaccinium uliginosum*), heather

(*Calluna vulgaris*) and purple moor-grass (*Molinia caerulea*). We sampled 12 localities within bilberry / pine woodlands. Here the vegetation was richer than in the heather / pine type, the forest was denser and trees taller. Scots pine still predominated but some deciduous trees such as downy birch (*Betula pubescens*) and grey alder (*Alnus incana*) also occurred. The field layer had much bilberry (*Vaccinium myrtillus*) and the ground was usually covered by peat mosses (*Sphagnum* spp.).

Deciduous forest localities sampled included 14 localities. Two localities were in dry, predominantly oak (*Quercus* sp.) forest with a sparse field vegetation dominated by bilberry and small ferns, six localities in elm / lime type woodland (although lime was absent), with a tree layer of predominantly wych elm (*Ulmus glabra*) and ash (*Fraxinus excelsior*) and a field layer of various herbs and ferns. Three localities were in alder / ash type forest. These localities, which were all facing NW, had a tree layer of downy birch (*Betula pubescens*), grey alder (*Alnus incana*) and hazel (*Corylus avellana*), and the ground was densely covered by great wood-rush (*Luzula sylvatica*), male-fern (*Dryopteris filix-mas*) and lemon-scented fern (*Thelypteris limbosperma*). Three localities were in alder / bird-cherry type forest, all were on level ground next to small brooks, with a tree layer of grey alder (*Alnus incana*) and ground vegetation of predominantly grasses.

Finally, one locality was in a young (20-25 years old) Norway spruce (*Picea abies*) plantation, with very dense forest with hardly any ground vegetation.

## Dataset 2

In 1998, we sampled 26 different localities. We put out traps between 28. April and 4. May and operated them until 30. November - 1. December 1998. Whereas dataset 1 had localities from rather homogenous forest stands or bogs, the sampling in dataset 2 was focused on more heterogenous stands. The traps were placed on a transect line with a distance of 2-3 meters between each trap. We did not confine the traps to a single homogenous stand but rather stretched out over a gradient so that as many as possible of the vegetation types in the immediately surrounding area would be sampled. For this reason the localities were less readily classified according to forest type than the 1997 sites. All sampling sites in 1998 were from productive pine forest, but some of the localities had numerous deciduous trees (birch, alder, oak) as well. 13 localities were in predominantly heather-pine woodland, eight in predominantly bilberry-pine woodland and five localities in predominantly low-herb-pine woodland. 13 of the sites had steep, narrow ravines, in which cases we extended trap lines across the ravines and included the ravine bottom.

## Environmental variables

Environmental variables were recorded during the forest biodiversity research project "Miljøregistrering i skog" (Gjerde & Baumann 2002, Pommeresche 2002). Variables investigated are listed in Table 1.

**Table 1.** Evironmental variables tested.

| Variable | Abbreviation | Type |
|---|---|---|
| Number of common shrews collected | Sorearan | Continuous |
| Number of pygmy shrews collected | Soreminu | Continuous |
| Total adult beetles collected | Coleopte | Continuous |
| Total adult carabid beetles collected | Carabids | Continuous |
| Individuals of *Carabus* spp. collected | BigCarab | Continuous |
| Total adult staphylinoid beetles collected | Staphyli | Continuous |
| Wood ants (*Formica* spp.) present? | Woodants | Binomial |
| Total spiders collected | TotSpide | Continuous |
| Adult spiders collected | AduSpide | Continuous |
| Adult large spiders collected | BigSpide | Continuous |
| Index of earthworm abundance | Earthwor | Categorical 0-2[1] |
| Number of snails collected | Gastropo | Continuous |
| Forest productivity | Product | Categorical 1-6[2] |
| Basal tree area | Basarea | Continuous[3] |
| Humidity rank | Humidity | Categorical 1-10[4] |
| Coverage of tree layer in percent | Treelay | Categorical, 5 % intervals |
| Coverage of shrub layer in percent | Shrublay | Categorical, 5 % intervals |
| Microtopography | Microtop | Categorical, 1-4[5] |

Comments: [1]: Bogs and heather-pine woodlands = 0, other pine woodlands =1, deciduous forest =2 [2]: divided into six classes based on economical maps. [3]: area of tree trunks in $m^2$ per ha. [4]: a relative scale with bogs given the value 10 and the driest localities sampled given the value 1. [5]: entirely even surface =1, with small tussocks and rocks < 20 cm high =2, highest tussocks and rocks 20-50 cm high =3, with boulders, rocks etc. > 50 cm high =4.

## Statistical procedures

To avoid the influence of between-year population variability and a slightly different sampling procedure, we analyzed the two datasets separately. Correlations were investigated using the nonparametric, Spearman Rank Correlation, because several of the variables tested obviously had highly non-normal distributions. Distributions of the two shrew species in time and space were analyzed separately using One-way ANOVA, and significance of between-sample differences was tested for using the Tukey-Kramer multiple comparisons test. The statistical tests were conducted using Stat-100 software (Biosoft Inc.) on a personal computer.

# RESULTS

## Distribution among habitats

We found both shrew species all over the sample area except that pygmy shrew was found only sparingly and common shrew not at all in the bog localities, and that pygmy shrew was not recorded from alder forest (3 localities). Common shrew was also rather sparse in this forest type, two individuals being collected in one of the localities and none in the others.

Trap catches of pygmy and common shrew were not significantly correlated in the two datasets (Rs = 0.241, $t_{48}$ = 1.72, 0.05 < p < 0.1 for Dataset 1, Rs = 0.291, $t_{24}$ = 1.49, p > 0.1 for Dataset 2). Mean trap catches of pygmy shrew increased from bogs through heather/pine woodlands to bilberry/pine woodlands, but were lower in deciduous forest (Figure 1). If the two classes of pine woodlands were pooled, mean catches were significantly higher in pine forest than in bogs and deciduous forest (Tukey multiple comparisons test, p < 0.05). Common shrew, on the other hand, was absent in bogs, and mean catches showed an increasing tendency from heather/pine woodlands through bilberry/pine woodlands to elm/ash dominated deciduous forest, but was significantly lower in oak-, hazel- and alder-dominated forest (Figure 1).

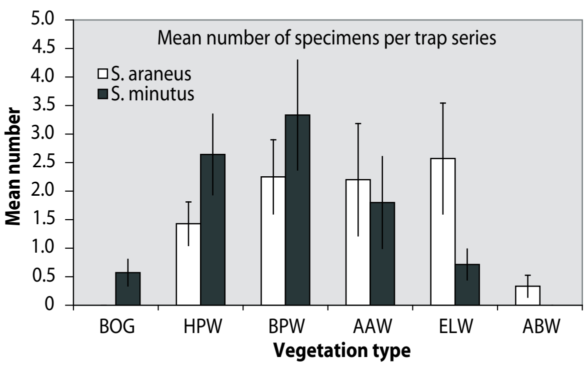


Figure 1. Mean numbers per trap series (8 traps) of pygmy and common shrews caught in different habitat types, Dataset 1. Forest types: AAW : Alder - ash woodland, ABW : Alder - bird-cherry woodland, BOG : Bog, BPW: Bilberry - pine woodland (including low-herb - pine woodland), ELW: Elm - lime woodland, HPW : Heather - pine woodland. Error bars = standard errors.

In dataset 1, trap catches of common shrew were positively correlated with forest productivity (Rs = 0.498, p < 0.001), microtopography (Rs = 0.504, p < 0.001) and basal tree area (Rs = 0.372, p = 0.008) and negatively correlated with humidity rank (Rs = -0,444, p = 0.001), while catches of pygmy shrew showed a weak positive correlation with coverage of shrub layer (Rs = 0.362, p = 0.01).

Localities within bilberry / pine woodlands fell into two groups with respect to catches of pygmy shrew. Four localities in Dataset 1 and seven localities in Dataset 2 all had 5-18 pygmy shrew collected, while six localities in Dataset 1 and six localities in Dataset 2 had only 0-3 individuals of pygmy shrew. The two groups of localities do not come out as distinctive based on vegetation, invertebrates or numbers of common shrew collected.

## Distribution with respect to prey animals

Trap catches of common shrew were positively correlated with the earthworm abundance index (Rs = 0.380, $t_{48}$ = 2.85, p < 0.01), while there was no such correlation for pygmy shrew. For both species there were tendencies towards negative correlations with trap catches of spiders, with a significant negative correlation between adult large spiders and common shrew (Rs = -0.345, p < 0.05). However, these tendencies were due to very large numbers of lycosid spiders in bogs and disappeared if bog localities were excluded from the analysis.

No significant difference was found between numbers of common nor pygmy shrew caught in pine forest localities with or without wood ants (*Formica* sp.), despite the ants having a profound influence on the abundance of insects. Mean number of carabid beetles caught was 256 in localities without ants versus 40 in localities with ants (Skartveit pers. obs.), and differences in biomass were even bigger since no large *Carabus* species occurred in localities with wood ants.

## Phenology and between-year variation in catches

Numbers collected of both species showed pronounced seasonal variation (Figure 2). Peak numbers were caught in June and July for both species in both years. Catches of *S. minutus* per trap-day were higher in 1998 than in 1997 (Figure 2), while catches of *S. araneus* were similar in the two years.

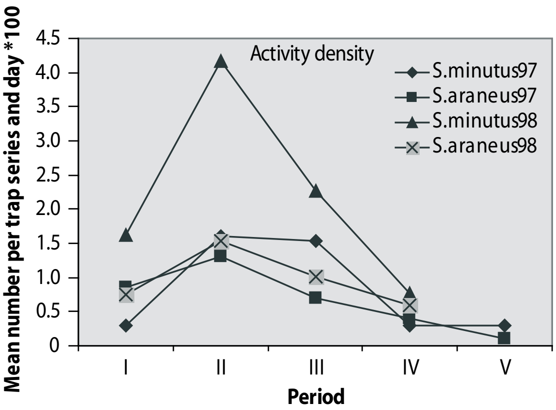


Figure 2. Seasonal pattern of catches of pygmy and common shrew (all localities pooled) during seasons in 1997 and 1998 (Datasets 1 and 2). Period I: April-May, period II: June-July, Period III: July-September, Period IV: September-November, period V: November-April.

## Other small non-avian vertebrates observed

Apart from these two shrew species vertebrates collected included a single water shrew (*Neomys fodiens*), 8 small rodents (*Apodemus sylvaticus*, *Clethrionomus glareolus* and *Microtus agrestis*), 32 toads (*Bufo bufo*) and 39 frogs (*Rana temporaria*). Crested newt (*Triturus cristatus*), viper (*Vipera berus*) and weasel (*Mustela nivalis*) (the latter Magne Sætersdal, pers. comm.) were seen in the area during the field work but none were caught in the pitfall traps.

# DISCUSSION

## Does the common shrew exclude the pygmy shrew?

In the present study, activity density of pygmy shrew was lower in deciduous than in coniferous forest (Figure 1). This is somewhat paradoxical since the deciduous localities were the richest in terms of number of beetles collected (Skartveit pers. obs.), and also rich with respect to spiders, Diptera larvae, woodlice and harvestmen. The reduction in activity density of pygmy shrew between coniferous and deciduous forest might suggest that it is partially excluded from the richer areas by common shrew, as was also suggested by Frafjord (1992). On the other hand, abundances of the two shrew species were not correlated, and many other abiotic and biotic factors also differed between the two forest types. In the study area, the pine woodlands, being more open, had much denser ground vegetation than the deciduous forests. This may possibly have facilitated the coexistence of both species in relatively high densities by providing cover for the pygmy shrew. Even though several of the deciduous forest localities were covered by tall ferns and rushes, the vegetation actually was not particularly dense at ground level. Yalden (1981) found that the pygmy shrew in England reached its highest densities in bogs where the common shrew was absent - this was clearly not the case in our study area, where the maximum activity density of the pygmy shrew was found in areas in which common shrew was present but not abundant. Common shrew distribution apparently followed the density of prey. In particular, we found a rather close match between common shrew and our rather crude index of expected earthworm density. It is interesting to note that the pygmy shrew seemed to be absent and the common shrew sparse in the alder / bird-cherry forest type. This was unexpected because these localities were the richest with respect to beetles, were also characterised by very high forest productivity and would also be expected to be quite rich in earthworms, important prey animals for common shrew (Pernetta 1976). The alder forest localities we investigated were grazed by cattle and sheep and the ground vegetation therefore remained rather short-cropped throughout the season. The localities thus offered the shrews little shelter against bird predators and this might be the reason why they were so little used by shrews.

Numbers caught peaked in June/July for both species (Figure 2), in agreement with what was found by Churchfield (1980) for the common shrew in England. This probably corresponds to the main breeding period. This would seem to indicate that shrews caught were either young juveniles still within their mother's territory, or juveniles searching for a territory. Shrews are active throughout winter and the low number caught during this period is interesting. The collecting efficiency of the traps may have been much reduced in winter due to partial freezing of the traps (though no frost-damage was noted in spring) and the traps being blocked by snow. The chances of a shrew encountering a trap under the snow might be much reduced because its movements are to a large extent limited to particular tunnels in the snow. Also, if a territory holder was removed by a trap in late autumn or winter, its territory might not be reoccupied until the next spring or summer, thus reducing the chances of any more shrews being collected there. A similar strong reduction in numbers of common shrew caught during winter was found by live-trapping in Central England (Churchfield 1980). This seems to be related to their short lifespan, with two generations present only from the first litters are born in spring until all adults die in autumn.

## Prey abundance

Pernetta (1976) found that pitfall traps gave reasonable estimates of the food availability for the pygmy shrew, all arthropods commonly found in pygmy shrew stomachs were also commonly found in pitfall traps. On the other hand, the diet of the common shrew was poorly sampled since earthworms and insect larvae were not sampled well by the traps.

In the present study, judging from the pitfall trap samples the most important potential prey arthropods in terms of biomass are wood ants (in heather/pine woodlands), ground beetles (highest densities in deciduous forest) and harvestmen (highest densities in deciduous forest in autumn). Less important in terms of biomass were spiders, other beetles and woodlice. Diptera larvae were few in the pitfall traps, however litter samples taken within the same areas showed that tipulid, sciarid and bibionid larvae were abundant in some localities. Snails occurred in moderate to rather high densities in the deciduous forest but rather sparsely in other habitats (Myrseth 1999, Vollan 2004). The negative correlation found between shrew and spider abundance is mainly due to the high abundance of spiders, and of lycosids in particular, in bogs, were the common shrew was absent and pygmy shrew apparently sparse.

The present dataset suggests that density of shrews is relatively weakly correlated to forest productivity and prey abundance. However, this effect may in part be an artefact of the collecting method, since pitfall traps sample actively moving animals. If animals have to move more extensively to find sufficient food in less productive areas, they will be more susceptible to getting caught in pitfall traps, thus the catchability will be higher. This might lead to density of shrews being overestimated in less productive areas. An individual might also be more inclined to take the risk of entering a trap if food availability is poorer. The study area consisted of a mosaic of different forest types, and the distance from any low-productivity patch to the nearest higher-productivity area was generally short. Thus, if pitfall traps attract shrews from some distance, some shrews collected at low-productive localities could originate from more productive areas near-by. If the area is saturated with shrews, with all territories occupied, one would expect only a weak relation between productivity and shrew activity, particularly if shrews move more in order to obtain food in a poorer environment. Under these conditions any territory vacated will be recolonised rather rapidly. Croin Michielsen (1966) found that a vacated shrew territory could be taken over by another individual within as little as one hour after the removal of its initial owner.

Both species were collected in larger numbers in 1998 than in 1997 (Figure 2). This could reflect population variations but not necessarily so. Traps in 1998 (Dataset 2) were stretched out on a line, while those in 1997 (Dataset 1) were more concentrated in a cross formation. The 1998 trap lines extended across ravines and valleys. If shrews were attracted from some distance to the traps then a stretched-out line of traps would probably collect more effectively than a more concentrated arrangement.

### Do pitfall traps give a biased picture of activity density of small vertebrates?

Clearly shrews are overrepresented in the traps compared to other small vertebrates. Pitfall traps are effective in catching shrews (Pucek 1969, Hanski & Kaikusalo 1989, Shore *et al.* 1995). Collection with snap traps and live traps tend to give many more rodents than shrews (e.g., Canova & Fasola 1991, Rozhdestvenskaya 1995, Kotzageorgis & Mason 1997, Hansson 1998) and probably more accurately estimate relative population densities. Pitfall traps are activity-dependent, and catch is highly dependent of the size of the traps. Individuals of pygmy shrew are known to have territories approximately twice as big as those of common shrew (Croin Michielsen 1966, Kollars 1995), and therefore probably move around more than the bigger species. This could lead to pygmy shrew being over-collected compared to common shrew by removal pitfall traps (Croin Michielsen 1966, Shore *et al.* 1995). Shrews probably enter the pitfall traps responding to the odour of animals already caught within the traps.

Frafjord (1992) found a marked decrease in the ratio of pygmy to common shrew from the outermost islands to inland localities in Western Norway, with approximately 80 % pygmy shrews in coastal localities and 2.2 % in inland localities. Our study site would correspond to the intermediate "coastal mainland" type of Frafjord (1992), with a distance from the coastline 21-40 km, where Frafjord found a mean proportion of 42 % pygmy shrews. Frafjord further found that the pygmy shrew was numerically dominant in traps in heath, marsh and coniferous forest localities while the common shrew dominated in deciduous forest, as we also observed in the present survey.

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## SAMANDRAG

### Fordelinga av dvergspissmus (Sorex minutus) og vanleg spissmus (Sorex araneus) innan eit skogområde på Vestlandet.

Me samla inn spissmus med Barberfeller i eit skogsområde i Kvam, Hordaland i 1997-98. Til saman vart det samla 205 dvergspissmus, *Sorex minutus*, og 129 vanleg spissmus, *Sorex*

*araneus*. Begge artane fanst i eit vidt spenn av skogtypar. Vanleg spissmus mangla på myrar og dvergspissmus var tilsynelatande fråverande i oreskog. Vanleg spissmus var nokså jamt fordelt over ulike skogtypar medan fangstane av dvergspissmus var signifikant lågare i lauvskog enn i furuskog, noko som kan tyda på at dvergspissmusa delvis vert fortrengd frå lauvskogsområda av vanleg spissmus. Me fann ingen utvetydig samanheng mellom fangstar av arthropodar og spissmus. Fangstar av spissmus var svakt korrelert med variasjon i skogproduktivitet, fuktigheit og tredekning. For begge artane var fangstane høgast i juni og juli, med ganske få eksemplar fanga tidleg vår og seinhaust/vinter.

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**Appendix I.** Summary of material. Forest types as in Figure 1 + LHD : Low-herb deciduous woodland (predominantly hazel), OAW: Bilberry - oak woodlands, SPP: Spruce plantation. * Indicates presence of wood ants (*Formica aquilonia*).

| Loc. ID | Dataset | Forest | *S.araneus* | *S.minutus* |
|---|---|---|---|---|
| 27 | 1 | BOG | 0 | 0 |
| 44 | 1 | BOG | 0 | 2 |
| 73 | 1 | BOG | 0 | 0 |
| 75 | 1 | BOG | 0 | 2 |
| 96 | 1 | BOG | 0 | 0 |
| 109B | 1 | BOG | 0 | 0 |
| 129 | 1 | BOG | 0 | 0 |
| 03* | 1 | HPW | 2 | 3 |
| 04* | 1 | HPW | 2 | 4 |
| 23 | 1 | HPW | 3 | 2 |
| 36 | 1 | HPW | 4 | 6 |
| 41 | 2 | HPW | 0 | 0 |
| 42 | 2 | HPW | 0 | 1 |
| 43 | 1 | HPW | 2 | 2 |
| 46 | 2 | HPW | 1 | 6 |
| 64 | 1 | HPW | 0 | 1 |
| 80 | 1 | HPW | 1 | 3 |
| 83 | 2 | HPW | 1 | 4 |
| 85 | 2 | HPW | 3 | 2 |
| 93 | 1 | HPW | 0 | 2 |
| 96B | 2 | HPW | 1 | 1 |
| 102 | 2 | HPW | 2 | 1 |
| 109A | 1 | HPW | 1 | 7 |
| 112 | 1 | HPW | 0 | 2 |
| 117* | 2 | HPW | 1 | 2 |
| 119* | 1 | HPW | 2 | 2 |
| 122* | 1 | HPW | 3 | 1 |
| 127* | 1 | HPW | 0 | 1 |
| 132* | 1 | HPW | 0 | 1 |
| 138* | 2 | HPW | 2 | 0 |
| 140 | 2 | HPW | 1 | 0 |
| 143* | 2 | HPW | 1 | |
| 146 | 2 | HPW | 0 | 1 |
| 147 | 2 | HPW | 0 | 3 |
| 7 | 2 | BPW | 1 | 18 |
| 13 | 2 | BPW | 5 | 3 |
| 21 | 1 | BPW | 4 | 1 |
| 24 | 2 | BPW | 0 | 5 |
| 25 | 2 | BPW | 3 | 8 |
| 32 | 2 | BPW | 4 | 1 |
| 49 | 2 | BPW | 4 | 6 |
| 51 | 2 | BPW | 4 | 10 |
| 53 | 2 | BPW | 2 | 2 |
| 58 | 2 | BPW | 2 | 10 |
| 60 | 1 | BPW | 2 | 5 |
| 69 | 1 | BPW | 3 | 5 |
| 70A* | 1 | BPW | 2 | 11 |
| 71 | 1 | BPW | 0 | 9 |
| 74 | 2 | BPW | 3 | 2 |
| 75B | 2 | BPW | 2 | 3 |
| 77 | 2 | BPW | 5 | 5 |
| 84 | 1 | BPW | 2 | 1 |
| 87 | 1 | BPW | 2 | 1 |
| 94 | 1 | BPW | 0 | 0 |
| 95 | 2 | BPW | 0 | 3 |
| 118* | 1 | BPW | 3 | 2 |
| 135* | 1 | BPW | 2 | 0 |
| 200* | 1 | BPW | 4 | 2 |
| 250 | 1 | BPW | 3 | 3 |
| 8 | 1 | AAW | 6 | 3 |
| 9 | 1 | AAW | 1 | 1 |
| 15 | 1 | AAW | 2 | 2 |
| 1B | 1 | ELW | 3 | 1 |
| 37 | 1 | ELW | 5 | 0 |
| 47 | 1 | ELW | 2 | 1 |
| 61 | 1 | ELW | 3 | 1 |
| 72 | 1 | ELW | 3 | 0 |
| 82 | 1 | ELW | 2 | 1 |
| 59 | 1 | LHD | 0 | 1 |
| 02 | 1 | ABW | 0 | 0 |
| 1A | 1 | ABW | 0 | 0 |
| 70B | 1 | ABW | 1 | 0 |
| 142A* | 1 | OAW | 0 | 1 |
| 142B* | 1 | OAW | 2 | 2 |
| 01 | 1 | SPP | 4 | 5 |
| SUM | 1-2 | | 129 | 205 |
| Localities | | | 51 | 59 |