

The Collembola of Surtsey, Iceland

By

HÖGNI BÖDVARSSON

Swedish University of Agricultural Sciences
Department of Plant Protection
Uppsala, Sweden

INTRODUCTION

The history of the Collembola of Surtsey is treated at length in Lindroth et al. (1973). In general, the account of this work is based on material collected up to the year 1970, but as for the Collembola, some material collected as late as 1972 is included. The account of the present paper is based partly on Lindroth et al. (1973), partly on material collected after 1972 and partly on older material not included in Lindroth et al. (1973). The material used in this paper has been collected by the present author and by Icelandic biologists working on Surtsey (Erling Ólafsson, Jón Eldon and Hálfván Björnsson).

GENERAL CONSIDERATIONS

Table 1 gives a survey of all Collembola known from Surtsey up to the year 1978. The table shows the number of specimens found of each

species from each year of collection. The species are arranged in the table so that those found at the earliest date come above those found at a later date. No collecting was done in the years 1973, 1975 and 1977. All species found on Surtsey since the publication of Lindroth et al. (1973) are treated in this paper. Reference may therefore be made to Lindroth et al. (1973) as to distribution and general ecology within Iceland.

It is seen from Table 1 that 16 species of Collembola have been found on Surtsey up to the year 1978. Of these, 9 species (56%) have been found in two of the years in question or more. The 4 uppermost species in the table have been found on by far the most numerous occasions. These species must be considered as permanent inhabitants of Surtsey (cf Lindroth et al. (1973), p. 267). As to the 5 species found during two or (in one case) three years only, this is of course

TABLE 1. The Collembola of Surtsey 1967-1978. The table shows the years of collecting and the total number of specimens collected each year. The species are arranged so that those found at the earliest date come above those found at a later date.

Year of collecting	67	68	69	70	71	72	74	76	78
No 1. <i>Archisotoma besselsi</i> Pack.	2	..	123	392	284	678	718	669	262
— 2. <i>Onychiurus duplopunctatus</i> Strenzke	1	..	..	..	7	5	8	1
— 3. <i>Isotoma maritima</i> Tullb.	15	..	18	18	44	13	28	..
— 4. <i>Hypogastrura assimilis</i> Krausb.	8	2	4	38	69	64
— 5. <i>Vertagopus arborea</i> L.	36	..	23	..	..	..
— 6. <i>Folsomia fimetaria</i> L.	3	1	..	..
— 7. <i>Proisotoma minuta</i> Tullb.	6	11	..	..
— 8. <i>Onychiurus armatus</i> Tullb.	6	217	9	..
— 9. <i>Anurida granaria</i> Nic.	1	..	..	..
— 10. <i>Folsomia quadrioculata</i> Tullb.	1	..	..
— 11. <i>Hypogastrura denticulata</i> Bagn.	2	..	..
— 12. <i>Friesea mirabilis</i> Tullb.	7	..	1
— 13. <i>Tullbergia krausbaueri</i> Börn.	6	..
— 14. <i>Isotoma notabilis</i> Schöff.	59	..
— 15. <i>Isotoma violacea</i> Tullb.	24	..
— 16. <i>Megalothorax minimus</i> Will.	37	..

more doubtful. One species (*Vertagopus arborea*) has not been found since 1972, two species not during the last two years of collection and one species not during the last year of collection. One specimen of *Friesea mirabilis* was found in 1978, whereas 7 specimens had been found in 1974, but under very special circumstances (in tuft of grass driven ashore from some other island (Ólafsson, 1978).

As to the remaining 7 species found during one year of collection only, permanent colonization is as yet extremely doubtful. Reservations must of course be made regarding imperfect collections. The collections have, however, been made in the same way and with similar intensity on each occasion. On the sandy northern part of the island, collecting has been made partly by turning stones, pieces of driftwood etc., and catching the animals observed by the naked eye or a magnifying glass with a brush dipped in alcohol, and partly by establishing traps in the form of petri-dishes three quarters filled with alcohol and buried in the sand up to the lip. Since 1972, when the mosses began developing to a certain extent in the southern lava areas, samples of the mossy vegetation have been collected, brought home and treated in Berlese-funnels.

THE DISTRIBUTION OF COLLEMBOLA WITHIN SURTSEY

Species of the shores. All the species of Table 1 down to no. 12 (*F. mirabilis*), i.e. 75% of all species, have been found on or near the shores. (*Proisotoma minuta* has as yet not been found on the shore itself but half-way between the shore and the house). Of these species, *Archisotoma besselsi*, *Onychiurus duplopunctatus* and *Isotoma maritima* are decidedly halobiontic, occurring almost exclusively on ocean shores. The remainder, with the exception of *V. arborea* and eventually *Hypogastrura assimilis* and *Anurida granaria*, are rather ubiquitous species, occurring in many different soil types and occasionally on ocean shores. The species *A. granaria*, *Folsomia quadrioculata*, *Hypogastrura denticulata* and *F. mirabilis* were all found in tufts of grass that were washed ashore. Of these, only *F. mirabilis* has been found again, i.e. in 1978, as a single specimen close to the shore. The case of *V. arborea* is extremely curious. The species is not found on the mainland of Iceland, but on the island of Bjarnarey. On the continent of Europe the species is most often found on the trunks of trees.

TABLE 2.

Species of the inner parts of the northern sandy plain.

<i>Archisotoma besselsi</i>
<i>Onychiurus duplopunctatus</i>
<i>Isotoma maritima</i>
<i>Hypogastrura assimilis</i>
<i>Vertagopus arborea</i>
<i>Proisotoma minuta</i>
<i>Onychiurus armatus</i>

Species of the inner parts of the northern sandy plain. Table 2 shows the species that have been found in the inner parts of the northern sandy plain, i.e. at least 50 metres from the shore and inwards. The innermost and highest point at which Collembola have been found in this area lies in the slope ca. 100 metres to the W of the house at a height of ca. 24 m above sea level in sub-area E3 (cf Lindroth et al. (1973), p. 149, Fig. 1). *A. besselsi* has been found in many places all over the sandy plain up to the highest point mentioned above. On the sandy plain between the shore and the beginning of the slopes, it was found up to the uppermost fringes of driftwood and debris thrown up by the heaviest winterstorms at a height of ca. 5 m a.s.l. which practically includes the whole plain (Fig. 1) Above these fringes no Collembola were found. This indicates that the species can only live where sea-water has deposited salt in the ground. The chronology of advance for *Archisotoma* is as follows: Up to 1972 only on the shore. In 1974 up to the uppermost fringes of driftwood and debris at the beginning of the hill-slopes to the SW. In 1976 up to the above-mentioned point ca. 100 metres W of the house. In 1978 no Collembola were found higher up than along the fringes of driftwood etc. along the beginnings of the hill-slopes. This retreat as compared with 1976 may be the result of the unusually dry weather in this summer (see later in this paper).

O. duplopunctatus was already found in 1972 in sub-area E3, i.e. well inside the sandy plain. In 1976 it had advanced up to the fringes of driftwood etc. at the beginnings of the hill-slopes to the SW. *I. maritima* was found up to 1974 exclusively on or close to the shore. In 1976 it was found in the fringes of driftwood etc. at the beginnings of the hill-slopes to the SW.

H. assimilis was found exclusively on the shores up to 1970. In 1972 it was found under pieces of wood and on the sand half-way between the house and the shore. In 1976 it was found only

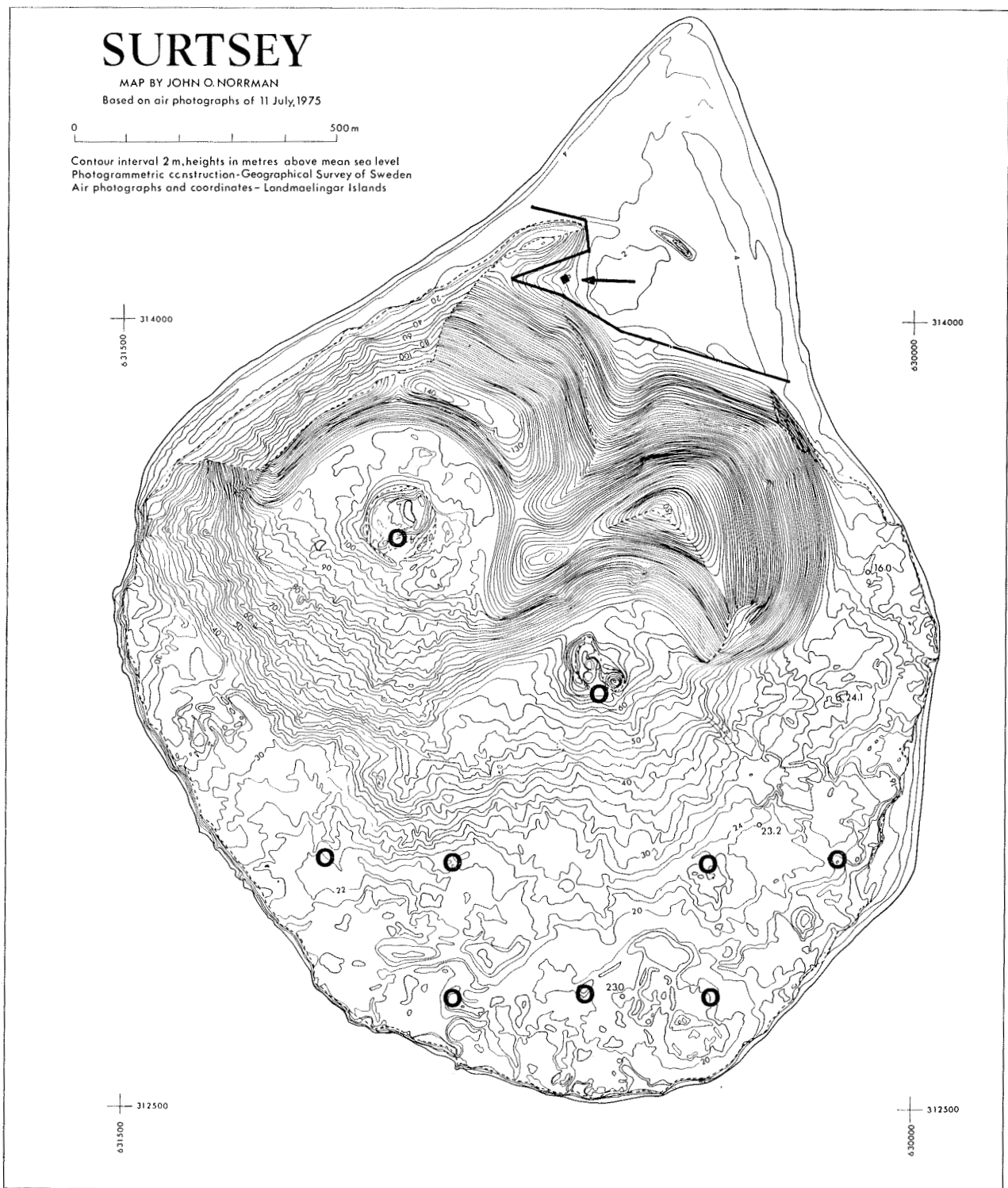


Fig. 1. Distribution of the Collembola of Surtsey. Thick line in the north: Limits of the distribution of Collembola on the northern sandy plain. Arrow: House. Black rings: Localities of Collembola of the lava mosses.

on the shore, but in 1978 it was found in the fringes of driftwood etc. at the beginning of the hill-slopes to the SW.

V. arborea was found on the shore only up to 1970, but in 1972 the species was found both on the shore and in the house. Since 1972 the species

has not been found again and as stated above, its occurrence on Surtsey is extremely curious.

P. minuta was found in 1972 and 1974 half-way between the house and the shore and under pieces of wood near the house. Up to now it has never been found on the shore proper.

Onychiurus armatus was found in sub-area E3 in 1972 and in a similar place in 1974. In 1976 it was found in the fringes of driftwood etc. at the beginnings of the hill-slopes to the SW.

Species of the mossy vegetation of the southern lava fields. As stated above samples of the mossy vegetation of the lava fields have been collected since 1972 and treated in Berlese-funnels. In 1972 and 1974 these yielded no Collembola, but in 1976 4 species, 126 specimens in all, emerged from the samples (30 samples were collected each year). The species and their total numbers are seen from Table I, nos. 13-16. All the species are very common soil animals on the mainland of Iceland and also found on Heimaey. All, with the exception of *Megalothorax minimus*, are also found on one or more of the nearby small islands. The numbers and distribution of the species is as follows (Fig. 1):

Tullbergia krausbaueri was found in 3 samples in the following sub-areas: E6 (1 ex.) in the eastern crater. D5 (1 ex.) in the western crater. D7 (4 exx.) in the lava.

Isotoma notabilis was found in 10 samples in the following sub-areas: E6 (10 exx.) in the eastern crater. D5 (6 exx.) in the western crater. C7 (16 exx.) in the lava. E8 (5 exx.) in the lava. F7 (20 exx.) in the lava. F8 (1 ex.) in the lava. G7 (1 ex.) in the lava.

Isotoma violacea was found in 3 samples in the following sub-areas: C7 (2 exx.) in the lava. D7 (21 exx.) in the lava. F8 (1 ex.) in the lava.

Megalothorax minimus was found in 5 samples in the following sub-areas: D7 (1 ex.) in the lava. D8 (7 exx.) in the lava. E6 (25 exx.) in the eastern crater. E8 (2 exx.) in the lava. F8 (2 exx.) in the lava.

In 1978 parallel collections were made and the same number of samples was taken. *No Collembola at all were found in the samples.* This result must be regarded as very remarkable since the catches of the previous collections were so rich. The only conclusion to be drawn is that an initial community of soil animals in a primitive, developing plant community as that of Surtsey is extremely vulnerable and may easily be eradicated (e.g. by extreme drought or by covering of sand or both in combination). When the members of the community are dead, there are

no adjacent communities to furnish new individuals to the plant community when the circumstances become more favourable. The plant community must therefore wait for new "deliveries" of animals from outside the island (cf Lindroth et al. (1973), p. 262).

In 1978 the collecting of Collembola was made at the end of July and the beginning of August. According to the Bulletin of the Icelandic Meteorological Institute (Vedrátan 1978), precipitation in July 1978 was less than half the mean precipitation for that month in SW-Iceland. The three nearest weather-stations on the coast, for which measurements are available, show the following precipitation as per cent of normal: Vik 41; Vestmannaeyjar 64; Eyrbakki 31. According to personal communication from people working over long periods on Surtsey in the summer 1978, the weather was occasionally so dry, that the mosses in the lava looked "burned". This seems to corroborate the theory that the Collembola of the mosses died of drought during July 1978, or some other period since 1976, probably not so long before 1978.

MODES OF DISPERSAL

The halobiontic species *A. besselsi* and *I. maritima* have often been observed in considerable numbers floating on the ocean surface along the shores. This indicates that these species may be transported from the other islands or from the mainland of Iceland floating directly on the surface. Two experiments have been made to corroborate this theory. These are accounted for on pp. 249-251 (the "Bottle-message" experiment) and on p. 260 (seawater exposure of *Archisotoma* and *Isotoma maritima*) in Lindroth et al. (1973). These experiments show clearly that halobiontic Collembola may easily drift by ocean currents over the distances in question here.

The fact that Collembola, both halobiontic and non-halobiontic, may be extracted from tussocks of grass washed ashore on Surtsey (see above) shows that this kind of transport has also occurred.

The occurrence in 1976 of considerable numbers of non-halobiontic soil Collembola in the mossy vegetation of the lava-fields in the inner parts of Surtsey strongly indicates aerial dispersal of these species. Zoochorous dispersal (with birds) and/or anthropochorous dispersal seems very unlikely for these animals.

ACKNOWLEDGEMENTS

The author is indebted to Dr. L. E. Henriksen, Uppsala, and Dr. Erling Ólafsson, Reykjavik, for valuable cooperation. The fieldwork was sponsored by the Swedish National Science Council and by the Surtsey Research Society.

ABSTRACT

Sixteen species of Collembola have been found on Surtsey up to the year 1978. Four species, *Archisotoma besselsi*, *Onychiurus duplopunctatus*, *Isotoma maritima* and *Hypogastrura assimilis* must be considered as permanent inhabitants of Surtsey in 1978. 75 per cent of all species have been found on or near the shores. Of these, *A. besselsi*, *O. duplopunctatus* and *I. maritima* are decidedly halobiontic. 7 species have been found in the inner parts of the northern sandy plain, the innermost and highest point, at which Collembola have been found, being ca 100 metres W of the house. Otherwise, Collembola occur over the whole plain up to the beginning of the hill-slopes to the SW. In 1976

4 species of Collembola, 126 specimens in all, were found in the mossy vegetation of the southern lava fields. These had, however, completely vanished in 1978, very probably owing to extremely dry weather during July 1978. Three modes of dispersal of Collembola have been demonstrated or can be inferred from the present studies: 1. Drifting by ocean currents (halobiontic species). 2. Transport with tussocks of grass drifting from other islands or the mainland (halobiontic and non-halobiontic species). 3. Aerial dispersal of non-halobiontic soil-living species.

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