

## ***Bryodema tuberculata* and *Psophus stridulus* in southwestern Finland (Saltatoria, Acrididae)**

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*Bryodema tuberculata* (Fabricius) was discovered as a species new to Finland at St: Säkyä, Säkyänharju, where it occurred sparsely together with *Psophus stridulus* (Linnaeus). The habitat on a SW-facing esker slope is described, and the spatial distribution of the two species is examined. Preliminary estimates of the population density, aggregation and vagility are calculated for *P. stridulus*. The biogeography and conservation biology of the species are discussed.

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### **1. Introduction**

Grasshoppers and related groups of the Saltatoria are quite well-known insects in northern Europe (Holst 1986). This is especially true of the grasshoppers with red hind wings and rattling or drumming sounds, since they are among the most conspicuous insects. New places of occurrence are seldom found far outside the known ranges of these species.

During a project on the conservation of threatened butterflies in Finland, special attention was paid to the population of *Pseudophilotes baton* (Bergstresser) (Lepidoptera, Lycaenidae) at St: Säkyä, Säkyänharju in southwestern Finland.

When the vegetation of the habitat was examined on 25 July 1990, the presence of another threatened species *Psophus stridulus* (Linnaeus) (Saltatoria, Acrididae) was observed. Thus, we commenced a mark-release-recapture study on this species as well, even though it was not a butterfly. This led to the still more surprising discovery of another acridid with red hind wings, *Bryodema tuberculata* (Fabricius), as a species new to Finland (Fig. 1). Here we describe the habitat and publish some preliminary results on the population ecology of these species, especially that of *P. stridulus*.

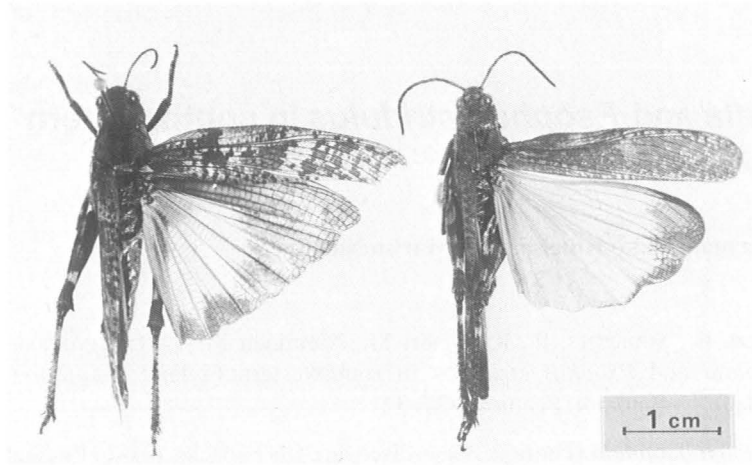


Fig. 1. *Bryodema tuberculata* (left) and *Psophus stridulus* (right) males. Inner area of the hind wing is bright pinkish red in *B. tuberculata* and orange red in *P. stridulus*. Note that the tip of the fore wing of *B. tuberculata* is broken.

## 2. Biogeography

*B. tuberculata* has a continental distribution from Central Europe to Siberia, Mongolia and Tibet (Harz 1957, 1975, Bei-Bienko & Mishchenko 1964). In Scandinavia, it occurs only in Sweden on the "alvar" heaths of Öland (Coulianos & Sylvén 1983). It was once very common on the moorlands of Jutland, but reclamation of these for agricultural purposes has reduced the species enormously, and it has probably disappeared from Denmark, the last record being from 1941 (Holst 1986). It has also been recorded from the Isthmus of Karelia (Nyberg 1905, Fieandt 1916) and Karelia ladogensis of the U.S.S.R. (Albrecht 1979, Holst 1986). In the Zoological Museum of the University of Helsinki there are old specimens from *Ik*: Metsäpirtti (1936–1937), Sakkola and Valkjärvi. Thus, the new record from *St*: Säskylä (Finnish uniform grid coordinates 6776:258) lies more than 400 km outside the previously known range of the species.

The total range of *P. stridulus* reaches from the Pyrenees eastwards through the steppes of Europe and Asia, and to Norway and Sweden in the north. It was widely distributed in Finland (Nyberg 1905, Fieandt 1916, Albrecht 1979), but in more recent years it has become rarer, and only two other populations are known from Finland: *Ab*: Pohja, and *N*: Mäntsälä. A few scattered records are also available from different parts of southern and central Finland (Hyönteiskartoitus / Insekt-kartering 81 1985).

## 3. Habitat

The Säskylänharju esker is situated in southwestern Finland more than 50 km east of the sea. The surrounding areas lie about 100 m above sea level, while the highest point of the esker reaches 145 m. The esker runs in a SE-NW direction and it is loosely connected to some other eskers and the Salpausselkä ridge (Fig. 2). It is mainly covered by dry pine forests and dry heath vegetation with *Calluna vulgaris*, *Arctostaphylos uva-ursi* and *Vaccinium vitis-idaea*, but also less common plants such as *Gypsophila fastigiata* and *Jasione montana* grow on the more open slopes and fields (Fig. 3).

Examination of the esker showed that *P. stridulus* was distributed at least over open and semiopen areas on the SW-facing slope and along the small road at the top.

The species exhibited an especial preference for a small spot at the western side of the north-western part of the area, and all the observations of *B. tuberculata* were made in or near that area (the NW spot). We analysed the vegetation of the NW spot on the basis of a sample of 12 squares of 100 m<sup>2</sup>. The NW spot was almost treeless, the proportional coverage of trees > 1 m being 0–5 %. The few "trees" were small saplings of pines, aspens and birches. The proportion of bare ground varied between 1 and 70 % (mean 29, *SD* 23). Small uncovered stones abounded on the ground. The mean height of the predominant vegetation varied from 2 to 30 cm, the dominant plant species being *Calluna vulgaris* (height about 30 cm, the other

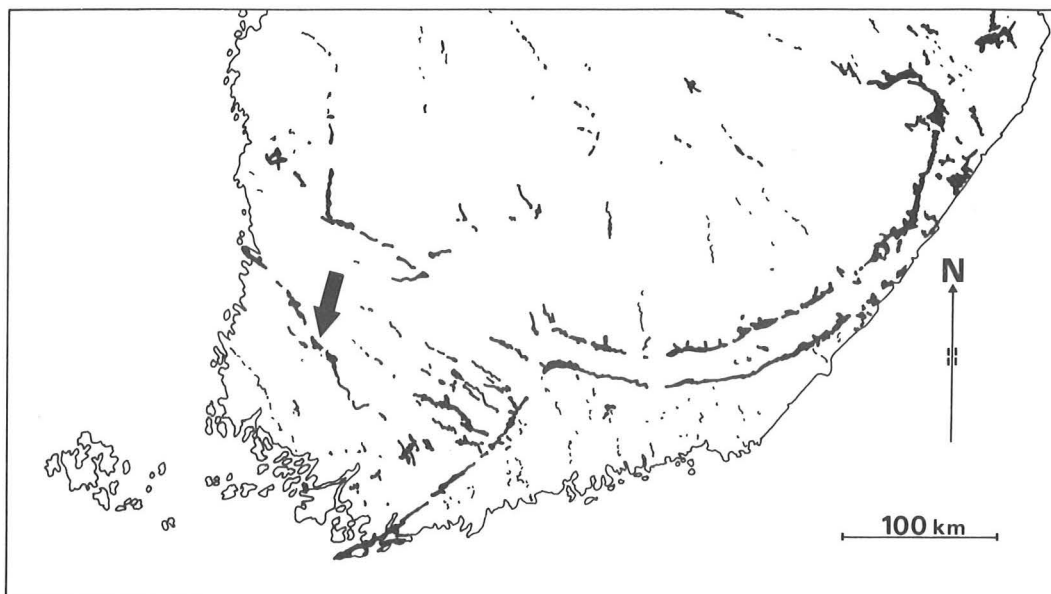


Fig. 2. The main esker areas in southern Finland. The arrow indicates the present study locality at *St. Säskylä*. The eskers have been major dispersal pathways for many plants (Jalas 1950).

plants distinctly lower), *Antennaria dioica*, *Arctostaphylos uva-ursi*, *Thymus serpyllum* and *Convallaria majalis*.

According to Holst (1986), *P. stridulus* in particular demands high temperatures, inhabiting sunny spots such as sandy plains, clearings in forests, and heathland. This description agrees with the present habitat, too. *B. tuberculata* inhabited Danish level moorlands with a stunted flora consisting of the shorter Ericaceae, slender *Sarothamnus* bushes, *Arctostaphylos*, *Vaccinium*, various Compositae and grasses, and between these plants patches of bare soil, clumps of moss and lichen (Norgaard 1942). On the island of Öland, *B. tuberculata* is a species of lichen "alvar", which has very poor vegetation consisting of lichens only (Coulianos & Sylvén 1983). The present habitat more closely resembles those in Jutland, but the species seemed to prefer the open, hot spots with sparse and low vegetation. In general, high survival, particularly of the very young acridid nymphs, and high fecundity of the adults both depend on the occurrence of warm, dry, sunny conditions which can be best encountered in sparse vegetation. However, high survival and

fecundity also depend on a plentiful supply of green food (Dempster 1963).

#### 4. Population ecology

The study area was examined for the grasshoppers on 7, 13, 14, and 15 August 1990. Captured insects were individually marked on the dorsal surfaces of the hind wings with felt-tipped, permanent ink pens, and they were immediately released after marking at the point of capture. The species, sex, number, date, time and quadrat were recorded for the initial capture and all subsequent captures.

The microdistribution and individual movements of *B. tuberculata* and *P. stridulus* are described in Figs. 4–5. *P. stridulus* was distributed along the whole esker, but it was aggregated in some spots, especially in the NW spot, while *B. tuberculata* was with certainty observed only in this NW spot. In the NW spot (12 100 m<sup>2</sup>), a total of 94 *P. stridulus*, including 15 females, were encountered in the mark-release-recapture study on 155 occasions. Only 1 female and 3 male *B.*



Fig. 3. The habitat of *Bryodema tuberculata* and *Psophus stridulus* at St. Säköylä, Säköylänharju.

*tuberculata* individuals were marked, but prior to the study approximately 5 observations of this species were also made on 27 July 1990.

The distribution pattern of *P. stridulus* was analysed using pooled total samples in the NW spot. Morisita's (1959) index  $I_m$  was 1.57 ( $F=1.73$ ,  $P<0.001$ ) indicating a slightly aggregated pattern.

The vagility of *P. stridulus* males was analysed in the NW spot as well. The mean length of movements between subsequent days was 30 m ( $SD$  20, maximum 95,  $N=21$ ). During one day the mean was about 8 m ( $SD$  5, maximum 20,  $N=11$ ). The mean minimum speed was 19 m/day ( $SD$  19, maximum 95,  $N=45$ ).

The population size and density of *P. stridulus* males were estimated at the densely populated NW spot using the simple Lincoln index with Bailey's modification for small samples (see Southwood 1978). Although *P. stridulus* does not

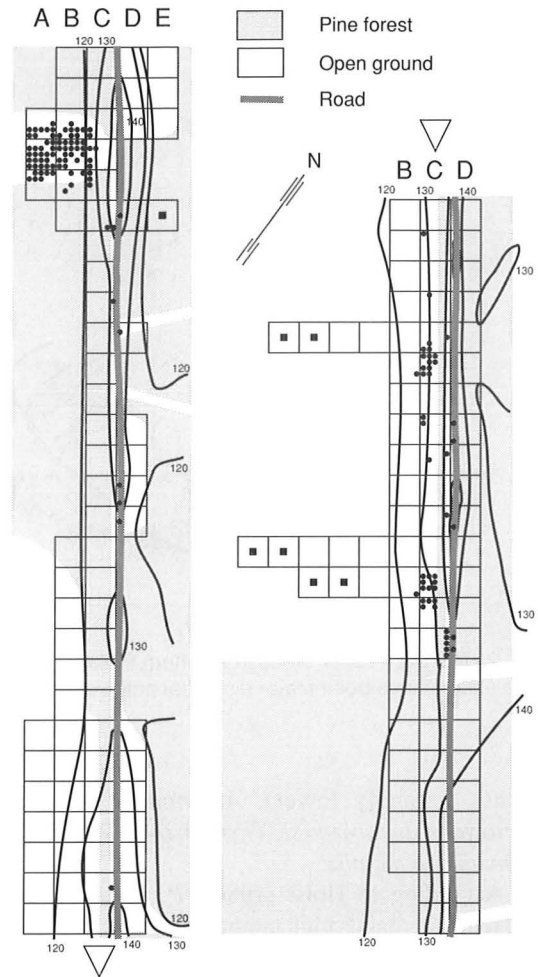


Fig. 4. Distribution of *Psophus stridulus* on the open and semiopen areas of the Säköylänharju esker. The location of the esker is shown with isopleths for height above sea level (m). Squares shown in the picture are 50 × 50 m. Note that the left column base continues at the top of the right one as indicated by the letter codes. A small black square mark indicates general presence within a square, a small filled circle indicates presence within a 100 m<sup>2</sup> subsquare.

form a closed subpopulation in the NW-spot, its number of individuals can be coarsely estimated. The daily estimate for the male population present at the spot on 14. August was 87 ( $SD$  20) and on 15 August 70 ( $SD$  14) individuals. The daily density

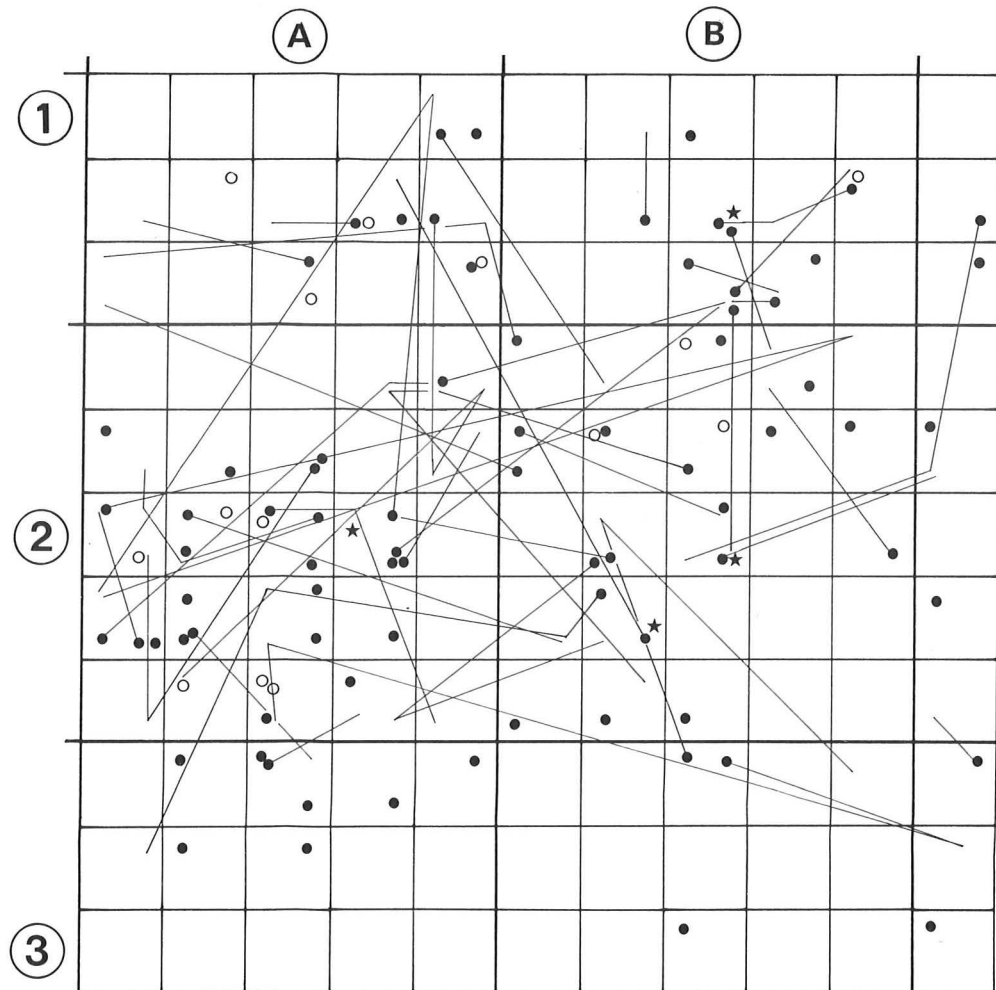


Fig. 5. Distribution and movement patterns of *Psophus stridulus* and *Bryodema tuberculata* in the northwestern part of the Säkylänharju esker where the grasshopper densities were highest. The area is surrounded by pine forest, except on the left, which is open field. Symbols for the first individual observations in each 100 m<sup>2</sup> square: open circle – *P. stridulus* female, black dots – *P. stridulus* male, black stars – *B. tuberculata*. Thin lines indicate observed movements. Codes for the larger 50 × 50 m squares as in Fig. 4.

estimates were 0.72 and 0.58 males per 100 m<sup>2</sup>, respectively. The population estimate for 13 August was 140 (*SD* 41), but this is heavily biased due to the long time between marking and recaptures, since the “population” is not closed. The simple Lincoln indices without any modifications gave only slightly higher population estimates.

On the basis of the preliminary estimates, the Säkylänharju population of *P. stridulus* apparently consists of several hundred individuals, thus rep-

resenting without doubt the largest population in Finland, while that of *B. tuberculata* is apparently much smaller. The results on the vagility of *P. stridulus* showed that the species is rather mobile, but can still be largely aggregated at a small spot. High-density populations of acridids are generally associated with a particular type of plant cover, characterized by a mosaic pattern of bare ground, sparse and denser vegetation possessing a wide range of microclimates (Dempster 1963).

## 5. Conservation biology

The Säkyänharju esker area belongs to the national programme for the protection of eskers in Finland. The study area is owned by the Finnish Army and parts of it have been used as target areas in military exercises. Almost all observations of the two grasshopper species were from the areas under this unusual management. These exercises have probably favoured the grasshoppers by preventing the reversion of the habitat to dense forest. At least four threatened insect species occur in the area, including the two grasshoppers, *P. baton* and a gelechiid moth, *Caryocolum petryi* (Hoffmann), living on *Gypsophila fastigiata*. Säkyänharju is the only known Finnish locality for these species, with the exception of *P. stridulus*, and it is interesting that *B. tuberculata* and *C. petryi* are characteristic species of the fauna of the Great Alvar on Öland, as well (Coulianos & Sylvén 1983).

It has been considered likely that Öland is a relict area for *B. tuberculata*, and that the species may have subsisted there since the Late Glacial or since the Preboreal era (Coulianos & Sylvén 1983). The Finnish population of *B. tuberculata* is probably also very old, possibly going back about 8000 years to the Boreal era, when many esker plants as well are held to have invaded Finland along the eskers and to have existed there since then (e.g. Jalas 1950).

The open and semiopen esker areas have in later times become isolated by forests and especially human exploitation of eskers. In particular the prevention of forest fires on eskers has led to a decrease in the suitable open habitats. It seems probable that the species has had a wider distribution in the past. Thus, it has a very high priority in terms of conservation, as indeed has the whole Säkyänharju esker with its several other rare species (e.g. Hakila & Kalinainen 1984). The habitat needs management. The proportion of open mosaic-like vegetation should be increased by felling trees and saplings at some places and by creating a mosaic of low vegetation and small spots of bare soil.

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