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Habitat restoration and a successful reintroduction of the endangered Baton Blue butterfly (*Pseudophilotes baton schiffermuelleri*) in SE Finland

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We reintroduced the endangered Baton Blue butterfly (*Pseudophilotes baton schiffermuelleri*, Bergsträsser) from its last known Finnish population to a site where it had become extinct. The butterfly is associated with dry and open eskers, but because of drastic habitat degradation only one population is known to have survived in Finland. The main reason for habitat loss is succession of pine forests. The last verified records of the species at the site of reintroduction date from 1984. The habitat was managed by the selective logging of pines in 1992. In 1994, after vegetation followups, 10 female baton blues were translocated. The introduced population was studied with the mark–recapture method in 1995–1996. Its size increased during this period to ca. 50 butterflies in 1996. Reintroduction, accomplished in close cooperation with forest industry, administration authorities and environmentalists, has diminished the probability of extinction of the baton blue in Finland.

1. Introduction

Many butterfly species in Finland live as isolated populations, considerable distances from each other, due to habitat destruction (Marttila *et al.* 1991, Hanski & Kuussaari 1995). Isolation may cause inbreeding in small populations, which together with different biotic and abiotic factors, such as parasitoids, weather conditions and changes in land use, can cause increasing threats to these populations (New 1991). Increasing isolation decreases the probability that suitable but empty habitat patches will be recolonized (Hanski 1991).

The distribution of the Baton Blue (*Pseudophilotes baton schiffermuelleri*, Bergsträsser 1779) in Northern Europe is restricted to Finland, although the species extends from Western Europe through Central and Eastern Europe to Asia (Hemming 1929, Higgins & Riley 1973). *P. baton* has been recorded in Finland at about twenty sites, but all except one of these local populations have become extinct during the past few decades (Väisänen *et al.* 1994, Kuussaari *et al.* 1995). These extinctions of *P. baton* are thought to be the result of a drastic degradation of suitable habitats (Rassi *et al.* 1986, 1992, Marttila *et al.* 1991).

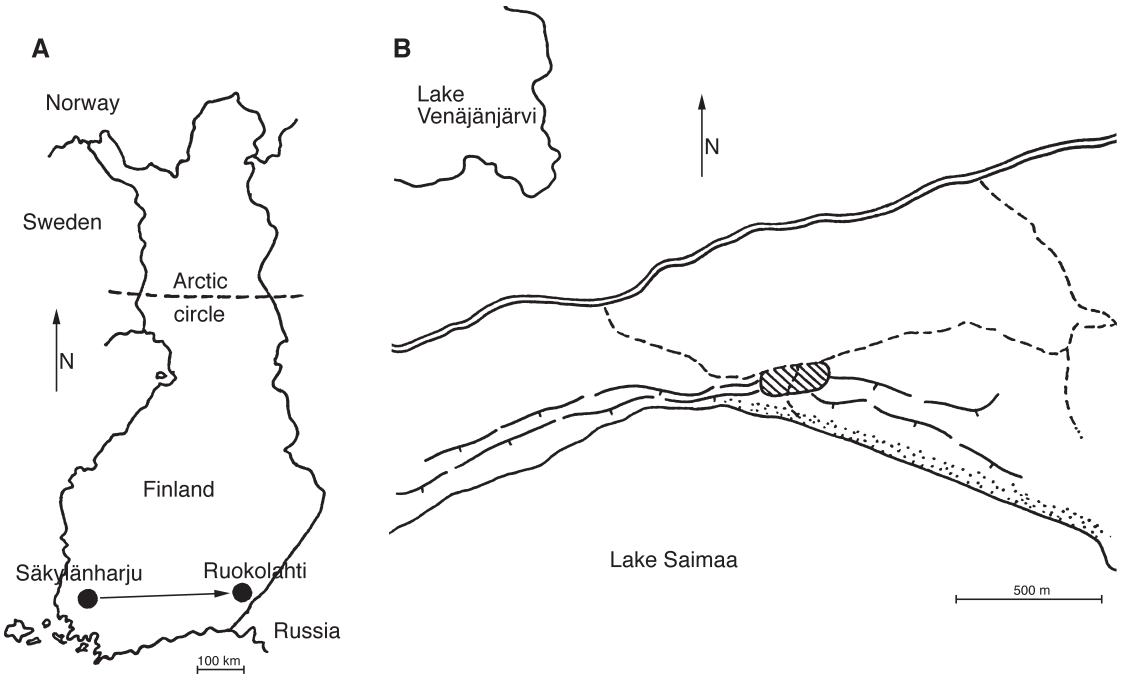

Fig. 1. (A) Location of Säkylänharju and Ruokolahti in Finland. (B) The Ruokolahti habitat is situated on a slope of the esker on the shore of Lake Saimaa.

Baton Blue inhabits sunny, sandy meadows on dry and open eskers. The larval host plant is *Thymus serpyllum*, L. The immature larva hibernates and the adults are in flight from late May to early June (Kaisila & Peltonen 1955, Marttila *et al.* 1991). The myrmecophily of *P. baton* larvae is not well-known (Malicky 1969).

For the last few years there has been increasing interest in Finland to protect butterflies by active projects (Blomster 1996, Marttila & Haahtela 1996, Ormio 1996, Seuranen 1996, Sihvonen 1996, Sundell 1996), but to our knowledge no reintroductions have been made to areas where a butterfly species became extinct. However, translocations of rare species may become an increasingly important conservation technique (Griffith *et al.* 1989, Armstrong & Craig 1995). According to Griffith *et al.* (1989), the two most important prerequisites of a successful translocation are the knowledge of species ecology and suitable, protected and maintained habitat. Successful translocations and reintroductions of *Fixenia pruni* (L.), *Lycaena dispar* (Hw.), *Lysandra bellargus* (L.), *Maculinea arion* (L.) (Thomas 1984), *Maculinea teleius* (Bergsträsser) and *Maculinea nausithous* (Bergsträsser) (Wynhoff & van der Made 1995) were performed. On the contrary, reintroductions of *Papilio machaon* (L.) (Dempster & Hall 1980), *Colias palaeno europome* (Esper) (Rueetschi 1988) and *Euphydryas gillettii* (Barnes) (Williams 1995) failed.

The aim of the present study was to reintroduce *P. baton* to an empty habitat in Ruokolahti. The reintroduction site at Sa: Ruokolahti (Finnish uniform grid coordinates 6804–5:574) is located 315 km east of Säkylänharju (Fig. 1A), where the only known extant population is living (Väisänen *et al.* 1994). The habitat was situated on a steep slope of the Inner Salpausselkä esker 100 m from the shore of Lake Saimaa (Fig. 1B). The last verified records of *P. baton* in this habitat date from 1984, when three or four males were observed (T. Haahtela, P. Ojalainen and first author, pers. comm.).

The history of the reintroduction site is poorly known. Although, it is known that since the 1950s clear cuts have been made in the area. According to personal communications with the land owner, a heavy thunder storm in 1972 destroyed the mature pine forest, thus opening the ridge, but the

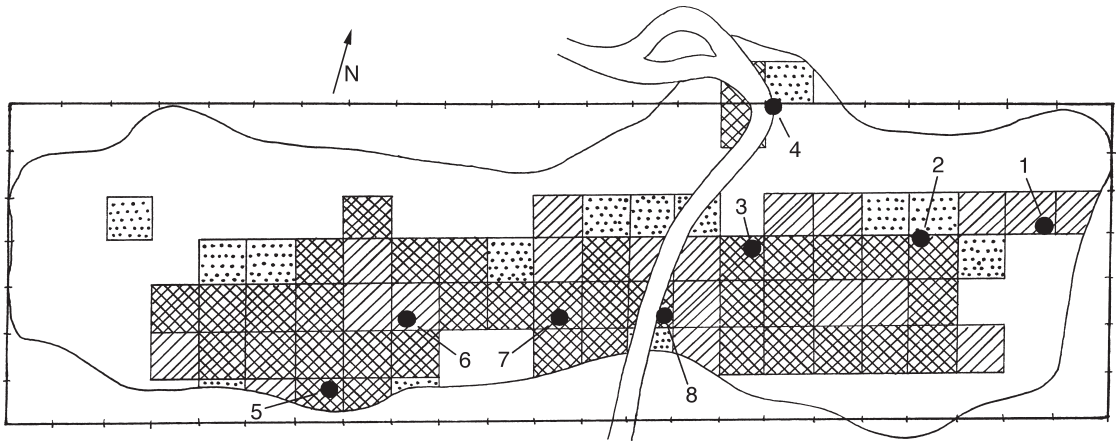

Fig. 2. The 10 × 10-m quadrats covered by *Thymus serpyllum* with an area of 0.01–0.05 m^2 (dotted), > 0.05–0.15 m^2 (oblique hatching) and > 0.15 m^2 (cross hatching) at the Ruokolahti habitat in 1996. The eight permanent vegetation squares (2 × 2 m) are also shown by the numbered black dots.

presence of suitable habitats before the storm is unknown. The first observations of the species are from the beginning of the 1970s. According to two amateur lepidopterists (T. Miettinen and H. Aarnio, pers. comm.), the species was "abundant", though the exact numbers are not known. First signs of succession were observed at the turn of the 1980s. Shading by young pines increased clearly in the early 1980s and resulted finally in the extinction of *P. baton*. We conclude that most probably the species was living in the area already before the 1970s, and the reason for extinction was succession.

The source population at St: Säkylä, Säkylänharju (Grid 6776–7:258–9) occurs on the eastern side of Lake Pyhäjärvi in SW Finland (Fig. 1A). The site has been kept suitable for the butterfly by forest fires and the activities of the military since 1963. The population, estimated at 850 adult individuals in 1990, was evaluated to be large enough to serve as a source for the establishment of a new population (Väisänen *et al.* 1994).

We report here the results of the habitat management, reintroduction and butterfly monitoring. The purpose of the reintroduction was also to protect the source population at Säkylänharju by dividing it into two locations.

2. Methods

The empty habitat at Ruokolahti was managed in 1992. In 1994, after vegetation followups, 10 females captured at Säkylänharju were translocated. The introduced population was studied at Ruokolahti in 1995–1996. The succession of vegetation was also studied.

2.1. Restoration of the habitat

The managed area, 230 × 70 m, extended from the lower slope to the top of the esker. The steep ridge was covered by young Scots pine (*Pinus sylvestris*, L.) (Fig. 1B). Selective logging of pines, planned by the authors and accepted by the administration of the South Karelia forestry society, was conducted by Enso Oy in late June 1992. An open but somewhat patchy environment was created. The logged pines and logging waste were removed in August 1992 and in May 1993. Some additional tree saplings were removed during the population study in 1996.

2.2. Vegetational succession

The occurrence of vascular plants in the study area was studied in mid June 1992 and repeated in mid July 1996. Immediately after logging, eight permanent 2 × 2-m squares were delimited in order to study the succession of field layer plants (Fig. 2). These squares were chosen to represent typical vegetation of the esker. The coverage (%) of each plant was evaluated in July 1992, 1994 and 1996. The vegetation of the Säkylänharju habitat was studied in June 1993 in order to compare field layer plants between the two habitats.

In early June 1994, the whole study area was divided into 10 × 10-m squares in order to study *Thymus* succession. The total number of squares, including those in which parts were beyond the border of the experimental area, was 129. The area covered by *Thymus* in quadrats was esti-

mated in four classes: < 0.01, 0.01–0.05, > 0.05–0.15 and > 0.15 m^2.

2.3. Re-establishment

In 1994, the flight season of *P. baton* started at Säkylänharju on 7 June. Due to poor weather conditions, the translocation was made in two days, the first group of four females were captured and released at Ruokolahti on 12 June, and the second group of six females nine days later on 21 June.

The females were marked on capture (see below) and each was put in a one-desilitre tube with damp moss on the bottom. The tubes were kept in a dark box and chilled to 12°C. Females were not fed. The female group caught in one day was transported on the same day to Ruokolahti and released at midnight, each individual on a different 10 × 10-m square covered by *Thymus*. After release, the butterflies were monitored daily through a mark–recapture study. Oviposition and interpatch dispersal of females were recorded. The translocation of females was permitted by the county government of Turku and Pori and the land owner of Säkylänharju, Säkylä (Huovinrinne) military garrison.

2.4. Monitoring of the introduced population

The success of the introduction was monitored in 1995 and 1996 by a mark–recapture study. The 10 × 10-m square for each captured individual was recorded. The study area was investigated on foot twice a day (09.00–11.00, 14.00–16.00) along the longitudinal lines of squares. All butterflies captured were marked individually on the underside of the wings using a permanent ultra fine-point pen and released immediately at the capture spot. Copulation and oviposition of butterflies were also recorded. Daily population sizes were estimated using the Jolly's stochastic method (Jolly 1965). The population sizes of the whole flight season were estimated using the method described by Watt *et al.* (1977).

Table 1. The 10 × 10-m squares (n = 129) covered by *Thymus serpyllum* (m^2) at Ruokolahti habitat in 1994 and 1996.

	< 0.01		0.01–0.05		> 0.05–0.15		> 0.15	
	n	%	*n*	%	*n*	%	*n*	%
1994	75	58	22	17	19	15	13	10
1996**	57	44	15	12	19	15	38	29

Difference between years was obtained using a Chi-Square test.
** $p < 0.01$

3. Results

3.1. Habitat restoration and vegetational succession

After management in 1992, the habitat was an open slope with low and fairly sparse vegetation. Bare sandy ground was exposed here and there. The abundance of *Thymus* increased after management (Table 1). The plants were mainly located on the lower slopes of the esker (Fig. 2). *Calamagrostis epigejos* (L.) slightly increased, but no other obvious changes in field layer plants were observed between the years 1992, 1994 and 1996 (Table 2).

The main field layer plants were similar and *Thymus* was estimated to be at least as abundant at Ruokolahti as at Säkylänharju. The total number of plant species at Ruokolahti increased from 31 to 36 in four years (1992–1996). Four forest species disappeared and nine new species of open habitats were recorded.

3.2. Population studies and behaviour

After release at the Ruokolahti habitat in 1994, altogether six of the females were observed on following days (four females on the first, one on the second and one on the third day). Two individuals were seen seven days after the release. Oviposition on *Thymus* was observed altogether 22 times by five different females.

We captured 24 baton blues in 1995 and 46 individuals of the next generation in 1996 (Table 3). Almost all the marked males (93% in 1995, 100% in 1996) were recaptured on the day following the marking. The fraction of recaptured females was also high (90% in 1995, 65% in 1996). The average residence time (the time from marking to the day of last recapture) in males was longer in 1996 than in 1995, while in females it was longer in 1995 than in 1996 (Table 3). The highest observed individual residence time of males was 32 days and females 24 days (two females). The estimates of daily population sizes of both sexes in 1995 and 1996 are shown in Fig. 3. The estimates of population sizes of the whole flight season in 1995 and 1996 are presented in Table 3.

Females were seen more often on the lower slopes than upper slopes of the esker, often on sites with a rich concentration of *Thymus* (see also Fig. 2). Males were mostly concentrated, especially in 1996, on upper slopes and on the top of the esker (Fig. 4). Two marked females were observed outside the suitable habitat patch. One of them was observed 100 m from the habitat on the sandy shore of Lake Saimaa. After two days that female was recaptured again in the habitat.

Altogether four copulations were seen, one in 1995 and three in 1996. The oviposition on *Thymus* was observed altogether 22 times by eight different females in 1995 and 18 times by 13 females in 1996.

4. Discussion

4.1. Succession of vegetation

The increased abundance of *Thymus* showed that the plant can quickly colonize open ground. Other changes in vegetation during the study years were rather small, but the total number of plant species increased by five. The four species that disappeared, such as *Monotropa hypopitys* (L.) and *Maianthemum bifolium* (L.), were typical forest species. On the contrary, the nine newcomers, such as *Rumex acetosella* (L.) and *Equisetum hyemale* (L.), were adapted to nutrient-poor, dry and open habitats.

Table 2. The coverage (%) of plant species in eight permanent 2 × 2-m squares at Ruokolahti habitat in years 1992, 1994 and 1996.

	Upper slope												Lower slope											
	1			2			3			4			5			6			7			8		
	92	94	96	92	94	96	92	94	96	92	94	96	92	94	96	92	94	96	92	94	96	92	94	96
Thymus serpyllum (L.)	7	15	20	–	–	–	2	1	–	10	15	15	10	15	30	5	1	2	2	+1/2		5	4	2
Bare ground	–	20	20	3	1	3	7	5	10	25	20	15	–	15	15	–	–	–	–	1	1	40	–	–
Litter	–	10	10	–	40	30	–	15	20	–	5	5	–	40	10	–	30	60	–	4	30	–	50	7
Lichens	50	50	40	25	30	15	10	10	10	–	15	5	20	–	2	5	7	15	5	7	7	5	+	2
Mosses	1	1/2	2	5	2	1	20	10	10	–	3	1	40	30	30	60	40	7	50	70	30	25	40	80
Pteridium aquilinum (L.)	–	–	–	–	–	–	3	+	–	–	–	–	10	1	2	7	7	10	15	20	25	5	15	10
Pinus sylvestris (L.)	–	3	2	0	–	–	–	–	–	–	–	–	–	–1/2		–	–	–	+	–	+	–	–	–
Juniperus communis (L.)	0	5	3	2	1	1	7	2	+	–	–	–	2	1/2	–	–	15	15	10	–	–	–	–	5
Pulsatilla vernalis (L.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	1	–	–	–	–	–	1
Betula pendula (Roth)	1/2	15	1	–	–	–	–	–	–	–	–	–	2	–	1	–	–	–	–	–	–	–	–	–
Calluna vulgaris (L.)	30	3	5	7	1	3	7	15	15	35	40	30	25	+	2	5	+	2	10	7	10	7	5	10
Arctostaphylos uva-ursi (L.)	–	–	–	60	40	40	30	40	40	30	30	30	–	–	–	–	3	5	–	2	10	–	+	1
Vaccinium vitis-idaea (L.)	10	5	2	0	1/2	2	10	5	5	+	+	+	15	2	7	10	3	+	7	10	7	7	3	5
Vaccinium myrtillus (L.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	+	–	–	–	–	+	–	–
Empetrum nigrum (L.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	5	3	–	–	–	–	–	–
Melampyrum pratense (L.)	+	–	+	–	–	+	+	–	+	1/2	–	–	–	1/2	–	+	–	–	–	–	–	+	–	1/2
Hieracium umbellatum (L.)	+	+	1	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	1/2	1	–	+	+
Polygonatum odoratum (Miller)	–	–	–	–	–	–	–	–	–	–	–	–	–	1/2	1/2	–	+	–	–	–	+	–	–	–
Carex ericetorum (Pollich)	–	–	–	–	–	–	–	–	–	3	5	2	–	–	–	–	–	–	–	–	–	–	–	–
Calamagrostis epigejos (L.)	–	1/2	1	–	–	–	+	+1/2		–	–	–	–	1/2	3	–	–	–	–	–	–	–	–	–

Table 3. Descriptive statistics from mark–recapture studies for the first two generations of *Pseudophilotes baton* produced at the reintroduction site in Ruokolahti.

	1995			1996		
	Males	Females	Total	Males	Females	Total
Individuals marked	14	10	24	23	23	46
Individuals recaptured	13	9	22	23	15	38
Total number of recaptures	91	49	140	157	51	208
Estimates of population sizes	12.7	9.0	21.7	17.0	19.4	36.4
Average observed residence time (days)	8.7	9.3	9.0	14.1	8.4	11.2

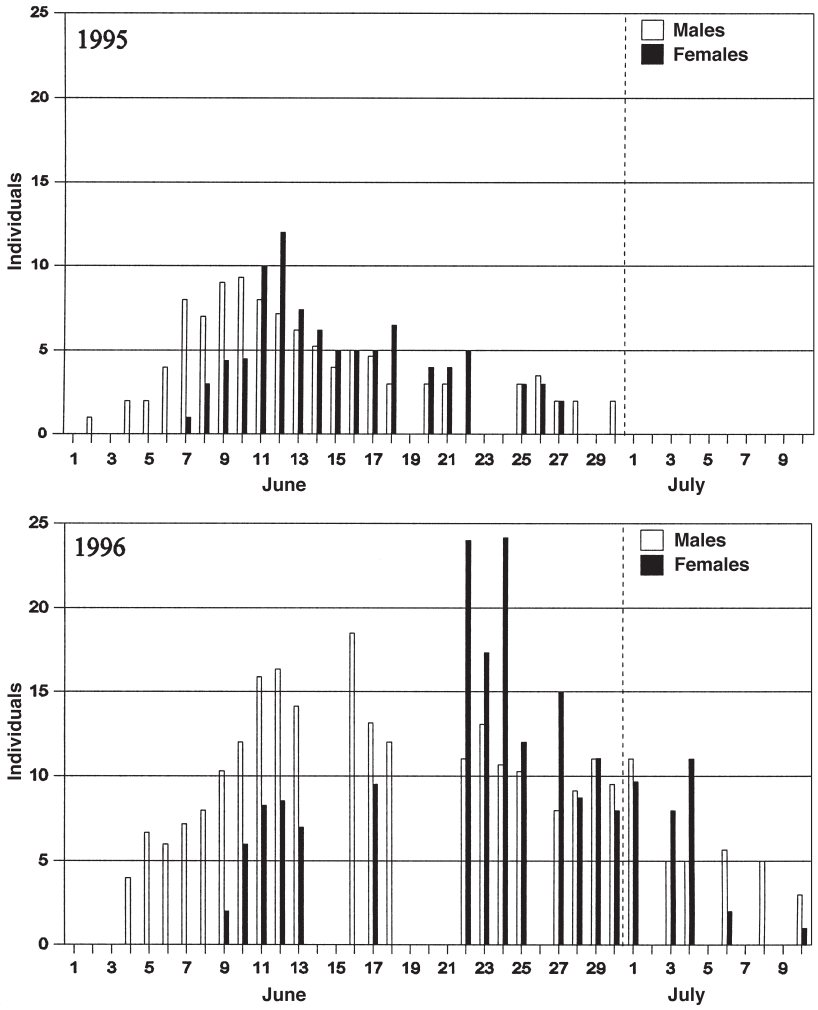

Fig. 3. Daily estimates of *P. baton* population sizes at the Ruokolahti habitat in 1995 and 1996. No values in those days without observations (poor weather conditions).

4.2. Reintroduction

In past decades *P. baton* occurred in the whole southern Finland, though the populations were typically located considerable distances from each other (Väisänen *et al.* 1994). We conclude that all the Finnish populations represented the same subspecies, and in the reintroduction there was no risk of introducing a race originally foreign to the area.

It was not possible to ensure that the translocated females had mated in the field. However, there was no doubt that the Säkylänharju population would be large enough for males to immediately find newly emerged females and copulate with them. At Säkylänharju, Kuussaari *et al.* (1995) noticed a *P. baton* copula, in which the newly hatched female had soft and undeveloped wings. The risk that introduced individuals might fly immediately away from the habitat (Kuussaari *et al.* 1996) was taken into consideration by releasing translocated females at midnight. Females accepted the new habitat and half of them were observed several times to lay their eggs on *Thymus*.

4.3. Reintroduced population

The reintroduced population of *P. baton* doubled in size from 1995 to 1996. At least partly this was due to good breeding circumstances in 1995. The weather conditions were much more suitable for flight in 1995 than in 1996. The average tempera-

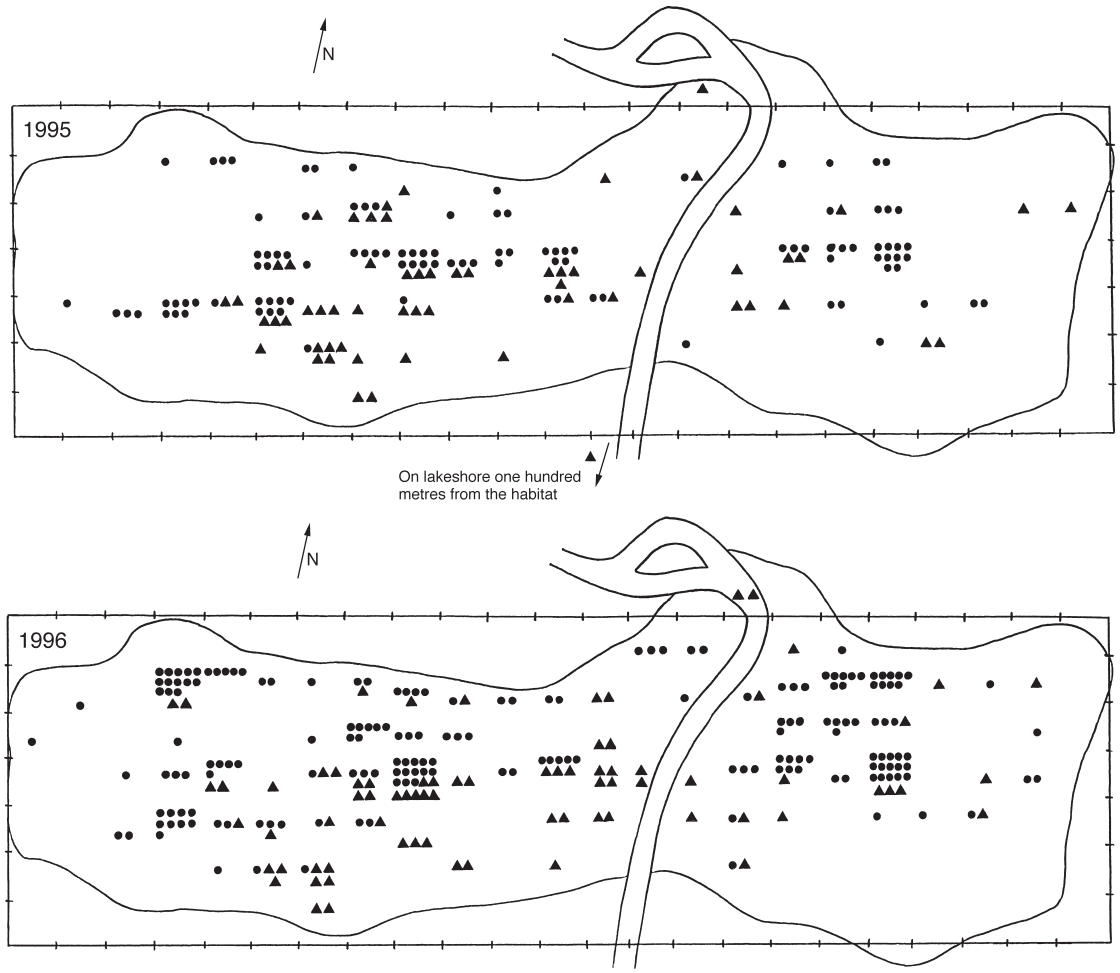

Fig. 4. Distribution of *P. baton* males (dots) and females (triangles) at the Ruokolahti habitat in 1995 and 1996. The number of all observations was 164 (105 males, 59 females) in 1995 and 253 (180 males, 73 females) in 1996.

ture of June 1995 was 17.6°C (own measurements), most of the days being sunny, while June 1996 was rainy and cloudy with an average temperature of 13.7°C.

The population sizes of the whole flight season estimated by the Watt *et al.* method (1977) were lower than the numbers of captured individuals. This was probably due to the intensity of the study and the small size of the study area. The large number of recaptures resulted in the high degree of day-specific survival rates (PHI), thus the small loss rates make the estimates smaller.

In the present study, the average residence times were considerably longer than observed at the Säkylänharju habitat (Kuussaari *et al.* 1995), where times were 2.7 (males) and 1.6 (females) days. We suggest that the long residence times in the present study may be due to only little emigration from the reintroduction site, which was almost completely surrounded by forest. Parallel to our results, Kuussaari *et al.* (1996) stated that a nature reserve surrounded by open habitat would loose more butterflies than a reserve surrounded by forest or some other barrier against emigration. However, the two marked females observed outside the suitable habitat patch might indicate the female disposition for dispersal behaviour. This has also been discovered in other butterflies (Baguette & Néve 1994, Hanski *et al.* 1994, Kuussaari *et al.* 1996).

4.4. Conservation and the future of the reintroduced population

Translocations are always risky, even if planned as well as possible. However, if there are no active efforts to protect endangered species, big risks are being taken that some species will become extinct. Before a reintroduction is started, the following questions should be answered: why the species disappeared from its habitat; why it should be returned; and what are the chances of an introduced population surviving? For a successful result, also close cooperation with researchers, landowners, administrative officials and environmentalists is needed (Moore 1991).

Väisänen *et al.* (1994) stated that the succession of pine forest is obviously the greatest threat to the survival of *P. baton* in Finland. This was also the reason for the extinction of the species at the site of reintroduction. There is no evidence that the extinction of local Finnish *P. baton* populations was connected to ants, though almost all lycaenids are protected by ants during their larval and pupal stages (Fiedler 1989, Pierce 1989, Thomas *et al.* 1989). Forster and Wohlfahrt (1955) stated that the western race of *P. baton* (*P. baton baton*) is myrmecophilous, but Weidemann (1986) does not include the *P. baton* in the species associated with ants. In the study of Väisänen *et al.* (1994), the association of *P. baton* with ants remained obscure.

Natural succession is a continuous threat in the reintroduction site. It is necessary to remove saplings every five years to prevent the overgrowth of the habitat. The managed site is the only suitable habitat patch for the species in the surroundings. Recent studies have indicated that species living in networks of habitat patches are highly dependent on the metapopulation dynamics for long-term persistence (Hanski 1991, Hanski & Gilpin 1991, Harrison *et al.* 1991, Thomas & Harrison 1992, Hanski & Thomas 1994, Nee 1994, Hanski *et al.* 1996). In an isolated population the rescue effect is not possible (Brown & Kodric-Brown 1977). In the present case, close cooperation with the land owner has given good opportunities to create such a network of habitat patches. There are several sites on the esker that could be made suitable for *P. baton*. In spring 1997, the land owner created five new patches by clearing openings in the pine forest. The size of new glades, planned by the authors, vary from 40×50 m to 50×80 m. The length of the whole area, spotted with new glades and the reintroduction site, is 1.5 km.

We conclude that the reintroduction of *P. baton* to managed habitat from which it had previously become extinct was successful. Reintroduction has diminished the probability of extinction of the Finnish *P. baton*, but it is still one of the most threatened butterfly species in Finland. In the long run, the new suitable habitat patches around the presently managed site guarantee the chances for survival of *P. baton* at Ruokolahti. Good planning, a knowledge of species ecology, and close cooperation with land owners, administrative authorities and environmentalists are necessary in using reintroductions as a species conservation tool.

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References

Armstrong, D. P. & Craig, J. L. 1995: Effects of familiarity on the outcome of translocations, I. A test using Saddlebacks Philesturnus carunculatus rufusater. — Biol. Conserv. 71: 133–141.

Baguette, M. & Néve, G. 1994: Adults movements between populations in the specialist butterfly Proclossiana eunomia (Lepidoptera, Nymphalidae). — Ecological Entomology 19: 1–5.

Blomster, O. 1996: Muurahaissinisiiven (Maculinea arion) elinympäristön hoitotalkoot Asikkalassa 1995. — Baptria 21: 145–146.

Brown, J. H. & Kodric-Brown, A. 1977: Turnover rates in insular biogeography: effect of immigration and extinction. — Ecology 58: 445–449.

Dempster, J. P. & Hall, M. L. 1980: An attempt at re-establishing the swallowtail butterfly Papilio machaon at Wicken Fen England UK. — Ecol. Entomol. 5: 327–334.

Fiedler, K. 1989: European and North West African Lycaenidae (Lepidoptera) and their associations with ants.

— J. Res. Lepidopt. 28: 239–257.
Forster, W. & Wohlfahrt, T. A. 1955: Die Schmetterlinge Mitteleuropas. Tagfalter. Diurna (Rhopalocera and Hesperiidae). — Franckhsche Verlagshandlung, Stuttgart.
Griffith, B., Scott, M. J., Carpenter, J. W. & Reed, C. 1989: Translocations as a species conservation tool: status and strategy. — Science 245: 477–480.
Hanski, I. 1991: Single species metapopulation dynamics: concepts, models and observations. — Biol. J. Linn. Soc. 42: 17–38.
Hanski, I. & Gilpin, M. 1991: Metapopulation dynamics: brief history and conceptual domain. — Biol. J. Linn. Soc. 42: 3–16.
Hanski, I. & Kuussaari, M. 1995: Butterfly metapopulation dynamics. — In: Cappuccino, N. & Price P. (eds.), Population dynamics: new approaches and synthesis: 149–171. Academic Press, London.
Hanski, I. & Thomas, C. D. 1994: Butterfly metapopulation dynamics and conservation: a spatially realistic model applied to butterflies. — Biol. Conserv. 68: 167–80.
Hanski, I., Kuussaari, M. & Nieminen, M. 1994: Metapopulation structure and migration in the butterfly Melitaea cinxia. — Ecology 75: 747–62.
Hanski, I., Moilanen, A., Pakkala, T. & Kuussaari, M. 1996: The quantitative incidence function model and persistence of an endangered butterfly metapopulation. — Conserv. Biol. 10: 578–590.
Harrison, S., Quinn, J. F., Baughmann, J. F., Murphy, D. D. & Ehrlich, P. R. 1991: Estimating the effects on scientific study on two butterfly populations. — Amer. Nat. 137: 227–243.
Hemming, A. F. 1929: Revision of the baton group of the genus Turanana Bethune-Baker, with an account of an unrecognized species, T. vicrama Moore. — The Entomologist 62: 27–34, 60–64, 84–89.
Higgins, L. G. & Riley, N. D. 1973: Euroopan päiväperhoset. — Tammi, Helsinki.
Jolly, G. M. 1965: Explicit estimates from capture-recapture data with both death and immigration – stochastic model. — Biometrika 52: 225–247.
Kaisila, J. & Peltonen, O. 1955: Philotes vicrama Moore (Lep., Lycaenidae) in Finland. — Ann. Entomol. Fennici 21: 9–12.
Kuussaari, M., Nieminen, M., Väisänen, R. & Somerma, P. 1995: Harjusinisiipi (Pseudophilotes baton) ja Säkylänharjun erikoinen hyönteislajisto. — Baptria 20: 1–22.
Kuussaari, M., Nieminen, M. & Hanski, I. 1996: An experimental study of migration in the Glanville fritillary butterfly Melitaea cinxia. — J. Anim. Ecol. 65: 791–801.
Malicky, H. 1969: Versucht einer Analyse der ökologischen Beziehungen zwischen Lycaeniden (Lepidoptera) und Formiciden (Hymenoptera). — Tijdschr. Ent. 112: 213–298.
Marttila, O. & Haahtela, T. 1996: Uhanalaisen kalliosinisiiven suojelu kantaa hedelmää. — In: Marttila, O. & Saarinen, K. (eds.), Perhostutkimus Suomessa: 48–51. Paino-Saimaa Oy, Lappeenranta.
Marttila, O., Haahtela, T., Aarnio, H. & Ojalainen, P. 1991: Suomen päiväperhoset. — Kirjayhtymä, Helsinki.
Moore, N. W. 1991: Observe extinction or conserve diversity? — In: Collins, N. M. (ed.), The conservation of insects and their habitats: 1–8. Academic Press, London.
Nee, S. 1994: How population persists. — Nature 367: 123–124.
New, T. R. 1991: Butterfly conservation. — Oxford University Press, Melbourne.
Ormio, H. 1996: Lehtohopeatäplämetsän hoito Pernajassa 1996. — Baptria 21: 144.
Pierce, N. E. 1989: Butterfly-ant -mutualisms. — In: Grubb, P. J. & Whittaker, J. B. (eds.), Toward a more exact ecology: 299–324. Blackwell, Oxford.
Rassi, P., Alanen, A., Kemppainen, E., Vickholm, M. & Väisänen, R. (eds.) 1986: Uhanalaisten eläinten ja kasvien suojelutoimikunnan mietintö. — Komiteanmietintö 1985: 43. Ympäristöministeriö, Helsinki.
Rassi, P., Kaipainen, H., Mannerkoski, I. & Ståhls, G. (eds.) 1992: Uhanalaisten eläinten ja kasvien seurantatoimikunnan mietintö. — Komiteanmietintö 1991: 30. Ympäristöministeriö, Helsinki.
Rueetschi, J. 1988: Reintroduction experiment with Colias palaeno europome Esper. — Nota Lepid. 11: 223–230.
Seuranen, I. 1996: Tummaverkkoperhosen (Melitaea diamina) elinympäristön hoitotalkoot Orivedellä 1996. — Baptria 21: 142–143.
Sihvonen, P. 1996: Kalliosinisiiven (Scolitantides orion) elinympäristön kunnostus Savonlinnassa. — Baptria 21: 147–149.
Sundell, P. R. 1996: Pikkusinisiipitalkoot Heinolassa 25.–26.5.1996. — Baptria 21: 141–142.
Thomas, C. D. & Harrison, S. 1992: Spatial dynamics of a patchily distributed butterfly species. — J. Animal. Ecol. 61: 437–446.
Thomas, J. A. 1984: The conservation of butterflies in temperate countries: past efforts and lessons for the future. — In: Vane-Wright, R. I. & Ackery, P. R. (eds.), The biology of butterflies: 333–353. Academic Press, London.
Thomas, J. A., Elmes, G. W., Wardlaw, J. C. & Woyciechowski, M. 1989: Host specifity of Maculinea butterflies in Myrmica ant nests. — Oecologia 79: 452–457.
Väisänen, R., Kuussaari, M., Nieminen, M. & Somerma, P. 1994: Biology and conservation of Pseudophilotes baton in Finland (Lepidoptera, Lycaenidae). — Ann. Zool. Fennici 31: 145–156.
Watt, W. B., Chew, F. S., Snyder, L. R. G., Watt A. G. & Rothschild D. E. 1977: Population structure of pierid butterflies. I. Numbers and movements of some montane Colias species. — Oecologia 27: 1–22.
Weidemann, H.-J. 1986: Tagfalter. Band 1. — Neumann-Neudamm, Melsungen.
Williams, E. H. 1995: Fire-burned habitat and reintroductions of the butterfly Euphydryas gillettii (Nymphalidae). — J. Lep. Soc. 49: 183–191.
Wynhoff, I. & van der Made, J. 1995: Reintroduction of Maculinea teleius and Maculinea nausithous in The Netherlands in 1990. — Proc. Sect. Exp. Appl. Entomol. N.E.V. Amst. 6: 79-80.