

## Brief reports • Tiedonantoja

### Establishment of a *Nucifraga-Pinus* mutualism in Finland

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The Eurasian Nutcracker (*Nucifraga caryocatactes* L.) and its North American congener, Clark's Nutcracker (*N. columbiana* Wilson) feed in winter on stored conifer seeds, mainly of *Pinus*. Preferred foods are the large, lipid-rich "pine-nuts", or wingless seeds of certain pines in the subgenus *Strobus* (Little & Critchfield 1969). Nutcrackers remove seeds undamaged from cones prior to or after cone maturation, store them briefly in a sublingual pouch, transport them some distance, and bury them singly or in groups beneath the soil or ground litter. Seeds not recovered by the following summer frequently germinate. One of the North American pines preferred by Clark's Nutcracker, whitebark pine (*Pinus albicaulis* Engelm.) has been shown to depend on nutcrackers for its regeneration (Hutchins & Lanner 1982) and a similar dependency is suggested for *P. cembra* L., the Swiss stone pine (Mattes 1982). The mutualistic relationship between *Pinus* and *Nucifraga* has received renewed attention from biologists in recent years (Mattes 1982, Crocq 1978, Vander Wall & Balda 1977, Tomback 1978, Lanner 1982, Saito 1983, Benkman et al. 1984).

Both species of nutcrackers are known to irrupt far beyond their breeding ranges in years of low coniferous seed production. Thus Davis & Williams (1957, 1964) have documented six irruptions of Clark's Nutcracker in California between 1898 and 1962, Vander Wall et al. (1981)

studied irruptions of this species in Utah in 1977, 1978, and 1979; and Dementeva et al. (1954) report 23 "sporadic flights" of the Siberian Nutcracker (*N. caryocatactes macrorhynchos* Brehm) into western Europe from 1753 to 1933. Strong irruptions of this subspecies into Finland occurred in 1968 and 1985 (personal communication, Risto A. Väisänen, 30 November 1987).

The only published information on nutcrackers subsequently nesting in the wintering areas into which they have irrupted is in the report by Vander Wall et al. (1981). The following June, when the newly fledged birds were full-grown, flocks in southern Utah were observed returning to the north.

The purpose of this article is to document the prolonged residence and nesting of Siberian Nutcrackers at Punkaharju, Finland, and their influence on the forest composition.

#### Study area

Punkaharju (61°48'N, 29°19'E) is on a peninsula between Lakes Puruvesi and Pihlajavesi about 350 km northeast of Helsinki. The Punkaharju Research Station of the Finnish Forest Research Institute has numerous plantations of exotic conifers, as well as native forests dominated by Scots pine (*Pinus sylvestris* L.). Fourteen of the plantations, totaling 5.27 ha, are recorded as "*Pinus*

*cembra*". About 0.38 ha were planted in the period 1889–1899, and the rest in 1929–1938. Tree heights averaged 11.3–17.3 m in 1979. An additional 1 ha or more is in roadside or other linear plantings.

Three of the 14 plantations are of unknown seed origin; two are of Swiss provenance; one is of USSR provenance; and the remainder are "second-generation Finnish". These latter plantations are believed to have originated from trees planted in the 19th century at numerous locations in Finland. These plantings were intended as a precaution against food shortages, by virtue of their large nutritious seeds.

The name "*P. cembra*" or Swiss stone pine is properly applied only to the plantations of Swiss provenance, all others belonging to *P. sibirica* Du Tour, or Siberian stone pine, which was formerly considered a variety of *P. cembra*. All of the plantations bear frequent and abundant cone crops. Swiss stone pine seeds are the major food of the European Nutcracker (*N. caryocatactes caryocatactes* L.) in the Alps (Mattes 1982, Crocq 1978); and the Siberian stone pine seeds are the major food of the Siberian Nutcracker in its Siberian range (Dement'ev 1954, Turcek and Kelso 1968). Seed maturity coincides with the timing of irruptions. Thus when irrupting Siberian Nutcrackers encountered the Punkaharju plantations, they found an available food supply with which they were already intimately familiar.

## Methods

Nutcracker activities have been observed by one of us (TN) from 1983 to 1989. Reports of stone pine seedlings at some distance from their putative parent trees were investigated by driving forest roads, surveying forest areas on foot, and examining several islands in Lake Puruvesi.

Siberian stone pine seeds are heavy (about 3000 per kg, Kozhevnikov 1963), and lack a wing. Therefore they cannot be dispersed by wind. Presence of seedling beyond the crown shadow of a stone pine therefore indicates animal dispersal. Siberian Nutcrackers are reported to transport seeds at least 16 km (Mezhennyi 1964). Seed caches of Siberian Nutcrackers contain up

to 23 seeds (Konev 1952), and, as with other nutcracker cached species, characteristically produce clumps of germinants. The clumping of stone pine seedlings far from a seed tree has not been found attributable to any other agent; and is thus assumed here to be evidence of harvest, transport, and caching of stone pine seeds by nutcrackers.

## Results

The presence of 20–25 pairs of nutcrackers in Punkaharju is well-known to local ornithologists, as are their harvesting, transporting, and caching of stone pine seeds.

Numerous Siberian stone pine cone remnants have been found from which the scales have been broken off, in typical nutcracker fashion (Lanner 1982). Clumped seedlings were observed throughout the Forest Research Institute plantations, under overstories of *Larix*, *Pinus*, and *Picea*. At the lakeside location Karjalankallio numerous stone pine seedlings to 12 yrs of age, and in clumps of up to 13 stems were found in *Vaccinium*, *Sphagnum*, and *Cladonia* ground cover in a Scots pine-silver birch (*Betula pendula* Roth)-Rowan (*Sorbus aucuparia* L.) forest where nutcrackers had earlier been seen caching seeds. A 25-year-old tree 2.6 m tall was probably established following an unrecorded irruption. The nearest seed source is Stand 53, about 400 m away, and along the contour.

On the island Muuraisaari, stone pine seedlings in clumps of up to eight stems were found in a ground cover of *Vaccinium*, *Sphagnum*, and *Cladonia* beneath Scots pine, silver birch, and Rowan. The nearest seed source, Stand 53, is 500 m away, mostly across water.

Along the Punkaharju Nature Trail numerous stone pine seedlings were found up to 500 m from the nearest source (Stand 239), which lies beyond an esker 25 m in height. Stand 24, which is up to 600 m distant, is the nearest possible seed source for numerous stone pine seedlings along the slope west of Valtionhotelli at the foot of the Punkaharju Ridge. As many as 14 stems per clump were found here. An about 30-yr-old stone pine about 5 m tall was also probably established following an unrecorded irruption.

## Discussion

The irruption of Siberian Nutcrackers observed in 1968 into an area in which the bird's major natural foodstuff was available has led to the formation of a nutcracker-pine mutualism in Finland. The future success of this relationship would appear to depend on many factors affecting the biology of both organisms. Perhaps most important is the continued availability of Siberian stone pine seed crops. We have observed nutcrackers feeding on seeds of Macedonian pine (*P. peuce* Griseb.) and Norway spruce (*Picea abies* (L.) Karst.) after the stone pine seed crop became exhausted in 1989. According to Risto A. Väisänen (personal communication, 30 November 1987) Siberian Nutcrackers that irrupted in 1985 nested in 1986–1987 at Kokkola, Tampere, and Nokia where they apparently fed mostly on Norway spruce. But for long-term survival and successful breeding, we suggest that the large, lipid-rich stone pine seeds (fat content to 76% of kernel dry weight, Shcherbina & Larionova 1963) are a necessity. Siberian stone pine has become a part of the Punkaharju flora. The relatively rapid growth of the planted trees leads us to think the natural seedlings will also do well, and will eventually produce seeds of their own, even though Punkaharju is about 1400 km from the Siberian stone pine range in the Urals (Critchfield & Little 1966). In the interim, it is important that the Finnish Forest Research Institute preserve its stone pines. This will insure that the lively and interesting nutcrackers will continue to "grow" their own food-producing trees, and will eventually become self-sufficient.

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## Selostus: Punkaharjun pähkinähakkien ja sembrojen yhteiselosta

Vuoden 1968 pähkinähakki-invaasion jälkeen Punkaharjulle asettui pesimään siperiansembran siemeniä syövä pähkinähakkikanta. Painavat siemenet eivät kykene le-

viämään tuulen mukana, mutta taimia löydettiin jopa 600 m:n päässä lähimmästä sembrasta. Näyttää siis siltä, että pähkinähakki levittävät sembransiemeniä tehokkaasti myös Suomessa, kuten ne tekevät Siperiassakin.

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