Measurements of the Siberian Nutcracker *Nucifraga caryocatactes macrorhynchos* and clines in irruption studies

ESA LEHIKOINEN

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In 1977 Siberian Nutcrackers invaded Finland in small numbers. Between 17 and 26 October 38 individuals were caught and measured in Turku. Of these 75—85 % were immatures. The measurements fit the values given for the race *macrorhynchos,* but the range of variation is smaller than that recorded during an irruption in 1968. Adults were slightly larger than immatures in all the dimensions measured.

It seems improbable that measurements and possible clinal variation can furnish important clues to the origin of irruptions, as certain biological factors tend to smooth out clines in irruptive species.

Esa Lehikoinen, Institute of Biology, University of Turku, SF-20500 Turku 50, Finland

A minor invasion of the Siberian Nutcracker took place in Finland in 1977 (e.g. Lappi 1978). A stationary flock gradually formed in the largest cembra pine *(Pinus cembra)* plantation in the town of Turku, SW Finland. Most of the Nutcrackers were caught between 17 and 26 October, and the number of ringed birds totalled 38. Using simple capture-recapture formulae, the size of the flock was estimated at 50 individuals at most.

Most of the birds were measured, and the retrapped birds were measured once more, to facilitate correction for personal differences in measuring habits. The wing was measured by determining the minimum chord, the bill dimensions by the methods recommended for this species by Svensson (1975). Except for the first few birds caught, most of the Nutcrackers were aged according to the new Russian guide by Vinogradova et al. (1976), using the colour of the wing coverts as criterion. In the first winter plumage some of the outer greater coverts and all the primary coverts are retained from the juvenile plumage. These are brownish with white, triangular spots at the tip, while coverts that replace them are glossy bluish black and lack the white spot. Among the 26 Nutcrackers that were aged were 4 adults and 22 immatures. Judged from the measurements, which is not an exact method, as many as half of the unaged birds could have been adults. Thus the proportion of immature birds was at least 75 %, but possibly even 85 %. This age ratio is typical of emigrating stocks of many irruptive species (e.g. Hildén 1974).

Results

Measurements of the sample. All the measurements for the adults were slightly larger than for the immature

TABLE 1. Measurements of immigrant Siberian Nutcrackers *Nucifraga caryocatactes macrorhynchos* ringed in Turku in autumn 1977, in relation to their age. The individuals measured were four adults, 12 fullgrown and 22 immature birds.

Variable		$\bar{x}$	*SD*	*CV*	Range
Wing	ad.	182.5	6.03	3.30	176 —189
	f.g.	183.1	3.87	2.11	176 —189
	juv.	178.8	3.57	2.00	172 —185
	all	180.5	4.36	2.42	172 —189
Bill length	ad.	48.35	1.626	3.36	46.3— 49.8
	f.g.	46.46	2.087	4.49	43.2— 51.0
	juv.	44.68	1.546	3.46	40.5— 48.0
	all	45.63	2.104	4.61	40.5— 51.0
Bill height	ad.	12.63	0.929	7.36	11.8— 13.7
	f.g.	12.36	0.642	5.19	11.6— 13.8
	juv.	12.40	0.459	3.70	11.6— 13.5
	all	12.41	0.564	4.54	11.6— 13.8
Bill index	ad.	26.13	1.775	6.79	23.9— 27.7
	f.g.	26.63	1.418	5.32	24.9— 30.3
	juv.	27.79	1.230	4.43	25.4— 30.9
	all	27.24	1.465	5.38	23.9— 30.9
Tail white	ad.	25.25	2.986	11.83	22 — 29
	f.g.	24.67	3.172	12.86	19 — 30
	juv.	24.05	2.380	9.90	20 — 30
	all	24.37	2.665	10.94	19 — 30
Weight	ad.	167.5	11.62	6.94	158 —184
	f.g.	165.8	12.24	7.38	145 —184
	juv.	160.5	13.10	8.16	145 —192
	all	163.0	12.69	7.79	145 —192

birds but, due to the small number of adults, only the difference in bill length was significant (Table 1).

An interesting question is whether the birds caught belonged to the slender-billed eastern race *macrorhynchos* or the more westerly nominate race. From the literature (Dement'ev & Gladkov 1954, Svensson 1975) it is known that measurements of the races show a certain degree of overlap. In addition, the Nutcrackers breeding in the European USSR belong to the nominate race and some of them may take part in the movements of the Siberian birds. The nominate race also breeds in small numbers within 50 km of the sample site in SW Finland.

Let us consider the hypothesis that all the sampled birds belonged to the race *macrorhynchos*. Using the ranges given by Svensson (1975) for the different dimensions, we can calculate the number of individuals that a sample of *macrorhynchos* may contain with one, two or three of the race criteria falling within the range of the nominate race. The race criteria used are bill length, bill height and the breadth of the white tip of the outermost tail-feather. The method of calculation, i.e. the multiplication rule of the elementary probability theory, presupposes that the three measurements are not intercorrelated. As shown in Table 2, the correlation coefficients remain rather low and the use of this simple method is thus allowed.

The relative overlap in each racial criterion is expressed as a fraction of

TABLE 2. Intercorrelations of variables in the Nutcracker sample ($N=38$) from Turku, 1977.

	Bill height	Bill index	Wing length	Weight	Tail white
Bill length	0.305°	—0.600***	0.287°	0.277°	0.294°
Bill height	.	0.576***	0.224	0.330*	0.209
Bill index	.	.	—0.218	0.045	—0.071
Wing length	.	.	.	0.098	0.392*
Weight	.	.	.	.	0.003

Symbols for statistical significance: ° = $P<0.1$, * = $P<0.05$, *** = $P<0.001$.

the total range of *macrorhynchos*. For bill length the overlap is 0.842, for bill height 0.158 and for the tail white 0.395. The possible effects of small age differences and sexual dimorphism, and of the form of the frequency distributions may be disregarded in the present connection. The expected numbers of individuals with two or three racial criteria falling in the range of the nominate race and the numbers actually observed are as follows:

Racial criteria	Expected	Observed
Bill length and height	5.1	4
Bill length and tail white	12.6	14
Bill height and tail white	2.4	2
All three criteria	2.0	2

The concordance of the expected and observed figures is nearly perfect. Hence, even those individuals which do not fulfil the racial criteria very well, when considered signly and dimension by dimension, nevertheless most probably belong to *macrorhynchos*.

Comparison of measurements with data in the literature. The only measurements from the breeding range of the race *macrorhynchos* available to me are those of Dement'ev & Gladkov (1954) and Vinogradova et al. (1976). Even these may partly relate to individuals caught during irruptions west of their breeding range. Comparison is also possible between irruptions of different years, as Piechocki (1971) provides data on the mass irruption of 1968. As always, the comparisons are hampered by the diversity of measuring methods. The measurements from the present sample show general agreement with those from breeding areas and the irruption of 1968 (Table 3). The greatest difference is in the variance (or range) of the measurements, which is smaller in my sample than in the others, except as regards the amount of white in the tail. Since not all the papers give the means and standard deviations, the variance here is measured as the percentage ratio of the range to the lower range limit (Table 4). The small variability in my sample means either that the whole irruption of 1977 originated from a relatively limited area or simply that the flock caught in Turku was homogeneous as to its origin. To my mind, the differences in sample sizes cannot be the whole explanation for the range size differences.

The weight of the Nutcrackers in this sample (Table 1) was that reported as normal for the species (Dement'ev & Gladkov 1954). The Nutcrackers weighed at Finnish bird stations (most during 1968) often seemed undernourished (average weight 148 grams, v. Haartman et al. 1969), but

TABLE 3. Some measurements of the Siberian Nutcracker reported in the literature. When available, the means are given in brackets after the ranges. References*: (1) Dement'ev & Gladkov (1954), (2) Vinogradova et al. (1977), (3) Svensson (1975), (4) Piechocki (1971).

Variable	Males	All	Females	Reference
Wing	170 —191 (181)	—	161.5—190 (177.3)	1
	168 —192 (180.6)	—	167 —188 (177.2)	2
	178 —197 (188.0)	—	174 —189 (182.0)	4
Bill	—	42 — 53.5	—	3
length	39 — 49 (44.7)	—	38 — 45 (40.9)	1
	41 — 55 (48.7)	—	37.8— 53.5 (46.4)	4
Bill height	—	11.5— 13.8	—	3
Bill index	—	23.2— 30.7	—	3
Tail	—	19 — 32	—	3
white	—	max. 35	—	1
	19.0— 27.5 (24.7)		20.5— 29.5 (23.9)	4
Weight[1]	153 —190 (176.4)	—	124 —184 (169.4)	1
	137 —197 (166)	—	134 —182 (156)	4a
	125 —134 (128)	—	110 —130 (125)	4b
		137 —190 (156)		4c

[1] The three separate sets of weight data given by Piechocki (1971) refer to (4a) birds shot, (4b) starving birds and (4c) birds trapped for ringing.
* Methods applied by different authors slightly variable.

the present Nutcrackers had evidently managed well so far in their incursion. The Nutcrackers examined in Central Europe in 1968 had also generally maintained their normal weight level (Piechocki 1971), although starving individuals were also caught. The weight of the present Nutcrackers did not change significantly during the catching period: there were 11 cases of weight gain (max 22 g) and 12 of weight loss (max 10 g). From this I infer that the irruptive movements were about to end for these individuals.

Discussion

Vepsäläinen (1975) proposed that measurements could be used to determine the origin of immigrant birds and the extent of their native areas. However, many difficulties are en-

TABLE 4. Variability of some dimensions of Nutcrackers in samples taken from breeding areas (b) or from irruptions (i). Variability is measured as the percentage ratio of the range to the lower range limit. Sample sizes in brackets.

Reference	Wing length	Bill length	Bill height	Bill index	Tail white
Dement'ev & Gladkov (b)	18.3 (252)	28.9 (67)	..	..	..
Vinogradova et al. (b)	15.0 (236)	..	..	..	..
Svensson (b, i)	..	27.4 (75)	20.0 (75)	32.3 (75)	68.4 (?)
Piechocki (i)	13.2 (79)	45.5 (49)	..	..	55.3 (27)
Present sample (i)	9.9 (38)	25.9 (38)	19.0 (38)	29.3 (38)	57.9 (38)

countered in such attempts. First, the age and sex of the birds usually affect the measurements to some degree. This was found to be the case with the Nutcracker: adults were a little larger than immatures (Table 1) and males a little larger than females (Table 3). If the measurements depend on age and/or sex and it is impossible to sex and/or age the species, the analysis is doomed to failure, as variations in the sex or age ratio may be responsible for the variations in the measurements. The species chosen as an example by Vepsäläinen was the Great Spotted Woodpecker *Dendrocopos major*. Sexing of this species in juvenile plumage is not generally possible during the early phase of irruption (i.e. before the feathers of nape are moulted), yet bill length, at least, is sexually dimorphic (my own data, also Hogstad 1978). Sexing of Nutcrackers is also impossible on live birds.

A furher obstacle to the use of measurements as clues to the origin of irruptions is the lack of adequate comparative material. Actually, a species which has mass eruptions at frequent intervals should perhaps not be expected to show significant geographic variation in its measurements. Eruptions, which were formerly thought to be a way to get rid of surplus individuals, may in fact at least partly be a way to mix the gene pool of a population with a very large geographical distribution. The return rates (and survival) of irruptive individuals have proved to be greater than earlier suspected (e.g. Hildén 1974). The fact that irruptive forms of, for example, the Great Spotted Woodpecker, the Nutcracker and the Nuthatch cannot be split into more races, in spite of their extensive breeding ranges, is a proof of genetic asociation and an argument against the probability that clines would be steep enough to be observable.

Yet situations can be imagined where the formation of clines is possible. If part of the population of an irruptive species is strictly sedentary (which seems possible as adult birds are so few among the irruptive individuals in nearly all species studied so far) or if the birds taking part in irruptions can return fairly exactly to their area of origin, an observable cline could result. Even in these cases we still have to suppose that some factors in the environment produce a sufficiently high gradient of selection pressure. Furthermore, the selection pressure has to be significantly higher than in the case of sedentary species precisely due to the effect of the irruptions.

The question of clines among irruptive species and their possible use in finding out the origins of immigrants must remain largely the study of Soviet ornithologists. Where measurements or variations in breeding populations of far-eastern areas are concerned, a co-operative North-European project for studying irruptions can make little real progress without the help of our Soviet colleagues.

Eriksson (1970) attempted to show that the Nuthatches *Sitta europaea asiatica* invading Finland in 1962 originated from Altai or even more eastern areas. Unfortunately, the method used in measuring the bill and the reasoning on the wing length variation and its dependence on the postjuvenile moult are both unsound, and his conclusion about the source area is thus doubtful. The bill was measured from "the front of the forehead", i.e. from the feathering (?), and compared with literature data presenting bill lengths measured from

"the base", i.e. from the skull(?) (Voous & van Marle 1953). Contrary to Eriksson's belief, the length of the primaries does not increase at the postjuvenile moult as they are not moulted then (Svensson 1975). Hence, no successful use of measurements and clines has yet been made in Finnish studies on irruptive species.

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Selostus: Pähkinähakkien mitoista ja kliinien käytöstä vaelluslintututkimuksessa

Turussa pyydystettiin rengastusta ja mittausta varten 38 pähkinähakkia syksyn 1977 vaelluksen aikana. Kaikki hakit kuuluivat rotuun *macrorhynchos,* jonka arvoja saadut mittaustulokset tarkoin vastasivat. Hakkien iän määritys tapahtui Vinogradovan ym. (1976) esittämin perustein. Nuorten lintujen vaihtumattomat isot peitinhöyhenet ja kaikki käsisulkien peitinhöyhenet ovat ruskeammat kuin vaihtuneet sisemmät isot peitinhöyhenet ja lisäksi niissä on valkeat kärkitäplät. Vanhojen lintujen kaikki isot ja käsisulkien peitinhöyhenet ovat sinertävänmustia ilman kärkitäplää. Iälleen määritetyistä hakeista oli nuoria 85 % ja niiden nokan pituus oli merkitsevästi lyhyempi kuin vanhojen. Samansuuntaisia eroja oli myös muissa mitoissa (taul. 1). Pyydystettyjen hakkien mitat vaihtelivat vähemmän kuin rodun koko levinneisyysalueen pesimälinnuilla ja syksyn 1968 vaelluslinnuilla (taul. 4), mikä lienee osoitus suppeammasta alkuperäalueesta.

Kirjoituksessa arvellaan, että kliineillä tuskin on kovin suurta merkitystä vaelluslintututkimuksissa. Ensinnäkin monen vaelluslintulajin yksilöitä on elävinä mahdoton määrittää sukupuolelleen ja iälleen. Tämä olisi kuitenkin välttämätöntä, koska monet mitat riippuvat linnun sukupuolesta (esim. monien tikkojen nokan dimorfia, ks. myös taul. 3) ja iästä (esim. monen lajin siiven pituus, ks. myös taul. 1). Toiseksi itse vaelluskäyttäytyminen toimii selvien kliinien muodostumista vastaan sekoittamalla laajojen alueiden geneettisen aineksen tehokkaasti. Vain jos huomattava osa vaeltavan lajin yksilöistä on paikkauskollista ja säilyy elossa seuraavaan lisääntymiskauteen tai vaeltavat yksilöt palaavat tarkasti ja merkittävässä määrin syntymäsijoilleen, voi selvä kliini muodostua. Lisäedellytyksenä on riittävän voimakas valintapaineiden gradientti.

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