The irregular migrations of the Crossbill, *Loxia c. curvirostra*, and their relation to the cone-crop of the Conifers.

By Antti Reinikainen.

During the last decades great irregular migrations of Crossbills over Europe have occurred, such as in 1909, 1927 and 1930. Numerous reports concerning these migrations are to be found in the ornithological literature of different countries. General investigations have been published by Whitaker (1909) and Jensen (1929). As an example of the development of such an irregular migration I quote a description of the events of 1927, according to Jensen (1929).

„The flocks came from the east, as we may conclude from the facts, that the first observations in different countries were made at the east frontiers, and that among them was also the eastern species *Loxia leucoptera bifasciata* (in Finland and Sweden). There were 2 principal directions: the Western (to W-France and Ireland) and the Southern or South-Western (to Hungary and Central-Italy). The foremost flocks showed themselves as follows: N-Italy, end of May; Hungary 1. VI; Finland and Esthonia, beginning of June; Sweden, Denmark and Germany, nearly at the same time; England, end of June. In the West, the abundance of the crossbills was greatest in July, decreasing in the autumn and the last observations were made in January, 1928. In the South, a part of them stayed as late as April (Venice). — The extension and intensity of the irregular migration is shown by its extending even to Iceland. In 1909, birds again wandered far South, to Sicily and Malta. — The migrating flocks are generally small. Sometimes large flocks also seem to foregather on the islands: Man, once 80—100 ind. together; Fair Island of Scotland, at least 300 ind. For comparison I mention, that I myself have only once seen something like it 4. XI. 34, Helsinki, about 80—100 ind."

The cause for the migrations is supposed to be lack of nourishment, caused by shortage of cones in the east, in Russia and Sibiria. Jensen (1935, p. 73) justifies this hypothesis by referring to the periodic wanderings of the squirrel which, according to his examinations, absolutely depends upon the variability of the seed-crop o conifers. In different handbooks and local faunistical investigations it is likewise mentioned, that local numbers of crossbills vary periodically owing to the same factors. It is however to be noted, that

these statements are mostly quite summary and founded upon casual observations. Thus, the causal relation between the *Loxia* wanderings and the seed-crop of the conifers is still somewhat hypothetical.

In the following an attempt will be made to determine 1) the correlation of the variation in the local *Loxia*-abundance to the cone-crop, and 2) the relation of the great irregular migrations to the abundance of crossbills in the area studied. The settling of the first question demands an analysis of the seed-crop of the conifers. In Finland, the forestry-scientists have devoted their interest to the question during many years. Recently, the Institute for Foresty Research has published crop-surveys from different parts of the country for the years 1931—36 (HEIKINHEIMO 1931—37). These surveys are illustrated, by the cone-maps, reproduced in this article. No map has been made for the winter 1932—33, because in the greater part of the country there was a wholesale failure in the seed-production of the conifers. There are also older accounts contained in the journals "Tapio" and "Metsätieteellinen aikakauskirja."

The leading features of the fluctuations of the seed-crop of Spruce and Pine are as follows: The Spruce (*Picea excelsa*) blooms in June, sometimes even at the end of May; the seeds mature in the autumn. The crop generally turns out well once in 3—5 years and is then very abundant. The Pine (*Pinus silvestris*) differs from the Spruce in that the maturing of the seeds takes a year and a half. The crop is very seldom abundant, but may be mediocre even 3 years running. An example of the fluctuation in the crop is given in diagram 1 (p. 59), showing the situation in the neighbourhood of Kuopio (Central-Finland) in 1927—37. During the same years the crop however varies greatly and very irregularly, in different parts of the country (compare with the cone-maps).

In order to determine the relative abundance of crossbills, I have made a series of partly quantitative investigations in the neighbourhood of Kuopio during 1927—37. I started the work without any real plan and aim. The data from 1927 are therefore very few, but they may give a good idea of the status during that year, when compared with later, more accurate observations. The almost com-

plete absence of Loxia in 1928 induced me to try and follow the changes in the abundance. In the following years I made as many observations as possible, among others a *linear transect* during several years. I skied during breeding-time, on the hills surrounding the city (Puijo, Neulamäki) and on the large islands of Kallavesi Lake (Salonsaari, Säyneensalo, Laivonsaari), always following as closely as possible the same route, of at least about 120 km annually, noting the number of crossbill-couples observed on my way.

The advantages of the method need scarcely be discussed here. On the other hand, a short presentation of the area of the investigation should be given. The territory borders upon the city, and the influence of civilization is therefore more or less obvious in the forests. The taxatory lines were chiefly directed within the interior of greater wooded areas, but the edges of woods could not be totally avoided. The spruce is the characteristic tree-species of the territory, most of the investigated places represent the mixed forest-type, spruce dominating. As my purpose was to determine the relative abundance of the breeding stock of birds, the observations have generally been made in March, which is known to be the best breeding-time of the Crossbills, a fact which is illustrated by the following numbers.

The following table illustrates the breeding-time of the crossbills:

Loxia curvirostra-nests in different months.
(* = fledgelings observed)

Month	VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII
McCabe's series . .	1	2	1	2	13	30	53	109	66	12	1	4
Finnish nests . . .	—	—	—	—	*	—	6	69	7	1	*	*

The former series (McCabe, 1933) is collected from a wide region and under varying conditions (29 nests from N-America, 1 from Algiers, the others from Central- and N-Europe). March is by far the most common breeding-month. The Finnish observations (from Central- and South-Finland, chiefly unpublished accounts, given by Grönvall, Hiilto, Putkonen, partly collected from the issues of „Ornis Fennica" for the years 1924—35) are still more

completely concentrated to the month of March. — All the quantitative data of the excursions, and the leading features of the general observations, are summarized in this paper, in which my own observations are supplemented by the reports of some of my colleagues, KUHMONEN, LUMIALA and TOIVANEN (in the following abbreviated K., L. and T. respectively). [1] — *The linear transects are given in italics.*

1927. During the spring only incidental notes; birds evidently moderately abundant (for instance 6. III. still about 20 ind. in a flock). In the autumn, IX—XII, completely absent.

1928. In the spring almost completely lacking: 21. II 3—4 ind., 10. III 1 ♂ (K., L.); in addition heard 2—3 times in March. At least in the beginning of VIII, if not in VII, an invasion into the territory: 5. VIII about 20 + 2 ind. in the parks of the city: 12. VIII about 15 ind., etc. At the end of the year common and abundant.

1929. I—VII. *On numerous excursions about 80 anticipated couples have been ascertained during February—March, of these at least 1/2 along the route, to which attention was limited later on.* Broods, and also larger flocks, abundant up to the middle of July, when observations were interrupted for 7 months.

1930. 1. III—10. VII, 17. VIII—7. IX, XII. Breeding birds apparently rather scarce, but my excursions were imperfect owing to my military service. Broods or small flocks: 21. IV, 4. V. In the summer similarly; a few records for instance 23. VI 11 ind. and 7. IX. — They evidently moved away for the winter: still 23. and 30. XI about 15 and 20 ind. (T.), but in XII only 16. XII 1 and 21. XII 2 ind.

1931. 1—15. I once 1 ind., 4. I. *Nests very scarce: linear transect made, 29. III—7. IV: only 3—4 singing ♂ ♂.* Broods: 5—6 ind. 20. V. (T.) and 30. VI—11. VII ♂ ♀ + 3 juv. — 11—31. XII lacking.

1932. Evidently a late invasion into the territory: 15. I 3—4 and 2. II. 2 ind. During breeding-time moderately abundant. *Transect 19—31. III: about 20 (15—22) couples.* Throughout the summer, 8. V—15. IX, small flocks: 5—7 records a month. 30. X still about 10 ind. (T.), but 15. XII. 32 —15. I. 33 lacking.

1933. Breeding birds very scarce. *Control of the route on skis 24—27. III: 2 couples only,* 17—29. V still lacking. Invasion in June: 24. VI—1. VIII often small flocks, in the autumn probably more and more abundant, 10. XII. 33—21. I. 34 singing ♂ ♂ in all quarters.

1934. Breeding birds exceedingly abundant. *Transect 24. III—8. IV: approx. 40 (36—45) couples per 120 km.* Flocks throughout the summer, still in town 6. VIII. Disappear later; 22. XII. 34—15. I. 35 heard once only (23. XII, a few ind.).

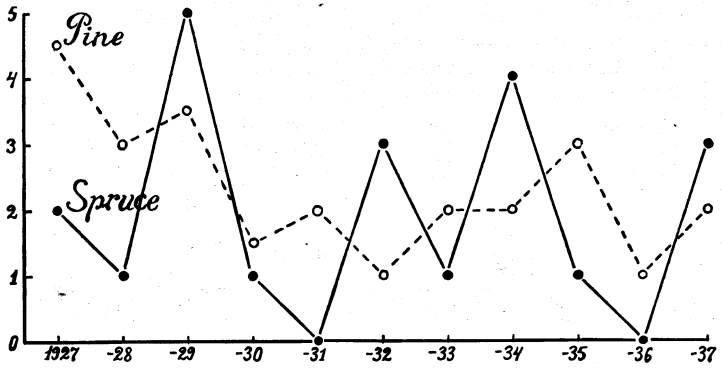
1935. Breeding birds almost lacking (T.). — 7. V—17. VI none were ob-

[1] To all the mentioned gentlemen I hereby express my best thanks.

served, not even in a wider region, during my excursions in several parishes. On 18. VI—2. VII a casual invasion occurred: 18. VI. Siilinjärvi, about 30 ind.; 21. VI parish of Kuopio, about 15 ind.; 24. VI Jäppilä, 13 ind.; 26. VI in the town; 2. VII, Maaninka, among others 10 ind.; 29. VII still 2 isolated observations from the city, 2 broods (?). — 1. VIII—8. IX lacking, similarly 15. XII. 35—10. I. 36.

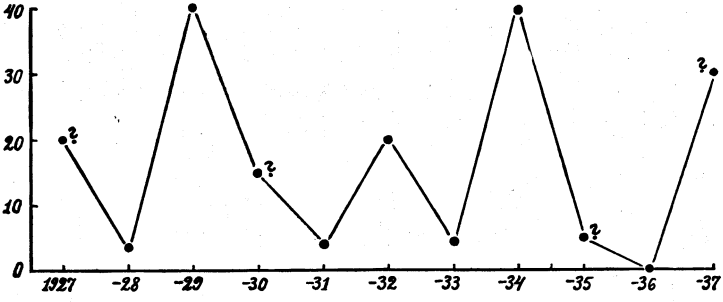
1936. In March crossbills probably entirely lacking: *1—8. III about 180 km on skis (22—23 hours) but no records.* In the summer, May—July, only a few ind. in a wide area of several parishes. A new invasion again took place about the beginning of VIII. 20. XII. 36—14. I. 37 flocks in every quarter: for instance, *22. XII about 35 ind. in small groups (walked 18 km).* — As a comparison it may be mentioned, that Klockars (1935 p. 140) presents certain *Loxia*-numbers, obtained through the linear transect method in the neighbourhood of Helsinki, 1934—35, at a time of great *Loxia*-abundance: observed in December 169 ind. per 67 km and 48 ind, per 24 km.

It has been generally proved, that *Loxia c. curvirostra* chiefly feeds on spruce-seeds although at times, at least in the spring and

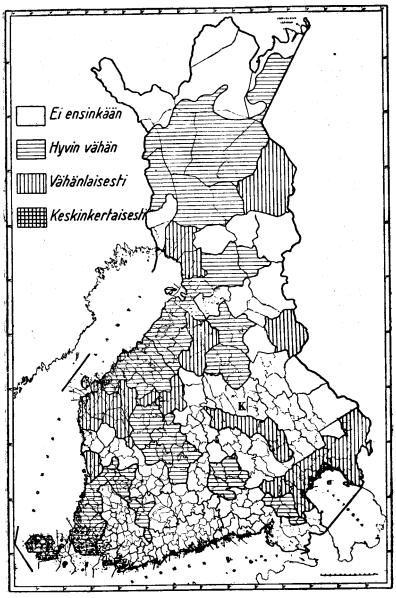


Diagr. 1. Cone-crop in Kuopio 1927—37.

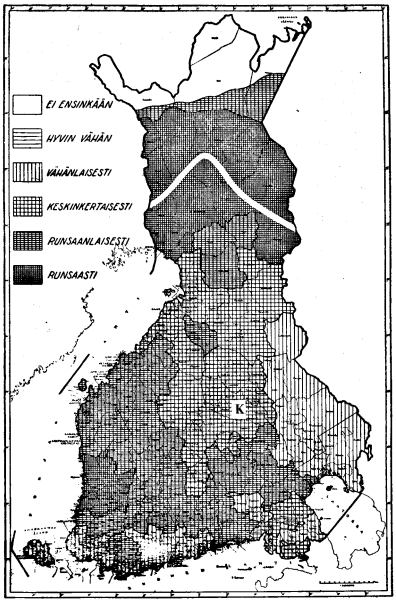
0 none 1 very scarce 2 rather scarce
3 mediocre 4 moderately rich 5 rich



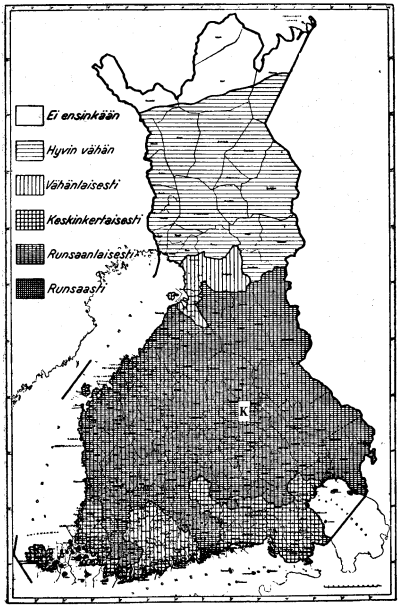
Diagr. 2. Loxia-couples in March per 120 km.



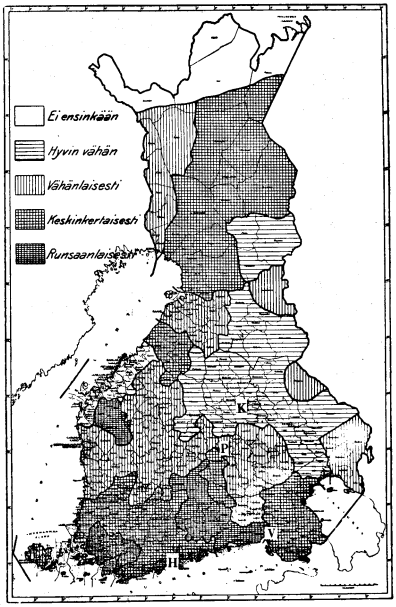
Map 1. The abundance of spruce cones during the winter of 1930—1931. (Ripened cones on the spruce.)



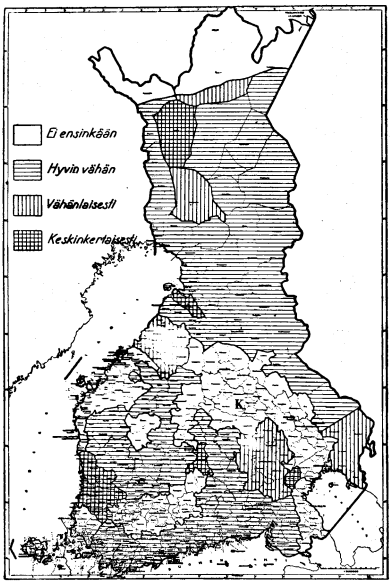
Map 2. The abundance of spruce cones during the winter of 1931—1932. White line denotes the approx. northern limit of serviceable, ripened spruce-seeds.



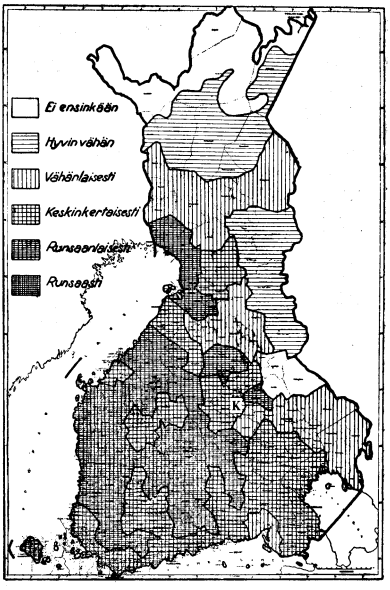
Map 3. Winter of 1933—1934.



Map 4. Winter of 1934—1935.



Map 5. Winter of 1935—1936.



Map 6. Winter of 1936—1937.

Explanation of signs.
Abundance of spruce cones:

- none
- very little
- comparatively little
- middling
- comparatively numerous
- numerous

H = Helsinki
K = Kuopio
P = Pieksämäki
V = Viipuri

summer, it also attacks pine-cones: for instance 30. VI—11. VII. 31. I often observed how a ♂ and ♀ fed 3 full-fledged youngsters with pine-seeds. To what extent does the seed-crop of these species of trees during the proper breeding-season, February—April, influence the numbers of crossbills? The fluctuations of the numbers of crossbills are illustrated by diagr. 2. A comparison with the cone-crop curves of the conifers shows, that *the curves for the spruce and the crossbill are concordant in all their parts, whereas the curve for the pine is quite different. Consequently the old observation, that the seed-crop of the spruce determines the density of the breeding Loxia-stock, is strongly confirmed.*

The same relations are found when comparing observations with the cone-maps. — Map 3 shows centrally a wide region, with rich cone-crop. It includes the region of Kuopio. The *Loxia*-abundance was here maximal and evidently similar in a great part of the country. It can thus be assumed, that the Crossbills had multiplied largely. The map of the following winter (4) is more varied, and the regions with rich crop are much diminished. The region of Kuopio (K) belongs to a district of almost complete scarcity. The crossbill-population of the previous year has evidently migrated correspondingly during the autumn (see above observations of 1934). Judging from the map, a rather short migration brought the birds into a region of richer cone-crop. As an example of how circumstances change in a short distance, it is suitable to compare the *Loxia*-situations of Pieksämäki (P) and Kuopio (K) with one another. In the region of Pieksämäki the Crossbill was "common" (SIIVONEN 1936, p. 26), in Kuopio almost lacking. The distance between Pieksämäki and Kuopio is only about 70 km, but Pieksämäki is situated on the northern border of the southern zone of richer cone-crop. In South-Finland the *Loxia*-abundance was also exceedingly large, perhaps partly because the birds had greatly multiplied during the preceding winter and were now concentrated in a narrower region than formerly. For instance, in Helsinki (H) and Viipuri (V) a great number of nests were found: GRÖNVALL in Helsinki alone 20, HIILTO likewise 13, PUTKONEN received information from Viipuri of 20 nests. (Verbal communication). — Maps 1 and 5 represent „years of famine," consequently the *Loxia*-curve falls to a minimum in 1931 and 1936.

A year of cone scarcity on the part of the spruce is generally followed by a mediocre or good crop, ripening before the autumn. In the territories, left uninhabited during the year of scarcity, a *Loxia*-invasion then appears. This is illustrated, for instance, by the above presented series of observations from the summers of 1928, 1933 and 1936. In 1933 the flocks began to arrive in June, in 1928 and 1936 in the beginning of August. In all these cases, the *Loxia*-abundance was already great in the autumn. After the lack of cones in the winter of 1930—31, and the great European irregular migration of 1930, I waited attentively for the return of the crossbills to the region studied. This did not happen before January 1932 (the first ones 15. I), that is much later than the recently mentioned invasions,

especially in 1933. I assume that the explanation is to be found, at least partly, in the cone-conditions. Map 2 shows, that in the summer of 1931 a richer crop ripened in wide regions south and west of Kuopio than in Kuopio itself, which remained in the area of mediocre crop. Thus the *Loxia*-flocks, returning from the west and the south, came immediately upon regions where there was much nourishment, and they advanced and expanded only later to the regions of poorer crop in the district of Kuopio. — On the other hand, the large region of rich cone-crop, seen in map 3, in the centre of which Kuopio is situated, may have caused in the summer of 1933 a quick and uniform expansion throughout the country, from whatever direction the birds may have arrived.

Only once during the years 1927—37 have two subsequent years of scarcity of cones occurred in Kuopio; in the summer of 1935, after a winter very poor in cones (1934—35), the crop failed completely. The region of failure was exceedingly wide (see map 5; compare with map 4). A peculiarity of the *Loxia*-observations of summer 1935 (see above) is the distinct invasion at the end of June, which however stopped in its commencement for the neighbourhood of Kuopio and vast surrounding areas belonged to the region of scarcity. The flocks therefore disappeared during the summer.

In this connection it should be noted that the occurrence of these local invasions, and of the great irregular migrations (compare the introduction) during the summer months, confirms that both these events arise in the period of motility, following the breeding-time. Whatever the ultimate causal factor may be, the result attained is, at least in most cases, advantageous for the maintenance of the species, *as the motility brings the birds to regions with rich nourishment and suitable for multiplication.* Two rich cone-crops seldom occur in exactly the same region in subsequent years.

These few observations on the *Loxia*-abundance, its variations in the same region during different years, as well as the variations in different regions — even in adjacent ones — during the same time, show very strikingly how *the abundance of Crossbills at breeding-time is determined by the seed-crop of the Spruce.* The influence of the same factor is also seen, though less obviously, in the *local fluctuations (invasions in the region of rich crop, etc.)*

In addition, a few words may be devoted to the relation be-

tween the great *Loxia*-migrations and the local variations of *Loxia*-abundance. We find that a distinct decrease appears in the *Loxia*-curve of the region of Kuopio in 1927 and 1930 — the years of the general European *Loxia*-migrations. — Map 1 proves, at least in the latter case, that a scarcity of cones occurred at the same time in very wide regions. *Thus appear simultaneously 1) an extensive scarcity of cones, 2) a general irregular migration of Loxia, and 3) a subsequent local lack of Loxia. The causal connection between these phenomena is evident.* This, however, does not imply that lack of nourishment alone would suffice for the explanation of the problem of the great irregular migrations of *Loxia*. Such facts, as the great expansion and the intensity of the migrations — for instance appearance of Crossbills on Iceland or Malta — brings to mind the wanderings of the real migratory birds.

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Neue Beobachtungen über den Gartenrotschwanz, *Phoenicurus ph. phoenicurus* (L.) als Bodenbrüter.

Von Lauri Siivonen.

Im folgenden sei eine zusammenfassende Übersicht über neue [1]) Erdnestfunde des Gartenrotschwanzes gegeben, die Verf. gemacht hat oder die ihm aus verschiedenen Gegenden mitgeteilt worden sind:

[1]) Siivonen, L., 1935, Über die ursprüngliche Nistweise des Gartenrotschwanzes, *Phoenicurus ph. phoenicurus* (L.). — Ornis Fennica XII, 1935, S. 89—99).