Clutch size, nestling growth and nestling mortality of the Starling *Sturnus vulgaris* in south Finnish agroenvironments

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Tiainen, J., Hanski, I. K., Pakkala, T., Piiroinen, J. & Yrjölä, R. 1989: Clutch size, nestling growth and nestling mortality of the Starling *Sturnus vulgaris* in south Finnish agroenvironments. — Ornis Fennica 66:41–48.

The breeding success of Starlings *Sturnus vulgaris* was studied in six nest-box colonies in habitats varying from mixed farming to intensive cereal and root crop cultivation. In the colonies studied, only a few Starling eggs failed to hatch and a small number were lost through desertion or predation. In the areas of specialized cultivation, however, only 20–30% of the hatched eggs produced fledglings, whereas in mixed farming areas the proportion was 70–90%. The nestling weights were lower and within-brood weight differences larger in specialized than in mixed farming areas. In the areas of cereal and root crop monoculture, many nests were fouled and suffered from heavy mortality because of wet nestling faeces. Nestling mortality was high when the mean weights were low and between-sibling weight differences large. The starvation of chicks and fouling of nests suggest that the amount of food available is smaller and its quality poorer in monoculture than mixed farming areas.

It is suggested that changes in farming at least partially explain the recent decrease of the Finnish Starling population. In southern Finland, farmers have largely specialized in cereal and root crop production, so that the number of cattle and extent of pastures have greatly decreased and mixed farming has become rare over large regions.

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Introduction

The Starling *Sturnus vulgaris* population crashed in Finland in the mid-1970s (Orell & Ojanen 1980). Decreases were also reported at this time from Sweden (Svensson 1981), Denmark (Møller 1983), Poland (Tomiałojc et al. 1984), and the GDR (Schneider 1982, Dathe 1983), but not until the early 1980s from Belgium (Tahon 1980, Clobert & Leruth 1983) or England (Feare 1984; recently also the British populations have declined (Feare, pers. comm.)).

In general, the possible explanations of the decline are increased mortality or decreased natality. Both may be involved in the case of Finnish Starlings (Orell & Ojanen 1980), which overwinter on both sides of the English Channel (Saurola 1978, Fliege 1984). In Belgium and France massive extermination operations have been carried out in the 1970s and 1980s (Lebreton & Landry 1978, Tahon 1980, Stevens 1982, Clobert & Leruth 1983, Douville de Franssu et al. nondated, 1988). This may have increased winter mortality, which in turn may have led to a decrease of the breeding population. However, the Belgian operations, started in 1972, have been carried out in summer, and hence they cannot be responsible for the decline of the Finnish population. The French operations have been carried out in winter, but did not start effectively until 1980. Moreover, in the French operations only about 2% of the winter population has annually been killed (P. Douville de Franssu, pers. comm.).

On the other hand, the Finnish agroecosystems have changed due to an intensification of farming from the 1950s onwards, and especially since the end of the 1960s (as documented by e.g. Varjo 1984, Solonen 1985, Tiainen 1985, Raatikainen 1986, Hanski & Tiainen 1988). Besides a many-fold increase in the use of pesticides and artificial fertilisers, the major changes in the Finnish farmland habitat include substitution of subsurface drainage for open drains, and a great decrease of animal husbandry, particularly outdoor grazing, in southern Finland, with the conse-

Table 1. Nest-box areas studied in Lammi (Nos. 1–5; 1986) and Elimäki (1985 and 1986), southern Finland. As there was only one nest in the boxes in Syrjäntausta, this area was pooled with Iso-Evo.

Study areas	No. of nestboxes	Nestboxes erected	Surrounding habitat
1. Kivismäki	20	1986	Specialized cereal and root crop cultivation
2. Lammi cemetery	20	1986	Rural village, small fields
3. Biological station	120	1969	Specialized cultivation, nearest pastures at a distance of 300–500 m
4. Iso-Evo	20	1986	Traditional mixed farming
5. Syrjäntausta	20	1986	Traditional mixed farming
6. Elimäki	57	early 1980s	Traditional mixed farming

quent disappearance of pastures and leys. If the agroecosystem has deteriorated as a breeding habitat for the Starling, a reduction in the reproductive output may have followed.

To study this possibility, we investigated reproduction in Starlings in six breeding colonies in southern Finland. The Starlings bred in nest-boxes placed in different kinds of agricultural environments. We wished to know whether the reproductive output differs with the intensity of agriculture.

Study areas, material and methods

We studied six nest-box areas, five of which were situated in Lammi (about 61°05′N, 25°00′E) and one in Elimäki (about 60°38′N, 26°15′E; Table 1). Three of the areas were traditional mixed farming agroecosystems, characterised both by dairy husbandry (including outdoor grazing) and by cultivation of cereals and root crops. As there were pastures and cattle in the immediate vicinity of the colonies, these Starlings could forage on pastures, leys or arable fields. Two areas were surrounded by fields devoted to specialized production of cereals, sugar beet or potatoes. Pastures and livestock grazing occurred at distances of 300 m and more in the surroundings of one of these areas. The sixth study area was the cemetery of Lammi village (2500 inhabitants), bordered by a small cereal field. In all areas, except Iso-Evo, the Starlings had the opportunity to forage on lawns. In Lammi village they apparently did so, but in other areas foraging on lawns was probably very limited. However, it should be noted that we do not know exactly how the Starlings used the different foraging habitats.

In the area of biological station, nest-boxes were first erected in 1969 and in Elimäki in the early 1980s. In all other areas boxes were introduced in 1986. Starling colonies already existed in old boxes or natural cavities in all areas before. According to our censuses (Tiainen et al. 1985, Pakkala et al. 1986, and unpubl.), the Starling colony in Syrjäntausta included 19, 13 and 15 pairs in 1984–86 but, due to the availability of many old boxes near farmhouses, only one pair accepted our boxes in 1986. As the surrounding habitat was similar in Iso-Evo and Syrjäntausta, we pooled the results from the two areas under the name Iso-Evo.

In Lammi the nest-boxes were first visited during the incubation stage, to determine the clutch size. In three cases missing values were replaced with the average clutch size. Other visits were made at about hatching time, when the nestlings were 9 and 14 days old, and after fledging.

In Elimäki the only visits were made on 25 and 31 May (and after fledging). This made it impossible to determine clutch size accurately, because most nestlings were already 3–4 and 7–10 days old (1985 and 1986, respectively). Because of the possibility of nestling disappearance, we did not estimate the clutch size or hatchling number for Elimäki in 1986. The estimated values for 1985 may be slightly too low.

Usually, we could not determine the day of hatching directly. If the nest was not visited on the day of hatching, the hatching date was calculated with the aid of a wing length growth curve, which was constructed from measurements of nestlings of known age. The growth data were obtained by measuring the maximum wing length to the nearest 0.5 mm and by weighing the nestlings with an accuracy of 0.1 g.

In the case of age determination with the aid of growth curves, the earlier it can be done, the more accurate it is (Tiainen 1978). At the time of age determination in Lammi, the Starling nestlings were older than 5 days (not over 8 days) in nine out of 30 nests (the nestling period totals 20 days; von Haartman 1969, own observations). In Elimäki, in 1985 the

Table 2. Number of nests and variation in the starting date of laying in the Starling colonies studied in southern Finland. As the nests were first checked after hatching in Elimäki the clutch sizes may be too small and the laying dates consequently too late. On average this error should be small, of the order of one day.

Colony	Nests	Start of laying Median	Range
Lammi 1986			
Cemetery	5	7 May	5–8 May
Iso-Evo	10	6 May	3–9 May
Biological station	8	7 May	3–9(10?) May
Kivismäki	7	7 May	2–8 May
Elimäki 1985	27	6 May	4–9 May
Elimäki 1986	23	2 May	29 April–8 May

nestlings were five days old in six nests and younger than five in 21 nests at the time of the first visit. In 1986 they were older than 5 days in all but two nests (not over 10 days).

We calculated the date on which the first egg was laid by assuming that the incubation period is 12 days (von Haartman 1969). If one nestling was one day younger than its siblings, we assumed that incubation had started with the laying of the second last egg.

Results

Clutch size and nestling survival

The total number of Starling nests studied was 27 in 1985 and 53 in 1986 (Table 2). In Lammi, the nestlings were cared for by single females at one nest in Kivismäki and at the biological station. In Elimäki the number of single females was not known. The onset of laying was very synchronous within and between the colonies (Table 2).

The average number of eggs laid (Table 3) was 4.9 (n=27) in Elimäki in 1985 and 4.8 (n=30) in Lammi in 1986 (all areas pooled). In Elimäki in 1985 there were 4.4 hatchlings and 4.1 fledglings on an average (n=27). In 1986 the mean hatchling number was 4.7 (n=30) and the mean fledgling number 3.1 (n=53; Elimäki included).

Clutch size was slightly, but not significantly (t-tests) higher in the traditional agricultural areas of Iso-Evo than elsewhere. Fewer eggs hatched at the biological station and in Elimäki (1985) than in other areas, but the differences were due to desertion of one clutch in both areas. Eggs that failed to hatch in otherwise successful clutches were found only in Iso-Evo and Elimäki (Table 3).

Nestling survival varied much more between colonies than either clutch size or hatching success (Table 3; the number of hatchlings/nest did not differ significantly between colonies (1-way ANOVA, $F=0.65$, $df_1=4$, $df_2=52$, $P>0.10$), but the number of fledglings/nest did ($F=11.36$, $df_1=5$, $df_2=73$, $P<0.001$)). Only two young died before fledging in the cemetery colony and ten (seen for the first time as 2–3 days old nestlings and taken as hatchlings) in Elimäki in 1985. The mortality of 9 days old nestlings in Elimäki in 1986 was of the same order of magnitude as in 1985. In Iso-Evo, nestling mortality was higher (a quarter of the young perishing there), but low compared with the mortality figures of almost

Table 3. Mean number of eggs/nest, and fate of eggs and chicks in the Starling populations studied. In addition to the egg losses shown in the Table, one clutch in Elimäki was destroyed by a predator.

Nesting stage	Cemetery n=5 mean±SD	Iso-Evo n=10 mean±SD	Biol. station[1] n=8 mean±SD	Kivismäki n=7 mean±SD	Elimäki 1985 n=27 mean±SD	Elimäki 1986 n=23 mean±SD
Eggs						
Mean	4.8±0.45	5.1±0.57	4.8±0.45	4.8±0.67	5.0±0.78	–
Hatching failure	0	0.2±0.42	0	0	0.2±1.15	0.1±0.34
Deserted	0	0	0.6±1.77	0	0.2±1.15	0
Nestlings, means						
0 days	4.8±0.45	4.9±0.57	4.2±1.73	4.8±0.67	4.4±1.28	–
5 days	4.6±0.55	4.4±1.07	3.1±2.03	3.3±1.70	4.2±1.50	4.4±1.37
9 days	4.4±0.55	4.3±1.16	3.0±2.00	2.1±2.27	4.1±1.45	4.2±1.64
14 days	4.4±0.55	4.1±1.20	2.4±1.60	1.7±2.36	4.1±1.47	4.2±1.64
20 days	4.4±0.55	3.5±1.08	1.7±1.89	1.0±1.53	4.1±1.47	4.1±1.62

[1] Number of nests at egg stage = 6, at nestling stage 8.

Table 4. Intrabrood variation (difference between the largest and the smallest nestlings) and growth of the wing length (mm) and weight (g) of 9 days and 14 days old nestlings in Starling populations studied. The number of nestlings at 14 days is smaller than at 9 days, because of mortality. n gives the number of broods.

	Cemetery	Iso-Evo	Biological station	Kivismäki
	n=4	n=10	n=6	n=3
Mean nestling weight at 14 days	73.1	66.7	62.5	62.3
Mean intrabrood difference				
Wing length, 9 days	8.7	10.2	10.4	12.6
Wing length, 14 days	8.0	8.5	8.4	15.5
Weight, 9 days	7.2	9.2	15.0	16.3
Weight, 14 days	8.9	8.6	7.4	13.4
Mean growth between 9 and 14 days				
Wing length	30.5	29.0	27.2	29.4
Weight	8.4	6.7	11.5	6.1
Number of nestlings at:				
9 days	17	43	24	13
14 days	17	41	19	12

70% at the biological station and almost 80% in Kivismäki. The mortality pattern differed between the latter two areas; more nestlings died before the age of 9 days in Kivismäki (between the ages of 5 and 9 days, only one nestling died in the six nests at the biological station, but eight died in the six nests at Kivismäki).

Nestling growth

As the age of most nestlings was determined by comparing their wing lengths with a growth curve, wing growth differences between the colonies were studied only by examining the increment between the ages of 9 and 14 days. At this time the wing length growth was almost linear, and errors caused by inaccurate age determination could be large if we had compared the wing lengths directly. As the weight increase has already ended at the age of 14 days (e.g. Feare 1984), we compared both the increment between 9 and 14 days, and the average brood weights at 14 days.

When the colonies are arranged according to nestling survival (see Table 3; Elimäki excluded because of lack of growth data), an increase in the intrabrood difference between the largest and smallest chick is apparent in both wing length and weight at the age of 9 days (Table 4). These differences are not significant (1-way ANOVAs), however. These data do not include the many runts eliminated by mortality before this age; this markedly reduces the intrabrood differences when mortality is heavy.

There were no marked between-area differences in wing length or weight increments between the ages of 9 and 14 days (Table 4). The marked weight increase at the biological station was due to a single brood in which the mean nestling weight increment was 30.9 g (the wing length increment did not differ from that of other broods). Hence, the survivors grew at similar rates in all colonies. Nestling growth will be studied in greater detail elsewhere.

Nestling weight and survival

The mean nestling weight at 14 days was lowest in Kivismäki and at the biological station and highest in the cemetery (Table 4). One might expect that the nestling weight curves would reach a higher plateau in small than large broods (Tinbergen 1981, his Fig. 17), but we did not find a relationship between the mean nestling weight and the brood size at 14 days (r_s=0.142, n=26, P>0.10). In contrast, there was a significant positive correlation between brood size at fledging and the mean weight at the age of 14 days (Fig. 1). Hence, a high mean nestling weight predicts good fledging success. The mean nestling weight at 14 days was significantly lower in broods which suffered mortality between day 14 and fledging (61.8 g, SD = 6.11, n=7) than in broods in which no mortality occurred (68.6 g, SD = 4.67, n=17; t=2.97, P<0.01).

As there were no clear growth differences between colonies, but there were differences in intrabrood nestling size variation (Table 4), we examined

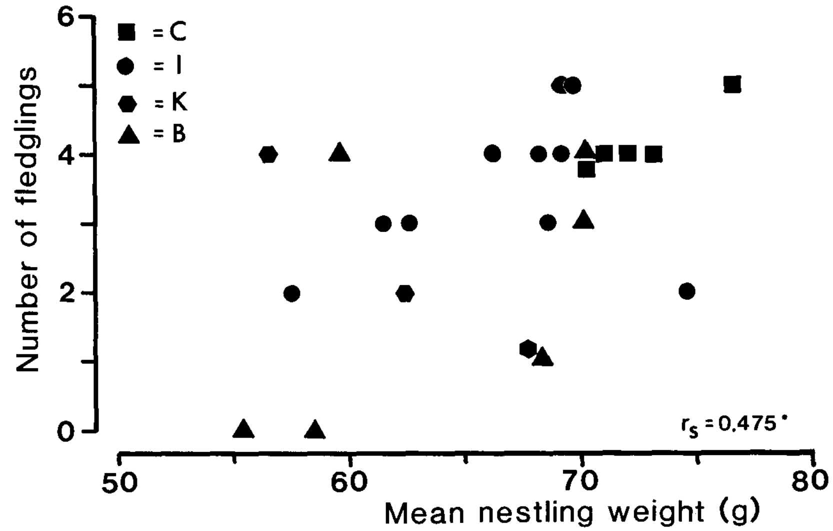

Fig. 1. Relationship between the number of fledglings and the mean nestling weight in broods aged 14 days. I = Iso-Evo and Syrjäntausta, C = cemetery, B = biological station, K = Kivismäki.

whether nestling survival was related to intrabrood weight differences (Table 5). The intrabrood weight difference at the age of 9 days appeared to be decisive for further nestling survival. Significantly fewer nestlings died when the intrabrood weight difference was 10 grams or less than when it was over 10 grams. Further survival did not depend significantly on the weight difference at the age of 14 days. Nestling survival was not correlated with brood size at 9 or 14 days.

Nest sanitation and survival

The Starling nests could easily be classified as more or less clean and dry and wet and badly fouled by nestling faeces. This was done with at all nests at the age of 14 days, as we did not pay enough attention to the sanitation on day 9. All the nests in the cemetery colony and most nests in the Iso-Evo colony were dry and clean. In the colonies at the biological station and Kivismäki, only half of the nests were dry. Breeding success was clearly related to the sanitary condition of the nest at the age of 14 days, significantly more nestlings fledging from the clean nests (Table 6).

Discussion

Our results show that the breeding success of Starlings varies greatly in different types of agricultural environments. Monocultures of cereals and sugar

Table 5. Dependence of nestling survival on the weight difference between the largest and smallest sibling in Starling broods (small = 0–10.0 g, large = over 10 g). The table gives the numbers of nestlings surviving and dying between the ages of 9 and 14 days (A), 9 days and fledging (B), and 14 days and fledging (C and D). χ^2-tests without Yates's correction, except in A, where Fisher's exact probability test was used.

	A Weight difference at 9 days		B Weight difference at 9 days		C Weight difference at 9 days		D Weight difference at 14 days	
	Small	Large	Small	Large	Small	Large	Small	Large
Surviving	43	42	43	24	43	24	41	35
Dying	1	7	1	25	0	18	7	11
P	0.083		<0.001		<0.001		ns	

Table 6. Number of dry "clean" and wet fouled Starling nests in Lammi (number of nestlings at the age of 14 days in parentheses), and number of successful nests (with at least one fledgling; total number of fledglings in parentheses). The difference in total the number of successful and unsuccessful nests between the dry and wet nests (pooled data) was not significant (Fisher's exact probability test, P=0.194), but the difference in the total number of surviving and perishing nestlings was highly significant (χ^2=22.1, df=1, P<0.001).

Nest condition	Cemetery	Iso-Evo	Biological station	Kivismäki	Total
Dry					
Successful	5 (22)	7 (28)	2 (7)	2 (6)	16 (63)
Unsuccessful	0 (0)	0 (4)	1 (3)	0 (2)	1 (9)
Wet					
Successful	0 (0)	2 (8)	2 (5)	1 (1)	5 (14)
Unsuccessful	0 (0)	0 (3)	1 (9)	1 (6)	2 (18)

beet were clearly less suitable for Starling reproduction than mixed farming areas, where the birds can use pastures for foraging. Nestling survival and growth, both indicators of the quality of the foraging grounds, were best in the mixed farming areas (Iso-Evo, Elimäki) and Lammi cemetery.

Our present results from Lammi come from a single year, but two facts support the above conclusion. Firstly, the breeding success of the colony at the biological station has consistently been low since the mid-1970s, when mixed farming was abandoned in the immediate surroundings (T. Solonen, J. Tiainen & P. Saurola, unpubl.). Secondly, the breeding success in the Elimäki colony was good in both the years for which we had data at our disposal.

At the age of nine days the mean differences in wing length and weight between the largest and smallest nestlings in a brood tended to be smallest in the cemetery and mixed-farming areas (Table 4). The mean introbrood difference in weight increased from the age of 9 days to 14 days in the cemetery, which was the only area where there was no nestling mortality after day 9. The mean intrabrood difference was largest in the specialized cultivation area of Kivismäki.

The nestling weights were highest in the cemetery and mixed-farming areas. These patterns were related to nestling survival: many young fledged from broods in which the mean nestling weight was high (Fig. 1) and the intrabrood weight difference small (Table 5).

The differences observed in the reproductive success seem to be related to the feeding habitat. The parents apparently have difficulty in finding enough food for their offspring in Kivismäki and at the biological station. In both colonies the nestlings starved more often than in the cemetery, Iso-Evo and Elimäki. There were also differences in the quality of the food fed to the young, but on this point we have only indirect evidence.

One may ask about the role of the age distribution of the parent Starlings; young birds are known to reproduce less well than experienced birds (e.g. Feare 1984). The average age of the adults might be expected to be lower in the new nest-box colonies. We do not have data on the ages of our Starlings, but it is not likely that variation in the age distributions could produce such differences as those found between the colonies. Furthermore, we had both new and old colonies among the successful and less successful ones.

Nestling mortality was apparently related to nest hygiene (Table 6). Mortality was significantly higher in wet fouled nests than in dry clean nests. Kluyver (1933) and Tinbergen (1981) described sanitation problems in Starling nests caused by an almost exclusive diet of leatherjackets (*Tipula* larvae). In the Netherlands leatherjackets are easily found by the Starlings, and the nestlings are mainly fed with leatherjackets at the time of the highest energy demands (Tinbergen 1981). Since leatherjackets are not likely to be abundant on farmland which lacks leys and pastures in the rotation (Vappula 1962, own observations), our Starlings either fed their young with some other prey causing the same changes in nestling faeces as leatherjackets, or used distant foraging sites beyond the arable fields where leatherjackets were easily and quickly exploited.

The present results show that mixed farming areas are better breeding habitats for the Starling than specialized cultivation areas. The Starlings also clearly prefer breeding habitats where mixed farming is carried out. About 1400 hectares of fields in Lammi have been censused in recent years (Tiainen et al. 1985, Pakkala et al. 1986). In 1984–86, the total numbers (and densities as pairs/km^2) of breeding Starling pairs in six large and medium-sized mixed-farming fields (total area 6.2 km^2) and in five large specialized cereal and root crop fields (total area 5.1 km^2) were as follows:

	1984	1985	1986
Mixed farming	62(9.9)	47(7.5)	58(9.3)
Specialized cultivation	32(6.3)	28(5.5)	24(4.7)

The availability of nest-boxes is not limiting in any of the fields, and the absolute number of boxes, and also of natural holes, is larger in the specialized cultivation areas. In some of the mixed farming areas, pastures cover only small parts of the entire field. Here and elsewhere in southern Finland in similar areas, the Starlings can be seen to make regular 0.5–1-km flights to the pastures. Long feeding flights are costly in terms of time and energy (see Tinbergen 1981), which may explain why nestling growth and survival were so poor at the biological station.

In Finland the field size varies from less than a hectare to several hundreds of hectares. In Lammi the largest fields are 200–400 hectares. Individual fields are usually more or less clearly isolated from other fields by forests, and they are usually owned by several or many farmers. Earlier, almost all farms had dairy cattle and outdoor grazing (in 1969 still most farms), and every field (as specified above) included pastures. Since the end of the 1960s, Finnish agriculture has changed as a result of the new agricultural policy, which has led to specialization in both single farms and large regions (Varjo 1984). In southern Finland, including Lammi, the number of cattle, and accordingly the area of pastures and leys have declined tremendously. From 1969 to 1980, the number of farms with dairy cattle in various parts of southern Finland declined to 29–44% of their former number, and their percentage of all farms declined from 61–78% to 23–46% (the total number of farms dropped to 74–76%; data from Anon. 1971, Anon. 1986). The total area of pastures probably did not decline to the same extent, as the size of herds has roughly doubled at the same time, but these figures should illustrate the decline in the number of good breeding sites for the Starling in Finland.

Nowadays only a few of the farms in Lammi have cattle and pasture. Where there are pastures, they form only a small portion of the whole farmland.

The present results indicate that the changes in Finnish agroecosystems at least partially explain the crash of the Starling in Finland. In southern Finland, the agricultural changes have increasingly resulted in the habitats characteristic of Kivismäki and the surroundings of the biological station. As a result, the reproductive success of the whole south Finnish Starling population must have declined. Owing to lack of data, it is not possible to decide whether the reduction in food availability caused by the change in habitat composition has been aggravated by increased use of pesticides.

Acknowledgements. T. Aalto and E. Virolainen helped in the field work, and C. J. Feare, A. Järvinen, O. Järvinen and M. Orell made useful suggestions on the manuscript. This study is a part of the project "Changes and status of the avifauna of Finnish farmland", partly supported by the Academy of Finland.

Selostus: **Kottaraisen pesyekoko ja poikasten kasvu ja kuolleisuus eteläsuomalaisessa maatalousympäristössä**

Suomen kottaraiskannat romahtivat 1970-luvulla. Vähenemistä on sittemmin raportoitu monista muistakin maista. Vähenemisen yleisenä syynä voi olla joko kuolleisuuden kasvu tai syntyvyyden lasku. Suomessa on suosittu edellistä selitystä, koska Belgiassa ja Ranskassa on 1970-luvulta lähtien harjoitettu kottaraisen tuhoamista. Belgiassa tuhoaminen on kuitenkin ajoittunut keskikesään ja Ranskassa se on alkanut massiivisesti (kuitenkin vain 1–2% talvehtivasta kannasta) vasta vuonna 1980, joten on vaikea nähdä, miten nämä operaatiot olisivat syynä omien kottaraistemme romahdukseen.

Tässä tutkimuksessa selvitettiin jälkimmäistä vaihtoehtoa. Suomalainen maatalousympäristö on muuttunut suuresti 1960-luvun lopulta lähtien maatalouden erikoistumisen myötä ja on ajateltavissa, että se on huonontunut kottaraisen pesimäympäristönä.

Kottaraisen pesintää tutkittiin kuudessa pönttöyhdyskunnassa Lammilla ja Elimäellä (Taulukko 1). Kolme niistä oli perinteisessä maatalousympäristössä karjalaitumien äärellä. Kaksi oli erikoistuneen viljelyn alueilla, missä aivan lähettyvillä ei ollut laitumia. Kuudes yhdyskunta oli Lammin kirkonkylän taajamassa, missä pellot, nurmikot ja tienpientareet muodostivat mahdolliset ruokailualueet, mutta laitumia ei ollut lähettyvillä.

Yhdyskuntien välillä ei ollut eroja pesinnän ajankohdassa eikä pesyekoossa (Taulukot 2 ja 3). Sen sijaan poikasten kuolleisuus oli merkittävästi suurempaa erikoistuneen viljelyn alueilla (70–80% kuoriutuneista poikasista) kuin muilla alueilla (10–30%; Taulukko 3). Poikasten väliset kokoerot pesyeiden sisällä olivat suurempia ja poikaset kevyempiä erikoistuneen viljelyn alueilla kuin muilla alueilla (Taulukko 4). Viljelyalueilla poikasten ulosteet myös sotkivat monia pesiä pahasti.

Poikaskuolleisuus oli suurinta silloin, kun poikasten väliset kokoerot pesyeen sisällä olivat suuret (Taulukko 5), poikaset olivat keveitä (Kuva 1) ja pesät ulosteiden sotkemia (Taulukko 6); nämä seikat viittaavat sekä laadullisesti että määrällisesti huonoon ravintotilanteeseen.

Maatalouden muutos selittänee vähintäänkin suuren osan kottaraisen vähenemisestä Suomessa. Vuonna 1980 lypsykarjatilojen määrä oli pudonnut 29–44%:iin vuoden 1969 määrästä ja lähes vastaavassa suhteessa laitumet ovat siirtyneet erikoistuneen viljelyn piiriin, missä kottaraisen pesimistulos on heikko.

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Received 18 June 1988, accepted 15 August 1988