Growth and mortality in the chicks of Arctic Terns in the Kongsfjord area, Spitsbergen in 1970

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LEMMETYINEN, R. [Department of Zoology, University of Turku, SF-20500 Turku 50, Finland.] 1972. — *Growth and mortality in the chicks of Arctic Terns in the Kongsfjord area, Spitsbergen in 1970.* Ornis Fenn. 49:45—53. At Ny Ålesund, 46 nests were each surrounded by board barriers and the fences were checked daily. The mean clutch size in the fenced nests was 1.83 ± 0.06. Only 4.3 per cent of the eggs were lost in the enclosures before hatching, but in the whole colony losses were greater. No eggs were destroyed by predators. The mean interval between the hatching of the first and second egg was 1.78 ± 0.14 days, which was significantly longer than that of 1.19 ± 0.10 on the Finnish coast. In broods of two the first chick weighed 13.3 ± 0.2 g at hatching and the second 12.3 ± 0.3 g. The pattern of growth rates was different between first and second chicks, for a few second chicks increased in weight, even temporarily. Growth rates also varied greatly between different first hatched chicks. In general, growth was clearly slower on Spitsbergen than in Finland. Six-day-old chicks weighed at Ny Ålesund, on average, 50 per cent less than those on the Finnish coast. The food consisted principally of the small crustacean *Gammarus setosus*. Some fish were also taken. Mortality among chicks was about 75 per cent. The probable reason for great mortality was shortage of food which, to some extent at least, was caused by unfavourable and in particular cloudy weather. The effect of predators on mortality were unimportant.

1. Introduction

The ability of adult birds to rear broods of different sizes to the fledging stage and the growth rates of chicks are at least partly dependent on how easily parents can obtain food for their young. In the southern parts of the distribution range of the Arctic Tern, on the coasts of the North and Baltic Seas, there are no significant differences in the growth rates and mortality of chicks in broods of one and two (BOECKER 1967, PEARSON 1968, Lemmetyinen unpubl.). In districts with more severe weather conditions, however, parents are usually able to rear to fledging no more than one chick per brood (HANTZCH 1905, PETTINGILL 1939, HAWKSLEY 1957). In addition, it has been proved that the initial growth-rates of chicks are slower and maximum weight is reached at a later age in such areas (HAWKSLEY 1957, BELOPOLSKII 1961, PEARSON 1968). According to PEARSON (1968) the slower growth rates of northern chicks may be due to the lower ambient temperature at high latitudes.

Environmental conditions, especially weather, have a strong effect on the breeding ecology of birds in arctic areas (FISHER & LOCKLEY 1954) and for this reason, the breeding success of the Arctic Tern varies considerably from year to year (NORDERHAUG 1964, GULLESTAD & NORDERHAUG 1967, BENGTSON 1971, EVANS & MCNICHOLL 1972).

This paper deals with the growth rates and mortality of single and fraternal chicks of Arctic Terns in a colony at Spitsbergen in the high arctic (78°55'N, 12°00'E). Some comparisons are made with results obtained in the archipelago of Southwestern Finland (60°35'N, 21°15'E).

2. Study area, material and methods

The study area comprised a narrow stretch of tundra between the shore line and mountains in the vicinity of the mining village, Ny Ålesund. A more detailed description of its topography, climate, fauna and of human influence on the area is presented by AHLÉN & ANDERSSON (1970). BENGTSON (1971) studied breeding success of Arctic Terns in the same colony in 1967. The number of pairs was not counted accurately in 1970, but the colony was estimated to be about 200 pairs.

On arrival in the district on 11th July, egg laying was complete. 46 nests were then each surrounded by board barriers approximately 30 cm high and 85 cm in diameter. PALMER (1941) and PEARSON (1968) as well as my own experience in Finland have shown that enclosing chicks of the Arctic Tern in this way causes them no inconvenience. 38 nests included two eggs and 8 nests one egg. The nests were checked daily at approximately the same time each afternoon during the remaining incubation and early fledging periods. After hatching the chicks were weighed daily with 30 g and 100 g springbalances accurate to 0.5 and 1.0 g respectively. In addition fraternal chicks were ringed with plastic colour rings for individual identification. The colony was populated so sparsely that each tern pair was disturbed for only a few minutes during our checking circuit. Daily weights and survival of chicks were recorded until 31st July.

Data concerning the weather conditions at Ny Ålesund in July, 1970, are based on daily records from the Meteorological Station at Ny Ålesund.

3. Weather

The daily records of mean temperature, winds and cloud cover at Ny Ålesund during July, 1970, are given in Fig. 1. The figure shows mean daily values derived from observations made three times a day, at 07, 13 and 19 hours.

The weather was very windy and cool between 13th and 20th July. After a small drop between 24th and 26th July, the temperature

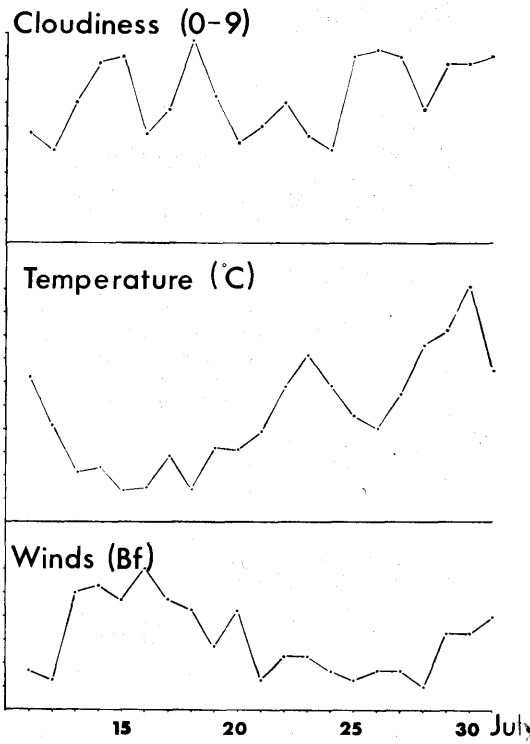

FIGURE 1. Daily changes in cloud cover, temperature and winds at Ny Ålesund, Spitsbergen 11th—31st July 1970.

rose towards the end of the month and greatly exceeded the long-term averages for this time (HISDAL 1972). In addition, winds were quite slight after the 21st July. Cloud cover varied daily between 11th and 24th July. During the period there were a number of days with cloudless or half-clouded weather (Table 1). However, after 25th July the sky was overcast almost continuously every day to the end of the month (Fig. 1). The only exception was a short period of partly clear sky on 28th July.

Rainfall was low during the entire study period. Precipitation was 1.00 mm on 29th and 0.40 mm on 31st July. On the other hand, occasional mist and fog occurred on some days. Wet snow fell overnight on 18th and 19th July but melted quickly.

TABLE 1. The daily weather records including rainfall and visibility at the Meteorological Station Ny Ålesund Spitsbergen, during the 11th—31st July 1970.

11th	July	clear
12nd	„	mist, fog
13th—17th	„	clear
18th	„	mist, sleet, clear
19th	„	mist, drizzle, clear
20th—25th	„	clear
26th	„	mist, fog, drizzle, clear
27th—28th	„	clear
29th	„	rain, drizzle, mist
30th	„	mist, clear
31st	„	drizzle, mist, clear

4. Clutch size and hatching success

Mean clutch size in the fenced nests was 1.83 ± 0.06 ($n = 46$). It is possible that the mean value for the whole colony was slightly lower. No nests with three eggs were found.

The day when a newly hatched chick was seen for the first time is regarded as the hatching date. The first chicks hatched on 16th July and the peak was reached on 20th—22nd, but incubation continued in some nests into August (Fig. 2).

Hatching success was rather good in spite of the period of very cold weather between 13th and 20th July. Only 4.3 per cent of the 72 eggs in the two-egg nests were lost before hatching, and these were either infertile or contained a dead embryo. No eggs were seen to have been destroyed by nest predators. BENGTSON (1971) also observed that the Arctic Fox *Alopex lagopus*, the most important nest predator on Spitsbergen, was absent in the colony beside the village due to the hunting activity of people. The Glaucous Gull *Larus hyperboreus* is not an important predator of terns at Ny Ålesund (AHLÉN & ANDERSSON 1970).

Survival of eggs in the present study was far greater than in other studies carried out on Spitsbergen (NORDERHAUG 1964, BENGTSON 1971). However, incubation had been taking place for a long time on our arrival at the colony, and it is therefore most likely that total losses were greater than those actually recorded.

The interval between the hatching of the first and second egg in the two-egg clutches varied between 0 and 3 days, with a mean of 1.78 ± 0.14. This was clearly less than the interval of 2.93 days recorded by NORDERHAUG (1964) at Hornsund, Spitsbergen. The difference is statistically significant ($F = 12.65$, $p < 0.01$).

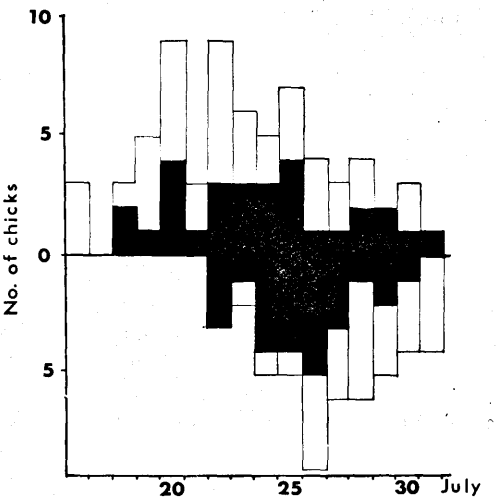

FIGURE 2. Daily numbers of new hatched chicks (above the horizontal line) and of new dead chicks (below the line) at Ny Ålesund 16th—31st July 1970. White columns = the only or first-hatched fraternal chick, black columns = the second chick.

5. Growth of chicks

The mean weight of all newly hatched chicks less than one day old was 12.9 ± 0.2 g. However, in broods of two the first chick weighed 13.3 ± 0.2 g at hatching and the second chick 12.3 ± 0.8 g.* The difference is significant ($F = 10.64$, $p < 0.01$). As the interval between the hatching of fraternal chicks was nearly two days, the first chick was over 4 g heavier than its sibling when the latter hatched.

The pattern of growth was very different between first and second chicks (Fig. 3). Only very few second chicks increased in weight even temporarily. Among the first hatched chicks the growth-rates were positive during early development. Growth varied, however, greatly between different individuals. E.g. the weights of eight-day-old chicks ranged from 13.5 g to 41.5 g.

Fig. 3 also shows the curve of the mean weights of all the chicks of the Arctic Tern weighed in the archipelago of Southwestern Finland. From the very beginning, growth was more rapid in the Finnish archipelago. For example, six-day-old chicks at Ny Ålesund weighed on average only 50 per cent of those weighed on the Finnish coast.

The daily weight changes of first and second chicks of different age categories expressed as a percentage of their weights on the preceding day are given in Fig. 4. Growth rates in first chicks 1—3 days old were high between 18th—23rd July, the mean daily increase in weight varying between 18 and 20 per cent. Growth, however, was clearly delayed on 24th—25th July in this age group and was only 6—7 per cent per day between 26th—29th July. A conspicuous decrease in growth rates occurred after 21st July also in chicks between 4—6 days old. On 29th July their growth rate became negative and then remained unchanged until the end of the month.

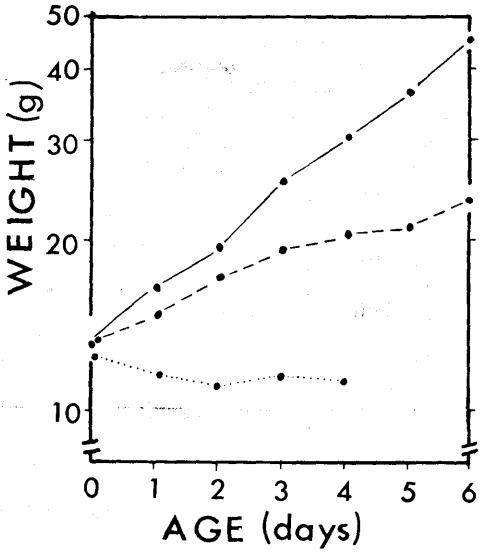

FIGURE 3. Weight development in chicks of the Arctic Tern in the first six days of life. Solid line = weights of all chicks in Southwestern Finland, broken line = first chicks in fraternal broods (Spitsbergen), dotted line = second chicks (Spitsbergen).

The weight curve of second chicks differed appreciably from that of first chicks. Second chicks did not gain weight at all, except for a slight increase between the second and third day of life (Fig. 3). However, the standard deviation suggests that this increase is not significant.

6. Mortality of chicks

The number of chicks found dead in the enclosures is given below the horizontal line in Fig. 2. Dead chicks were not found before 22nd July and the

* Chicks from nests with one egg weighed 14.1 ± 0.2 g (n = 5) on hatching. Mortality among second chicks in broods of fraternal young was so great that it was pointless to differentiate the weights of single hatched from those of first fraternal chicks.

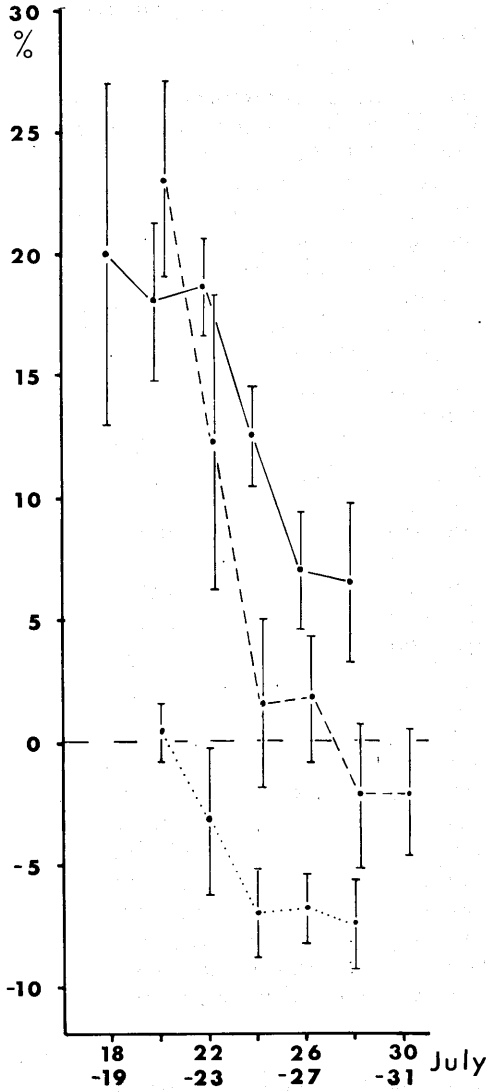

FIGURE 4. The changes in chick weights on 18th—31st July 1970 at Ny Ålesund. The points are expressed as percentual changes in weight compared with the preceding day. Solid line = single or first-hatched fraternal chick 1—3 days old, broken line = single or first-hatched fraternal chick 4—6 days old and dotted line = second chick 1—3 days old. Range is the mean ± standard error.

maximum number was observed on 26th July. Thereafter, many dead chicks were found every day right up to the end of the month. Invariably, the chicks which died first were the second-born in broods of two offspring. Dead single or first-hatched fraternal chicks were not found in appreciable numbers until after the 25th. According to Fig. 2, mortality among chicks was 73.1 per cent. However, it is likely that the proportion of chicks dying was even higher since a number of individuals, which were alive on 31st July when we left the area, had hatched only a few days earlier. On these grounds, a conservative estimate of nestling mortality was about 80 per cent.

The effects of predators on mortality were unimportant. Only six chicks disappeared without trace from the enclosures. As it is more likely that they escaped, they are not regarded as losses in Fig. 2.

All the chicks classified as lost in Fig. 2 were found dead in the enclosures. The alimentary tracts of nine such chicks were opened and analysed. All the tracts were quite empty and this indicates that the chicks had probably perished from starvation.

To compare the mortality of chicks hatched outside the enclosures we made occasional surveys in other parts of the colony. We found 17 chicks altogether, of which 15 (88 per cent) were dead.

7. Food of the young terns

In order to analyse the diet of young Arctic Tern the pellets (see BAUER 1965), faeces and some food specimens which were not eaten by chicks were collected from the enclosures. The results are shown in the table 2. The most important food was the crustacean *Gammarus setosus*. A few fish were also taken. Dark pieces of dead moss passed through the alimentary canal were quite

TABLE 2. Food composition of the Arctic Tern on the basis of samples collected from enclosures of chicks at Ny Ålesund in July 1970. For further details see text.

	Frequency of occurrence	No. of food items
Fish	4	4
Gammarus setosus	11	17
Gammarus spp.	5	5
Crustacea non det.	3	5
Moss	6	—
	29	31

common in the enclosures and possibly indicate a shortage of marine food (BURTON & THURSTON 1959).

8. Discussion

Climatic factors have a great effect on the breeding biology of the Arctic Tern, especially in arctic regions. This is discovered at many different phases in the nesting cycle of terns (NORDERHAUG 1964, GULLESTAD & NORDERHAUG 1967, BENGTSON 1971, DE KORTE 1972, EVANS & MCNICHOLL 1972).

In the Finnish archipelago I found that the first egg laid in a clutch of two was always the first to hatch, and there is no reason to doubt that this was also true of terns at Ny Ålesund. The interval between the hatching of the first and second egg was 1.19 ± 0.10 days in samples collected in 1966—70 on the Finnish coast, where climatic conditions are less severe. The interval is significantly shorter than that measured at Ny Ålesund (Mann Whitney $p < 0.001$). However, the longest interval was recorded by NORDERHAUG (1964) on Spitsbergen (p. 47). HAUKIOJA (1970) observed in the Reed Bunting *Emberiza schoeniclus* that the laying interval between successive eggs was longer during periods of unusually cold weather. Similarly, in the Arctic Tern which starts incubating after the first egg is laid, weather conditions at laying could affect the time interval between the laying, and ultimately the hatching, of successive eggs. For example, mean temperatures during laying periods were 10.2 ± 0.3 C° in Southwestern Finland and 4.4 ± 0.2 C° at Ny Ålesund.

The second chick of the Arctic Tern was clearly lighter at hatching than the first chick. In addition, the competitive situation of the second chick is made worse by the fact that it hatches on average nearly two days later than its sibling. Survival of the second chick was impossible even during quite favourable weather conditions. It seems to me that second chicks are able to survive to fledging very rarely and only under exceptionally favourable conditions in arctic regions (cf. HAWKSLEY 1957). These chicks are therefore a reserve that can be utilized only in very good years (LACK 1954). The growth rates of single and first fraternal chicks were clearly slower than those in the Finnish archipelago even during favourable weather. A cessation of growth rate after 22nd—23th July was so simultaneous overall in the colony that there is reason to believe it was caused by weather conditions or by sudden failure of food supply. Unfortunately, we were not able to examine possible changes in marine food supplies. However, temperature tended to increase from 26th July to the end of the month. The cessation of growth and widespread mortality could not have been caused by this factor. However, the sky was overcast on most of the days during this period and this may have adversely affected visibility of prey by foraging parents. SPRINGETT, SPRIGGS & LANGHAM (according to a report of a meeting of British Ornithologists' Union, Ibis 110: 234. 1964) emphasized that overcast weather clearly had a more negative effect than strong winds on the growth of chicks of the Arctic Tern. The negative effect of overcast conditions was noted by HAWKSLEY (1957). Further-

more, CLINE *et al.* (1969) observed in the Weddel Sea, Antarctica, that on days with heavy fog or strong winds Arctic Terns frequently rest on ice floes without feeding.

The results of the weight measurements showed that the single and first-hatched fraternal chicks were able to endure a shortage of food for about four days without incurring weight-loss. After this, weight began to decline very quickly and death by starvation followed after some days.

The food of the Arctic Tern on Spitsbergen was quite different from that recorded in the more southern parts of its distribution range. Crustaceans were the most important food at Ny Ålesund in the present study. BURTON & THURSTON (1959) and DE KORTE (1972), analysing some stomach contents of Arctic Terns on Spitsbergen, found only traces of crustaceans and polychaetes. According to HARTLEY & FISHER (1936) the terns in West Spitsbergen feed their young mainly on crustaceans, especially the species *Thysanoessa inermis* and *Gammarus locusta.* Crustaceans and other invertebrates are also considered by LØVENSKIOLD (1964) to be important in the diet of the Arctic Tern.

On the other hand, on the coasts of the North Sea the food consists very largely of fish. According to BOECKER (1967) and PEARSON (1968) the proportion of fish in the diet is about 50—95 per cent. In the Baltic Sea the most common food species is the three-spined stickleback *Gasterosteus aculeatus* (Lemmetyinen in prep.). On the arctic coast of the Barents Sea fish comprised about 65 per cent of the food of the Arctic Tern (BELOPOLSKII 1961).

Therefore it seems likely that the importance of crustaceans in the diet of the terns on Spitsbergen results from the greater availability of crustaceans compared with fish. Clupeidae and Ammodytidae, for example, which are the most important fish species taken by Arctic Terns in the North and Barents Seas (BELOPOLSKII 1961, BOECKER 1967, PEARSON 1968) occur only sparsely or are entirely absent (HOGNESTAD 1961, PARRIS & SAVILLE 1965).

BOECKER (1967) showed that Arctic Terns at Wangerooge fed their small young, less than one week old, almost entirely on fish food. Not until the chicks were older did parents begin to feed them on crustaceans, too. This is also emphasized by BELOPOLSKII (1961) for the chicks of the Herring Gull *Larus argentatus* and Great Black-backed Gull *Larus marinus* "as well as those of many other birds".

According to BOECKER (1967) small chicks with incompletely developed thermoregulation and plumage have a special need for fish food of high caloric contents (cf. SPAANS 1971). This is true especially in northern areas with colder climatic conditions. In this respect the isolated island group of Spitsbergen may be a less favourable nesting area for terns than the other coasts of the Arctic Sea, where in general marine production is very high (ASHMOLE 1971, DUNBAR 1968). At Ny Ålesund the apparent shortage of fish food had a striking effect on growth-rates and mortality of young chicks at a time when weather conditions were only slightly unfavourable.

Aknowledgements

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formation on Spitsbergen and Dr. Pauli Bagge for his assistance to identify the food samples.

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Selostus: **Lapintiiran poikasten kasvu ja kuolleisuus Kongsfjordin alueella, Huippuvuorilla, vuonna 1970.**

Lapintiiran poikasten kasvua ja kuolleisuutta tutkittiin Ny Ålesundin kylässä Huippuvuorilla 11.—31.7.1970 välisenä aikana. Kyseisenä aikana alueella vallinneet sääolosuhteet on esitetty taulukossa ja kuvassa 1. Tutkimusta varten aidattiin yhteensä 46 pesää. Pesät kontrolloitiin päivittäin. Poikasten kuoriuduttua nämä punnittiin jokaisen kontrollikäynnin yhteydessä. Keskimääräinen pesyekoko oli 1.83 ± 0.06. Kuoriutuminen alkoi 16.7. ja jatkui heinäkuun loppuun asti (kuva 2). Aidatuissa pesissä munista kuoriutui 95.7 %, mikä todennäköisesti oli suurempi kuin vastaava luku koko yhdyskunnassa. Petojen ei todettu saaneen aikaan munatappioita. Pesyeeen ensimmäisen ja toisen munan välinen kuoriutumisaika oli keskimäärin 1.78 ± 0.14 vrk., mikä oli merkitsevästi pitempi kuin vastaava aika Lounais-Suomen saaristossa (1.19 ± 0.10). Kaksi poikasta sisältäneissä pesyeissä vanhempi painoi välittömästi kuoriutumisen jälkeen 13.3 ± 0.2 g ja nuorempi 12.3 ± 0.3 g. Ensiksi kuoriutuneiden poikasten keskuudessa painon kehittymisessä oli erittäin suuria yksilöllisiä eroja. Sen sijaan erittäin harvat nuoremmista poikasista kykenivät lainkaan lisäämään painoaan (kuva 3). Poikasten keskimääräinen kasvu oli Huippuvuorilla selvästi hitaampaa kuin Suomessa. Esim. kuuden vuorokauden ikäiset poikaset painoivat Huippuvuorilla keskimäärin vain noin 50 % samanikäisten suomalaisten tiirojen painosta (kuva 3). Lapintiiran ravinto käsitti pääasiassa pieniä äyriäisiä, joista runsaimmin tavattiin lajia *Gammarus setosus*. Kalaravinnon osuus oli vähäinen (taulukko 2). Poikaskuolleisuus oli noin 75—80 % (kuva 2). Suuri kuolleisuus johtui todennäköisesti ravinnon puutteesta, minkä aiheuttivat ainakin osittain epäedulliset sääolosuhteet, erikoisesti pilvisyys (kuvat 1 ja 4). Petojen merkitys poikaskuolleisuuteen oli erittäin vähäinen.

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SLY:n uusi kenttäornitologinen lehti

Ornis Fennican muututtua viime vuosina yhä puhtaammin tieteelliseksi, kongressikieliseksi julkaisuksi, on helppotajuisemman, harrastelijoita kiinnostavan lehden tarve käynyt yhä ilmeisemmäksi. Viime vuoden lopulla SLY:n johtokunta teki päätöksen kenttäornitologisen lehden perustamisesta Ornis Fennican rinnalle. Ajatus oli ollut vireillä jo kauan, mutta se kypsyi päätökseksi vasta kun nuorisojaosto oli ilmoittanut haluavansa luopua Lintumiehen toimittamisesta. Valitettavasti päätös tehtiin niin myöhään, että vasta tämän vuoden puolella päästiin valitsemaan lehdelle toimittajat ja toimituskunta sekä aloittamaan aineiston hankinta. Kun vielä eräät käytännön hankaluudet viivyttivät alkuun pääsyä, kävi pian selväksi, ettei neljän numeron vuosikertaa saataisi kokoon kuluvana vuonna. Tästä syystä päätettiin aloittaa lehden julkaiseminen vasta vuonna 1973. Ykkösnumero tulee ilmestymään heti tammikuussa ja seuraavakin kevään kuluessa.

SLY:n uuden kenttäornitologisen lehden nimenä tulee säilymään nuorisojaoston lehdeltä peritty Lintumies. Se pyrkii monipuolisesti tarjoamaan uutta tietoa maamme linnustosta ja lintutieteen tutkimustuloksista sekä huolehtimaan lamassa olleesta faunistisen aineiston julkaisemisesta. Paljolta lehden sisältö ja taso tietenkin määräytyvät sen mukaan, miten paljon ja miten hyvää aineistoa siihen tarjotaan. Tässä mielessä SLY:n johtokunta vetoaakin kaikkiin maamme lintumiehiin ja paikallisyhdistyksiin kirjoitusten, tiedonantojen ja valokuvien saamiseksi.

Uuden Lintumiehen toimituksesta vastaa seuraava organisaatio: päätoimittaja O. Hildén, toimitussihteeri L. Laine, osastotoimittajat P. Linkola (lintusuojelu) ja I. Stén (rengastus). Päätoimittaja huolehtii varsinaisten tehtäviensä ohella myös faunistisen osaston toimittamisesta. Lisäksi on tarkoitus luoda todella aktiivinen ja koko maan kattava avustajien verkosto, joka vastaisi aluekohtaisen aineiston kokoamisesta ja lähettämisestä toimitukselle. Periaatteessa useimmat paikallisyhdistykset ovat luvanneet huolehtia tällaisen aineiston hankinnasta valitsemansa yhdysmiehen välityksellä, ja on vain toivottava, että tämä myös käytännössä toteutuu.

Lintumiehen tilausmaksuksi on vahvistettu 10 mk. Ensimmäinen numero tullaan postittamaan kaikille Ornis Fennican ja Lintumiehen tilaajille, ja sen mukana lähetetään tililleppanokortti. Ne, jotka jo ovat suorittaneet vuoden 1972 tilausmaksun, saavat vuosikerran 1973 lisämaksutta.

SLY:n johtokunnan puolesta

OLAVI HILDÉN