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A radar study of the spring migration of the Crane (*Grus grus*) over the southern Baltic area

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1. Introduction

In April 1972 a study of the bird migration over southern Scandinavia and the southern Baltic Sea was carried out using simultaneous field and radar observations. The study was part of an investigation in progress in view of future warning and forecast systems for collisions between aircraft and birds. This investigation is a joint project between the Board of Civil Aviation, the Swedish Air Force and the Ornithological Society of Skåne, incl. Falsterbo Bird Station.

The hours selected for the field observations (06.00–11.00 and 14.30–18.30 hr) were not ideal in relation to the diel pattern of migratory activity of Cranes, and hence few field records were gathered. But the radar, filmed continuously throughout the 24 hrs of the day, showed frequent Crane movements. Echoes from Crane flocks were rather easy to identify, and there is reason to believe that the radar monitoring gave a fairly complete picture of the Crane passage over the area.

Schüz (1971) gives a summary of the broad pattern of Crane migration through Europe. European Cranes winter on the one hand in Spain, Portugal and western North Africa, on the other hand in the Nile Valley. If Scandinavian Cranes frequent both these areas and, if so, in what proportions, is not known.

During spring migration Cranes are known to rest in large numbers along the southern coast of the Baltic, notably on the island of Rügen. In southern Sweden, Lake Hornborgasjön is another important resting locality where several thousands of Cranes gather in April displaying and mating (Frändén 1958, Swanberg 1970).

The extensive use of radar monitoring allowed a detailed study of the passage of migrating Crane flocks from near the German Baltic coast up to and including the province of Skåne in southern Sweden. The most westerly flocks were seen over Zealand in Denmark, and the most easterly ones over the island of Bornholm.

2. Methods

From 4 to 23 April an L-band radar station in Skåne was filmed with time-lapse technique (2.5 frames/min.). The station was used with a range of 135 km, and the area covered is shown in Fig. 1. The same station has been used in earlier investigations and further data and general methods of analysis are described by Alerstam & Ulfstrand (1972) and Alerstam et al. (1974).

The radar is equipped with an MTI (moving target indicator)-system, which prevents slow and weak echoes from being registered on the PPI (plan position indicator).

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[1] Report No. 53 from Falsterbo Bird Station.

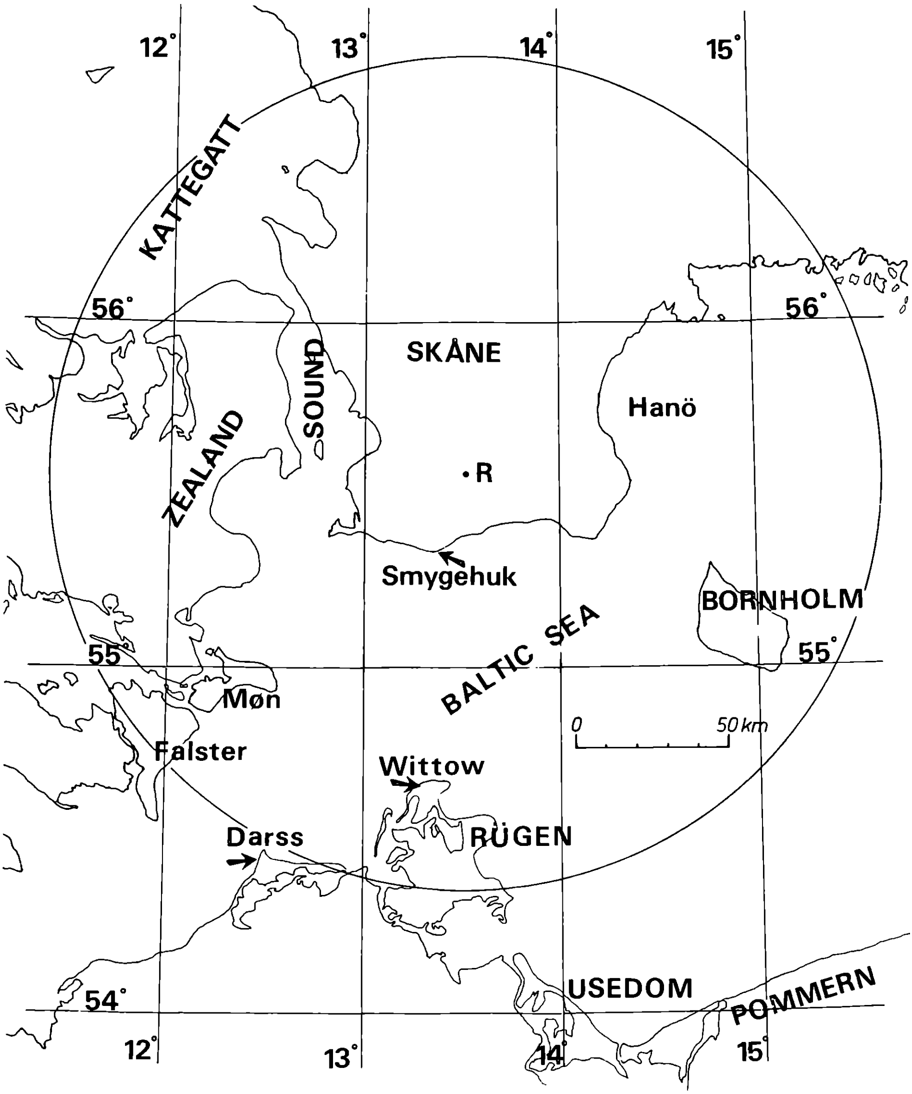


Fig. 1: Study area. The radar was situated at R and the area seen on the PPI is indicated. – Untersuchungsgebiet. R = Radarstation, Kreis = auf dem PPI abgebildetes Gebiet.

This system might lead to flocks of birds flying slowly, for example in headwind, being unregistered on the PPI. One might thus draw the wrong conclusion that the birds in question migrate only with following winds. There is still another factor contributing to the possibility of such misleading conclusions, viz. the tendency of birds to fly at lower altitudes, possibly below radar coverage, with headwind. With respect to the Crane, however, we regard these sources of error insignificant for the following reasons:

(1) From earlier experience, using the radar described above, it is evident that flocks of Cranes travelling 50–70 km/h should be unaffected by the MTI-system. In this study relatively few flocks were found migrating that slowly, and it seems improbable to us that flocks travelling even more slowly would occur to any large extent.

(2) Crane flocks migrating low (20—100 m) over the water surface off the south coast of Skåne were probably registered on the radar-PPI as low-altitude coverage in this area was very good, indicated by the registration of flocks of Eiders, *Somateria mollissima*, migrating along the coastline as well as of ships off the coast.

(3) Although sparse, field records of migrating Cranes during the period of investigation in Skåne are from days when radar showed migratory activity (cf. p. 14).

The ground speeds were calculated by tracing single echoes 20—60 km over the Baltic region and reading the time to the closest full minute. The flight distance was approximated to a straight line and thus represented the minimum distance. Only measurements with no noticeable deviations of the tracks were used for ground speed calculations. The maximum possible error of any calculated value is ± 10 %.

3. Identification of echoes

The prime clue for identification of Crane flocks on the radar was the geographical pattern of echoes moving almost due north-south, in this respect differing from almost all other migratory patterns in this area. Naturally some small fraction of the echoes accepted as Crane flocks in this study may have represented other species, but we cannot think of any other species during the season in question which would move as to create the echo pattern just described and, in addition, occur in numbers large enough to seriously interfere with our interpretation.

Most echoes were first seen near Rügen, but some appeared to the west and east of this island; irrespectively of their point of departure all of them behaved in a similar fashion. One day markedly differed from the usual pattern, viz. 5 April, when only few echoes departed from Rügen, while the majority moved west of Rügen and over Denmark on a NNE course. We believe that also these latter echoes represented Crane flocks, since smaller numbers of echoes travelling over the same area were seen also on other days with Crane migration and, moreover, their true air speed exactly agreed with indisputable Crane echoes. Furthermore spring migration of the Crane is known to take place in eastern Denmark (Salomonsen 1967).

During the study period migrating flocks of Eider were the most frequent source of distinct echoes. This species is dealt with in a separate paper where the whole problem of echo identification is discussed in further detail (Alerstam et al. 1974).

4. Passage over the Baltic and Skåne

The echoes of Cranes were frequently detected at distances of up to 120 km from the radar station across the Baltic, i. e. when the flocks were over land at Rügen or immediately off the German coast. Flocks were also noted crossing the easternmost Danish islands. The long-range coverage of the radar permits a broad outline of the proximate departing areas of the Cranes migrating through south-western Sweden (Table 1). Echoes from Pommern were noted on only one day, moving NW—NNW with a SE wind, arriving at the southeastern corner of Skåne.

Table 1. Travelling routes of the Cranes (Zugwege des Kranichs):

Travelling route	Per cent of all echoes
1. over eastern Zealand	5 %
2. over or very close to the islands of Mön and Falster	5 %
3. through the sound between Falster (Denmark) and Germany	9 %
4. from west of Rügen, dominantly from the peninsula of Darss	14 %
5. from Rügen (including Hiddensee), dominantly from the peninsula of Wittow, western Rügen	61 %
6. from immediately east of Rügen (probably the island of Usedom)	5 %
7 from Pommern (some passing Bornholm)	1 %
	100 %

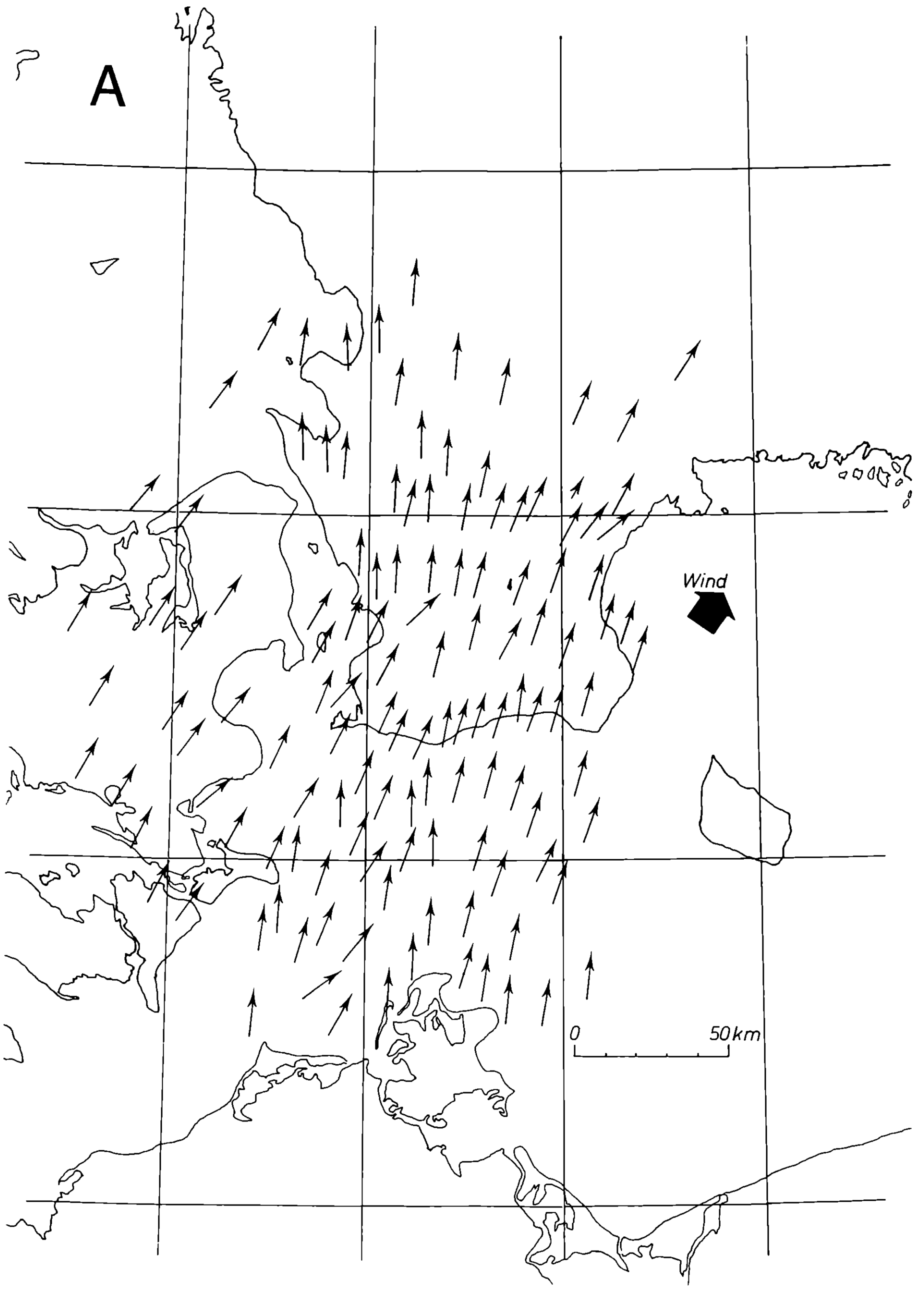
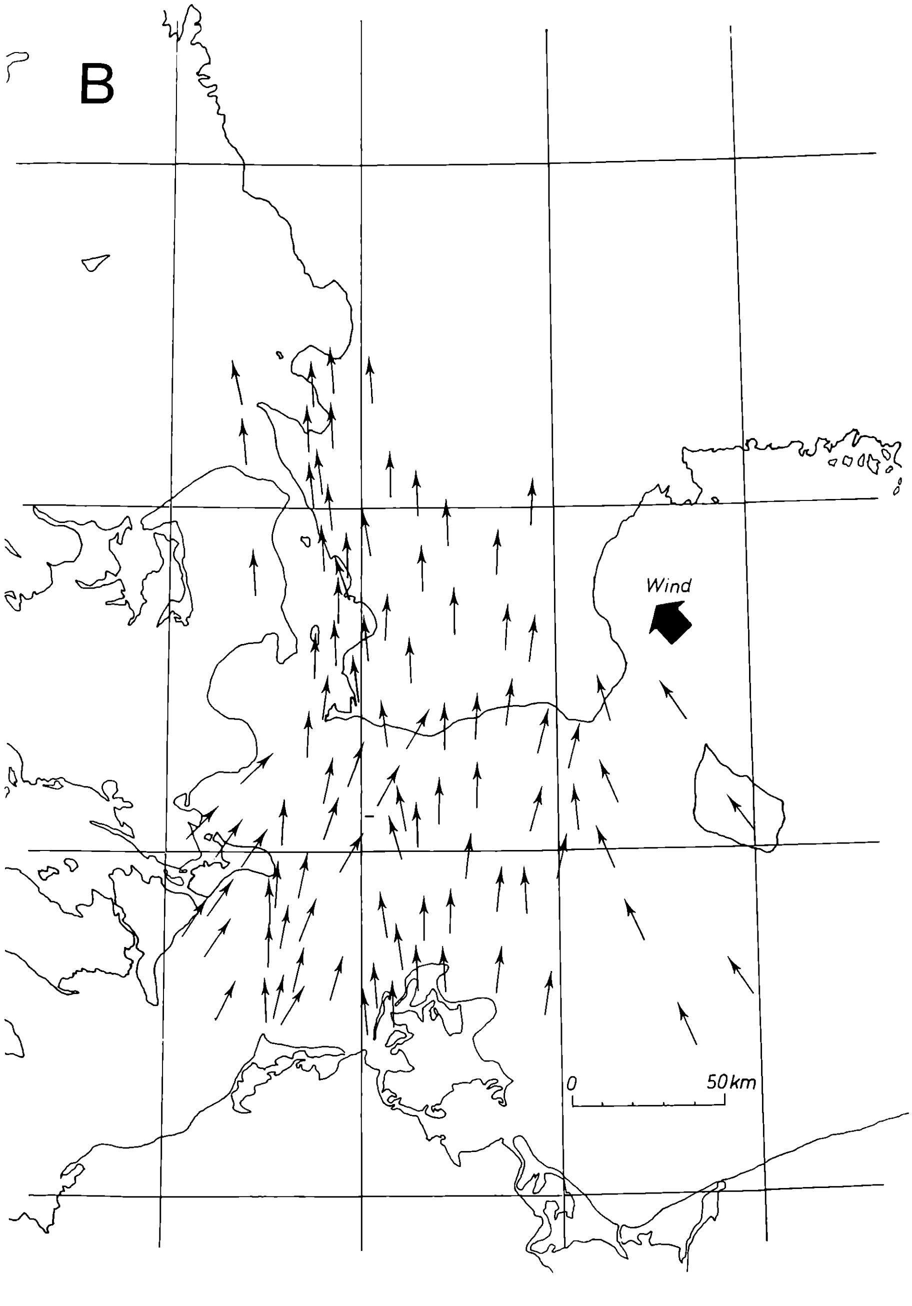
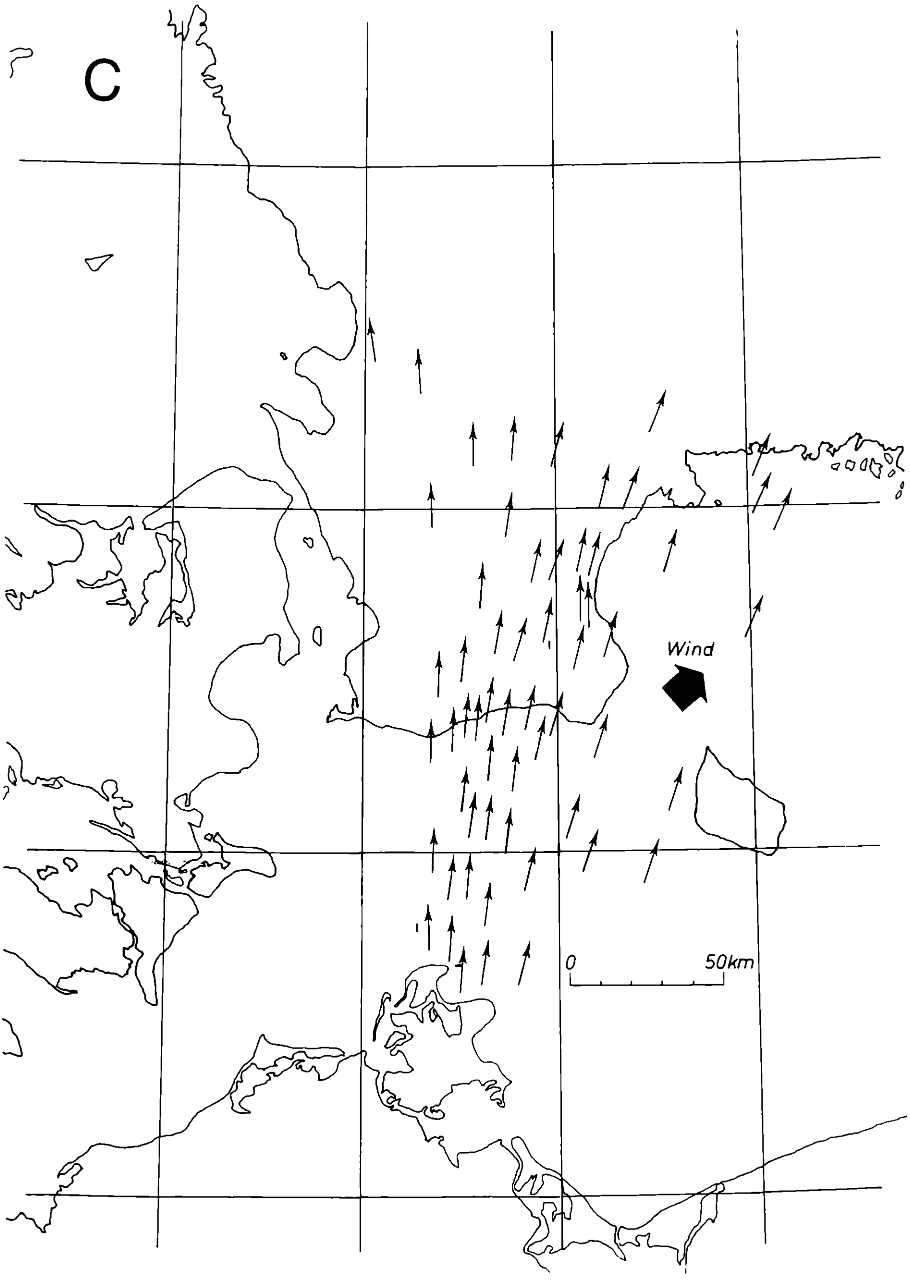


Fig. 2: A – D. Radar patterns of Crane migration. Two days with rather heavy migration are illustrated, A: 6 April, B: 15 April and two days with medium or sparse migratory activity, C: 9 April, D: 12 April. – Radar-Zugmuster des Kranichs. A, B: 6. bzw. 15. April, zwei Tage mit starkem Zug; C,D: 9. bzw. 12. April, zwei Tage mit mittlerem bis schwachem Zug.

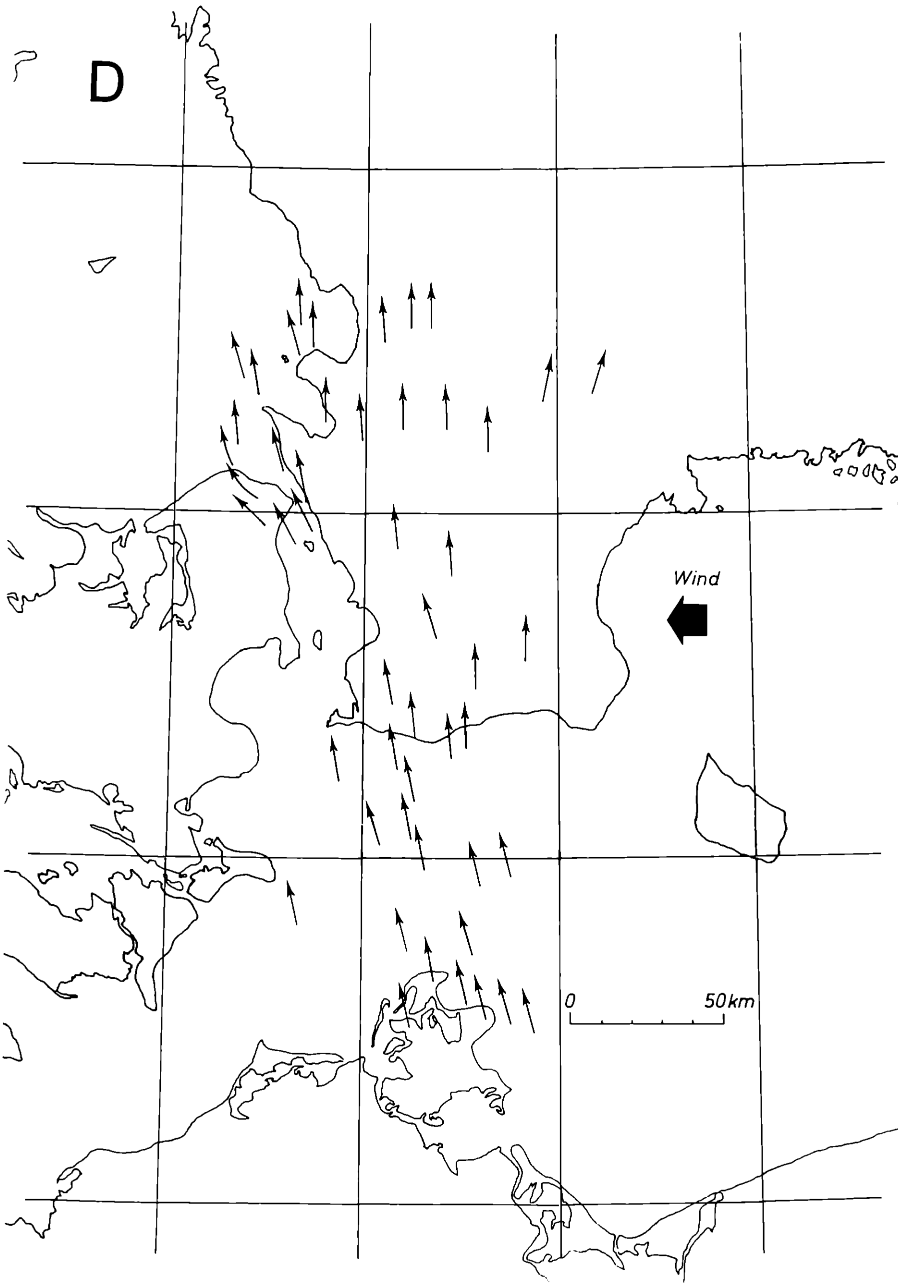


Most of the Cranes crossed the Baltic from Rügen, a distance over open sea of approx. 75 km. The Cranes from west and east of Rügen crossed approx. 105 and 150 km of open sea respectively.

The general pattern of the Crane migration over Skåne is illustrated in Fig. 2 A—D. The Cranes moved inland over the entire length of the south coast. Flocks, however, preferentially crossed the coast-line some 5—20 km east of the southern-



most point (Smygehuk). Many echoes were seen following the west coast of Skåne, some having arrived from over the Sound, and later crossing the bays in the northwestern part of the province. Some echoes departed from Zealand or the northwesternmost peninsula of Skåne northwards over the Kattegatt. Few birds migrated over the southeasternmost corner of the province. Rather many flocks travelling over land reached the coastline of the bay of Hanö and were then usually deflected northwards



along the coast. Few echoes were seen crossing the sea east of Skåne. Most of the echoes, however, crossed Skåne on almost due northerly courses, without contact with any coastlines.

It has been mentioned that the Lake of Hornborgasjön is a resting place of outstanding importance during the spring migration. The lake is situated approx. 300 km from the radar station at a longitude of 13°30′, i. e. due north of the station and the place of most intensive passage over the south coast (cf. Figs. 1 and 2, where the longitudes 12°—15° are drawn). It is obvious from Figs. 2 A—D that many echoes do not move towards this resting locality. One might broadly assume that Cranes leaving the province of Skåne northwards west of long. 14° will migrate west of the large lake of Vättern and hence not very far from Hornborgasjön. Cranes moving east of this longitude will migrate east of Vättern and cross central Sweden without contact with Hornborgasjön. Of the echoes noted in this study 65 % left Skåne west of long. 14°, 35 % east of this long.

On at least three days, echoes moving due north first appeared over the inland of middle and northern Skåne, apparently consisting of Cranes having rested for the night in Skåne. At least 120 such echoes were noted (on 11, 12 and 13 April).

5. Diel pattern of migration

The echoes of Cranes were counted over the Baltic in the area 10—20 km north of Rügen and the diel distribution of passages is presented in Fig. 3. Most of the echoes had left Rügen less than 15 min. before the time given in the figure, but flocks of Cranes from west or east of Rügen had departed from the German coast generally 30 min. before this time. The temporal distribution of passages inland over the south coast of Skåne was delayed with about 45 min. in relation to Fig. 3.

As seen from the figure departures from Germany were noted between 05.30 and 14.00 hr. Very sparse migratory activity occurred outside this interval, and migration during the night was never recorded.

On several days the distribution of migratory activity was bimodal. One peak occurred between 06.00 and 08.30 hr and the other between 10.00 and 14.00 hr. On other days only one of these peaks was noted. On one day no distinct peak was recognizable but activity was noted from 06.00 hr onwards, while peak activity on another day was recorded between 09.00 and 10.00 hr. As shown in Fig. 3, the period of heaviest migration was at 10.00—13.30 hr.

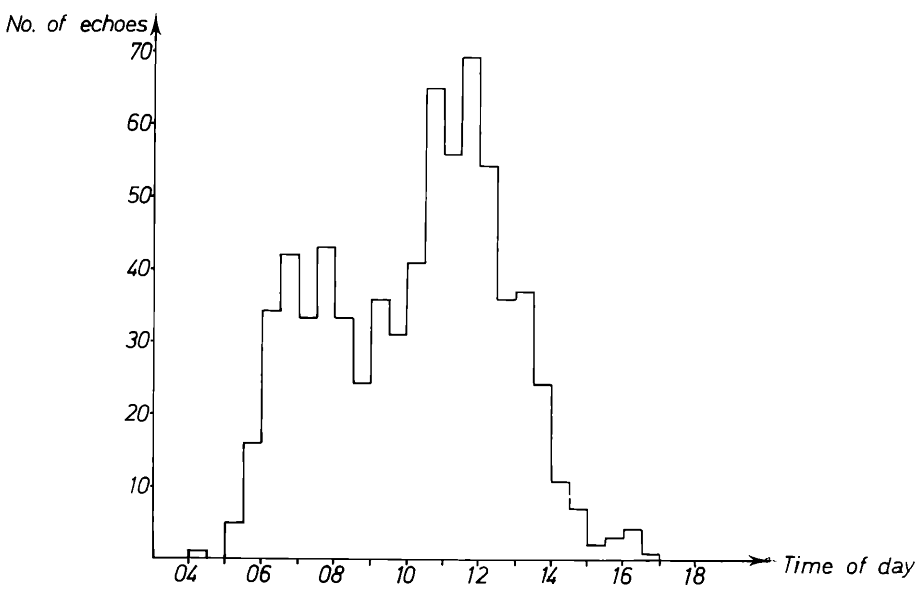


Fig. 3: Diel distribution of migration. No. of passages over the Baltic in the latitude immediately north of Rügen. — Tageszeitliche Verteilung der Durchzügler unmittelbar nördlich von Rügen.

One explanation of the bimodal distribution of activity might be that all Cranes start migrating at around the same time but depart from different areas separated by a distance covered by the Cranes in 4–5 hours. This would mean that the two areas would be 300–500 km apart (p. 13). However, to our knowledge no important resting places are found in Germany except in the coastal areas along the Baltic so this explanation is probably not correct. Cranes having rested scattered over wider areas may, however, depart at different hours and give rise to the temporal pattern observed off the German coast. Still another explanation might be that the Cranes resting on Rügen or on the German coast depart rather soon after sunrise and again to a large extent towards noon. The causes of this pattern are not known, but Cranes migrating later during the day could use thermal air to gain height over land areas. It is interesting to note, that a bimodal migratory activity pattern with one peak around or just after sunrise and another around noon is exhibited most typically by the Sparrow Hawk, *Accipiter nisus*, but similar tendencies are found with for example the Common and Honey Buzzards, *B. buteo* and *Pernis apivorus*, and the Kite, *M. milvus*, as described by Rudebeck (1950) from Falsterbo in autumn. The early morning birds flew actively at rather low altitudes, but the peak at noon consisted of birds soaring in thermal air.

The existence of two different modes of migration might be a frequent characteristic of bird species that make use of vertical air streams not indispensably but more or less often, to gain height and minimize energy consumption. It should be remarked that the discussion above is speculative and the bimodal diel pattern in this area has to be confirmed and the explanation definitely determined in future investigations.

Finally, on 10 and 11 April a number of echoes were noted between 14.00 and 17.00 hr and on 11, 12 and 13 April departures were noted from Skåne in the morning (cf. p. 8). This suggests that roosting does not occur in Skåne to any significant extent except if flocks arrive to the province late during the day. From this it follows that Cranes do not usually continue to fly late in the evening or during the night in the region studied.

One might speculate that if migration generally ceased around 16.00 hr, the morning birds could cover a distance of up to 600 km during a day, while birds starting towards noon would cover 300 – 400 km. In both cases the Cranes might well reach Hornborgasjön, 400 km north of Rügen, in a single day's flight.

6. Weather conditions during Crane migration

The present data are too sparse to permit any general conclusions concerning the effects of weather on the migration of Cranes, but some interesting aspects are briefly discussed below.

Wind conditions seemed to play an important role influencing migratory activity. As seen from Fig. 4, migration preferentially took place on days with southerly winds. Whether wind direction was slightly west of south or east of south did not seem to matter.

It is easy to appreciate the advantages of migration during tail-wind conditions. As the ground speed of the birds increases and hence the energy consumption per unit of distance covered decreases with stronger tailwinds, it seems reasonable to relate the migratory activity to the expected ground speeds of the birds (Fig. 4). Whether the combination of force and direction of the wind influences the activity or only the direction, cannot be determined.

As is seen from Fig. 4, the five days with most intensive migration were also those with the ground speeds of Cranes flying approximately due north to the largest extent exceeding the air speed (in Fig. 4 assumed to be 60 km/h). The theo-

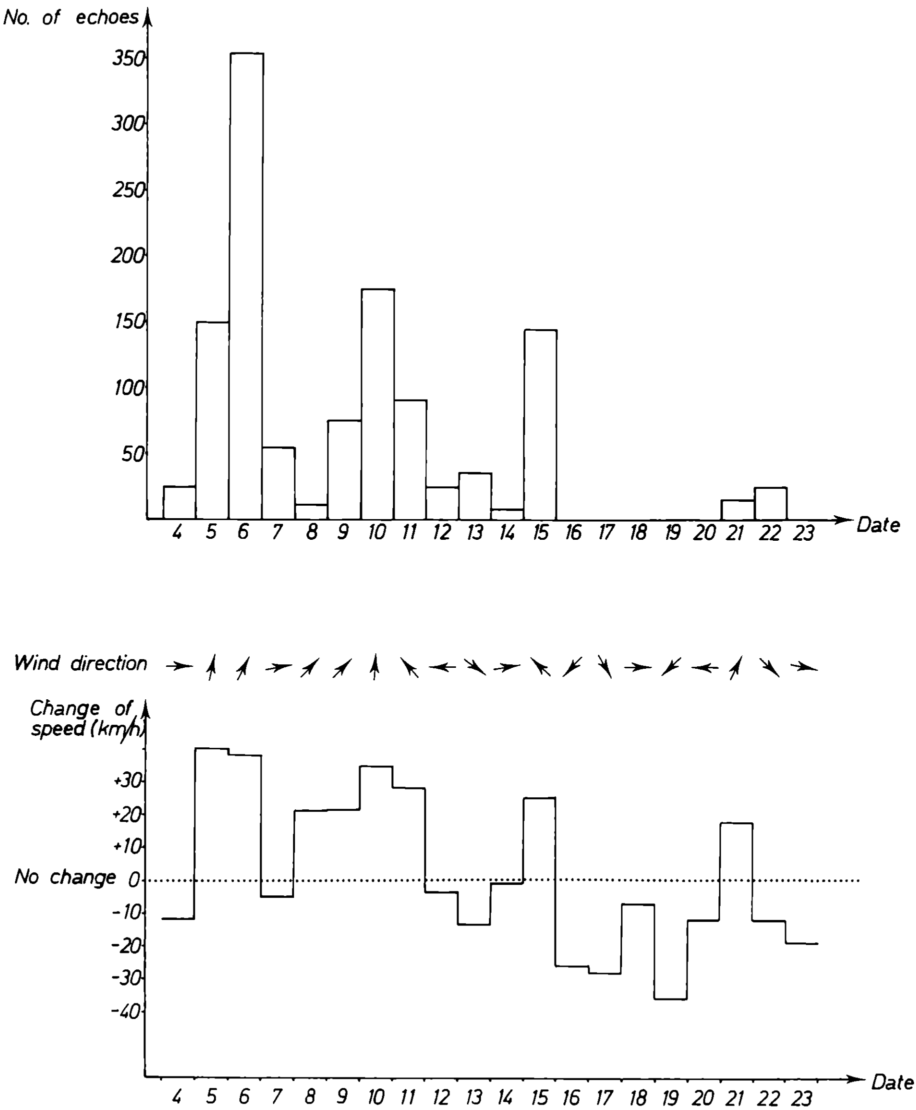


Fig. 4: The magnitude of the daily passage of Cranes (top diagram) in relation to wind direction and the expected ground speed of the Cranes (bottom diagram). The bottom diagram shows the divergence of ground speed from the air speed (assumed to be 60 km/h) for Cranes moving due north. + 20 thus indicates that the birds on that day were expected to move with a ground speed of 80 km/h, – 20 indicates an expected speed of 40 km/h. – Umfang des täglichen Kranichzugs (oben) in Beziehung zur Windrichtung (unten). Das untere Diagramm zeigt ferner die Differenz zwischen der Geschwindigkeit über Grund und der angenommenen Eigengeschwindigkeit von 60 km/h für genau nach N ziehende Kraniche, z. B. + 20 bzw. – 20 bedeutet somit: Es wurde angenommen, daß die Vögel mit einer Geschwindigkeit über Grund von 80 bzw. 40 km/h zogen.

retical ground speed on those days was calculated to 85—100 km/h and indeed many flocks were observed to travel with speeds 80—115 km/h (Fig. 6, p. 13), the difference being due to the fact that only Cranes on a due northerly track were considered when calculating the expected ground speeds.

Cranes have been observed to fly under extremely windy conditions. Libbert (1948) recorded a flock of Cranes drifting in front of a thunderstorm in North Africa as having a ground speed of approx. 200 km/h.

It might from our data be assumed that tailwind conditions favour extensive Crane migration over the Baltic. This preference for tailwinds is very similar to the situation found for Eider (Alerstam et al. 1974), Common Scoter (*Melanitta nigra*) and Long-tailed Duck (*Clangula hyemalis*) (Bergman & Donner 1964). Diurnal migration of passerines as seen on the radar is strongly reinforced with tailwinds, but it is known that large numbers of birds also migrate at low altitudes below radar coverage in the presence of headwinds (Alerstam & Ulfstrand 1972).

No other weather factor had any obvious influence on Crane migration. Considerable activity was found under various cloud conditions, but migration did not coincide with extensive rain or fog.

7. Compensation for wind deflection

At the radar PPI the pattern of Crane migration under varying wind conditions could be conveniently studied. Fig. 2 illustrates the patterns on four days, and the wind directions are also indicated. From this figure it can be easily seen that the pattern varies with different wind conditions. Thus, over Skåne, the „centre of migratory gravity" is moved westwards with easterly winds and eastwards with westerly winds. On every day with Crane migration this rule was followed.

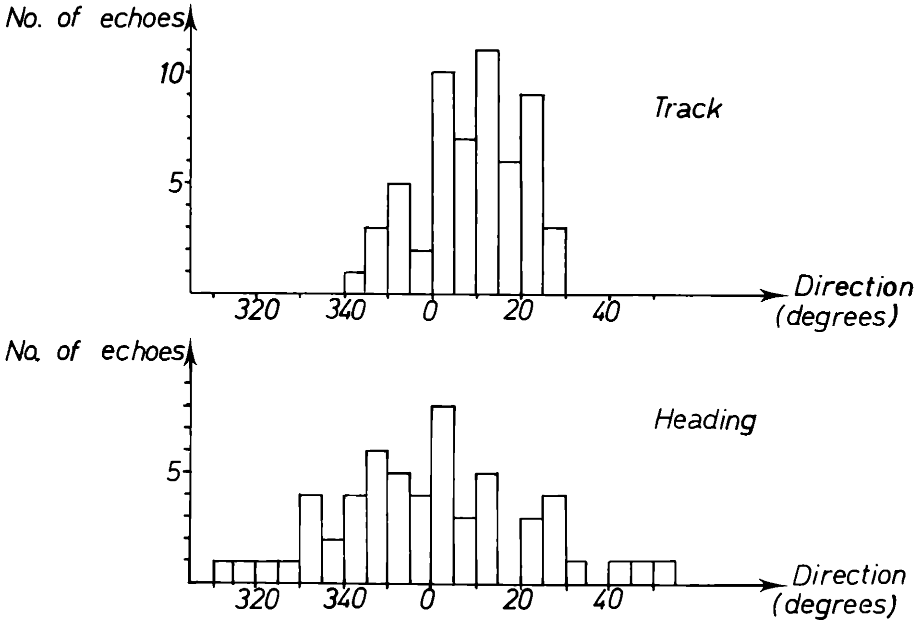


Fig. 5: Routes and calculated heading directions over the Baltic of Cranes having arrived from the island of Rügen. — Zugrichtungen und berechnete Kursrichtungen von Kranichen über der Ostsee, von Rügen kommend.

For the echoes from Rügen, the track and heading directions over the Baltic have been calculated and are shown in Fig. 5. It should be pointed out that no drastic or sudden changes of flight courses, suggesting that the birds would turn towards land when attaining visual contact, were ever seen. Thus, the track directions of the echoes were about the same close to Rügen as when approaching the southern coast of Skåne, as also illustrated in Figs. 2 A—D.

The track directions are concentrated on 50° around north (340°—030°), but the headings are scattered over the double width. This strongly suggests that Cranes do compensate for wind. One should be aware of the possibility that following winds could narrow the scatter of track directions in relation to heading directions with no need of assuming compensatory behaviour on behalf of the birds. This effect, however, could not account for the differences in this study as wind forces in relation to the air speed of the birds were too low and in many instances this effect could be entirely ruled out because of the direction of the wind. If Cranes were to leave Rügen on tracks west of 340° or east of 030° the passage over open sea would be extended, as the birds would not reach the south coast of Skåne but continue over the Sound or over the Baltic east of Skåne. Presumably selection would discourage unnecessarily long over sea travels.

Hence, on the one hand the large scatter of heading directions indicates compensation of wind deflection, but on the other hand this is contradicted by the overall geographical pattern of the migration which clearly is affected by prevailing wind directions. What conclusions can be drawn from these seemingly conflicting facts? One possibility is that Cranes only incompletely compensate for deflection. Another alternative is that different populations of Cranes blending at the resting localities have different primary directions and thus prefer different wind conditions for their movements. If this model of „selective population migration" (Nisbet & Drury 1967) is valid, compensation for wind drift may be complete. In accordance with the second alternative, the scatter of track directions of Cranes from Rügen would represent the scatter of preferred tracks (or primary directions) for the different populations of Cranes using this island as a stop-over.

Thus, the present study supports Bergman's (1964) contention that Cranes do compensate for wind deflection but could not provide an answer to the question whether this compensation is complete or not.

8. Speed of Cranes

The ground speeds of up to 20 echoes per day from Cranes were measured when crossing the open Baltic sea (Fig. 6). As can be seen the Cranes migrated surprisingly fast, predominantly between 80 and 115 km/h. This illustrates the coincidence of migratory activity with tailwinds (cf. p. 9). Thus the Baltic was regularly crossed in 45—60 min. The ground speed over land in Skåne on some occasions tended to be lower than over the Baltic, but on other occasions no differences were found. Presumably flocks sometimes circled over land in thermal air currents to gain height and in so doing, reduced their ground speed.

When trying to estimate the air speeds of the Cranes, there is a number of sources of possible errors. The wind data used were based on the conditions at Malmö at 600 m altitude and ground data from several weather stations in Skåne as well as ground data from synoptic maps over E Denmark, N Germany and Poland. Generally the data from 600 m were slightly modified on account of ground wind conditions in the Baltic region. The wind data that were used when calculating the air speed of the Eider during the same period were practically identical (Alerstam et al. 1974). Unfortunately no information on the altitude of Crane migration was available. Con-

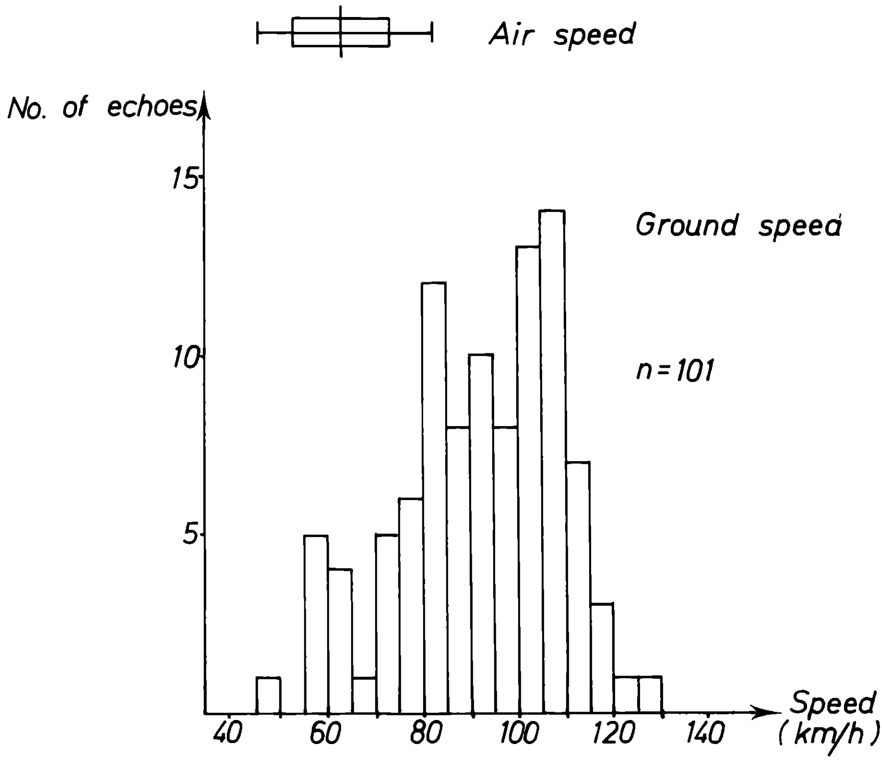


Fig. 6: Speed of flocks of Cranes over the Baltic. The mean value of the calculated air speeds is indicated as well as the width of variation and the standard deviation. — Geschwindigkeit von Kranichen über der Ostsee. Von der Eigengeschwindigkeit sind berechneter Mittelwert, Variationsbreite und Standardabweichung angegeben.

sequently there is no way of telling what wind conditions were really encountered by the birds, but we believe the wind data to be realistic. The air speed of Eider flocks was in the same way calculated to be 74 km/h, a figure that is in good accordance with other measurements (Alerstam et al. 1974). This is a support for the corresponding value of the Crane to be correct.

The air speed of the Cranes over the Baltic was calculated to 63 km/h (s = 10, n = 92). Libbert (1936) obtained an air speed of 51 km/h using reports from an advancing front of Cranes through Germany over a distance of 370 km. The figure was approximate as no single flock could be followed separately. Furthermore, it is a minimum figure, as it was assumed that the birds moved in a straight line, which, as Libbert also pointed out, was not the case. In the present investigation, the ground speed was noted on some instances to be significantly reduced over land, possibly indicating circling behaviour (cf. above). Mildenberger (1950) gives 12 values of ground speeds of Cranes over the area of Köln in spring. Using his figures of wind direction and force to calculate air speeds one obtains values of 41—86 km/h. Obviously the method used was too inaccurate to give any reliable estimate of the air speed. Bergman (1964) stated that the speed of the Crane did not exceed 50 km/h but did not explain on what data this statement was based. We thus consider the true air speed of the Crane to be approx. 60—65 km/h.

9. Numbers of Cranes

It may seem questionable to deal with quantities of birds from counts of echoes on the radar PPI. We, however, regard the estimates of numbers of Crane echoes as very accurate on the grounds of the easily recognizable, distinct and persistent type of echoes.

Since some years P. O. Swanberg (in litt.) has collected observations of migrating Cranes through appeals via press and radio. No public enquiry was sent out in spring 1972, but anyhow 48 „casual" observations were reported from Skåne. Seven observations were from before the investigation period and one was from after it. Consequently, by far the most of the Crane migration occurred during the study period. Of 81 reports (casual and systematic observations, cf. below) from the study period, only five were from days when no migration was recorded on the radar. This supports the assumption that the radar reflected all important movements of Cranes.

Under the premises stated above, it must be justified to speculate broadly on Crane numbers passing the southern Baltic and composing the Scandinavian population. Totally during the period 1190 echoes were counted, each regarded as a flock of Cranes. The number of echoes can be transformed to number of individuals by multiplying with the mean flock size.

The casual observations, discussed above, showed a mean flock size of 53. Swanberg received many reports in the spring 1968 from Skåne and from 268 flocks the mean size was calculated 64. These figures must, however, be considered to be too high, as one must assume errors to arise from the different detectability of small and large flocks, but also due to large flocks being much more frequently reported than smaller ones. Flock sizes up to 500 individuals were reported.

Continuous field observations were conducted during the investigation period in the morning and afternoon (Alerstam et al. 1974). Errors from such „systematic" observations must be considered much less, since the observers report Crane observations regardless of flock size. Variable detectability also is probably less important. 41 flocks were noted during these observations and mean flock size was 23. The largest flock size was 90. Unfortunately the data are too few — another observation of a flock of 300 birds, which is known from the casual observations to have occurred (Swanberg, in litt.) would have raised the mean flock size to 30. It is legitimate to include small flocks and single individuals when calculating the mean flock size, as they probably give rise to echoes.

In conclusion, it is reasonable to expect the true mean flock size to be between 20 and 40 birds. This would mean that no less than 24 000 but hardly twice as many Cranes passed the region of the southern Baltic during the study period, and these numbers would also be an estimate of the total Scandinavian population of Cranes. For comparison it could be noted that approx. 6 000 Cranes were noted resting at Hornborgasjön during the spring of 1972 (Swanberg, pers. comm.). Thus no more than 25 % of the Scandinavian Cranes rested at this lake.

It would be interesting not only to obtain a more reliable flock size figure and to cover the complete season of Crane migration, so be able to estimate the population size more precisely, but also to compare different seasons in terms of passing echoes to see if radar studies might reflect long-term changes of the size of the Scandinavian Crane population.

10. Acknowledgements

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11. Summary

The spring migration of the Crane over the southern Baltic Sea and Skåne was studied in April 1972 on a radar PPI in southern Skåne. It was concluded, through comparisons with field observations, that by far most of the season's Crane migration occurred during the study period, 4–23 April, and that the radar gave a fairly complete picture of the migratory movements.

About 60% of all Crane echoes arrived from the island of Rügen, but the peninsula of Darss, west of Rügen, was also an important area of departure. Smaller numbers migrated over eastern Denmark or arrived from areas east of Rügen. Most of the flocks of Cranes crossed central Skåne on almost due northerly courses, but some flocks migrated over the region of the Sound or along the east coast of the province.

The Cranes departed from the German coast rather soon after sunrise and again to a large extent towards noon. No Crane migration was noted during the night and those few Cranes that arrived late during the afternoon to Skåne apparently roosted in this province to continue their flight in the following morning. The Cranes migrated with following winds, and the five days with most intensive migration coincided with the days when maximal ground speed could be achieved. Consequently the ground speeds actually measured were very high, predominantly 80–115 km/h over the Baltic Sea. Speeds were, however, sometimes reduced significantly over land.

The true air speed of the Cranes was calculated to 63 km/h ($s = 10$, $n = 92$). The Cranes showed a clear tendency to compensate for wind deflection, but whether the compensation was complete or not was impossible to decide.

Counts of Crane echoes were performed and totally 1190 echoes were noted. As mean flock size was in the interval 20–40 birds, it was concluded that 24 000 – 48 000 Cranes passed the southern Baltic region during the study period. These numbers would also be an estimate of the total Scandinavian population of Cranes.

12. Zusammenfassung

Eine Radar-Studie des Frühjahrszuges des Kranichs im südlichen Ostseeraum

Über dem südlichen Teil der Ostsee und über Schonen wurde im April 1972 der Frühjahrszug des Kranichs von einer Radarstation in Südschonen aus studiert. Wir zogen Vergleiche mit Feldbeobachtungen und kamen zu dem Schluß, daß der Zug des Kranichs überwiegend während der Untersuchungszeit zwischen dem 4. und 23. April ablief und daß Radar ein ziemlich vollständiges Bild der Zugbewegungen ergab.

Ungefähr 60% aller Kranichechos kamen von der Insel Rügen, aber auch die Halbinsel Darss westlich von Rügen war ein wichtiger Ausgangspunkt. Kleinere Anzahlen zogen über Ost-Dänemark oder kamen aus Gebieten östlich von Rügen. Die meisten Kranichscharen überquerten den inneren Teil Schonens nordwärts, aber einige Trupps zogen über den Sund oder entlang der Ostküste Schonens.

Die Kraniche verlassen die deutsche Küste bald nach Sonnenaufgang und um die Mittagszeit. Bei Nacht wurde kein Kranichzug festgestellt. Die vereinzelten Kraniche, die Schonen am Spätnachmittag erreichten, rasten offensichtlich hier, um ihren Flug am nächsten Morgen fortzusetzen. Die Kraniche zogen mit dem Wind, und an den fünf Tagen mit dem stärksten Zug wurde die höchste Geschwindigkeit über Grund erreicht. Deshalb waren die ermittelten Geschwindigkeiten über Grund sehr hoch: über der Ostsee überwiegend 80 bis 115 km/h, über Land aber manchmal bedeutend weniger. Die Eigengeschwindigkeit der Kraniche wurde auf 63 km/h ($s = 10$, $n = 92$) berechnet.

Die Kraniche zeigten eine deutliche Tendenz, Windabweichungen auszugleichen, mit welchem Erfolg blieb offen. Insgesamt zählten wir 1190 Kranich-Echos. Die durchschnittliche Truppgröße betrug 20–40 Vögel. Daraus wurde geschlossen, daß in der Untersuchungszeit 24 000 bis 48 000 Kraniche das südliche Ostseegebiet überflogen. Dies erlaubt eine Schätzung des skandinavischen Kranichbestandes.

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Biometrische Untersuchungen an der Gelbfüßigen Silbermöwe *(Larus argentatus michahellis)* aus der Camargue

Von Paul Isenmann

1. Einführung

Über den Komplex der paläarktischen Großmöwen, den wir unter dem Formenkreis Silber-Heringsmöwen verstehen, gibt es eine umfängliche Literatur. Es sind jedoch einige Rassen dieses Formenkreises biometrisch und ökologisch ungenügend erforscht. Stegmann (1934) sowie Barth (1968) konnten sich in ihren Arbeiten nur auf wenige Exemplare der Gelbfüßigen Silbermöwe (*Larus argentatus michahellis*) aus dem Mittelmeer stützen. Um diesen Mangel zu beheben, gebe ich nachfolgend die Ergebnisse biometrischer Untersuchungen an dieser Möwe aus der Camargue (Rhône-Mündung) bekannt.

Herr Dr. F. Goethe sowie meine Frau sahen das Manuskript kritisch durch und machten zahlreiche Verbesserungsvorschläge. Herr Dr. L. Hoffmann, Station biologique de la Tour du Valat, überließ mir freundlicherweise das von seinen Mitarbeitern gesammelte Zahlenmaterial und gestattete mir den Zugang zu seiner Bibliothek. Ihnen allen gilt mein herzlichster Dank.

2. Material und Methode

Es werden hier die Maße (Flügel-, Lauf- und Schnabellänge) und die Gewichte von je 80 erwachsenen ♂ und ♀ aus der Camargue untersucht und mit Gelbfüßigen Silbermöwen aus anderen Gebieten verglichen. Diese Vögel wurden alle in den Frühjahren 1969 und 1971 in Brutkolonien gefangen, frischtot gemessen und gewogen. Die Flügellänge wurde am maximal gestreckten Flügel gemessen. Ferner habe ich den rechten Flügel von 79 weiteren Brutvögeln (39 ♂ und 40 ♀) aus dem Jahre 1971 zur Bestimmung der Flügelzeichnung untersucht. Bei meinen Untersuchungen dienten mir die Arbeiten von Goethe (1961) und Barth (1968) als Modelle.

3. Nomenklatur

Die Gelbfüßige Silbermöwe aus dem Mittelmeer wurde zum erstenmal von Naumann (1840) unter der Bezeichnung *Larus michahellis* beschrieben, später noch von