The spring migration of the Long-tailed Duck and the Common Scoter in western Finland

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The migration of *Clangula hyemalis* and *Melanitta nigra* in the SW archipelago of Finland, along the Gulf of Bothnia, and over the adjacent mainland is described and analysed. This investigation, based on radar films and field records, replenishes an earlier one made in S and SE Finland. The following factors affect the direction of the migration: visibility; the direction of the wind; resting traditions; how well the birds remember the landscape; the distance between resting areas and the coastline; how densely the islands are distributed in the archipelago; whether there are funnel-shaped coastal bays; different breeding areas; where the suitable feeding areas along the migration route are situated. From the SW archipelago, 20 000—40 000 Long-tailed Ducks and some thousands of Common Scoters leave for the Gulf of Finland, and less than 20 000 Long-tailed Ducks leave for the Gulf of Bothnia. The number of Common Scoters choosing the Bothnian route is of the order 100 000.

Over the mainland adjacent to the coast of the Gulf of Bothnia the heading of the flocks was 23° in the south, but 32° further north at a level corresponding to the middle of the Gulf of Bothnia, and 27° over the open sea at the latter latitude. The directions are more to the north than the corresponding headings over SE Finland.

Aim, methods and background

Aim and methods. In two earlier papers the spring migration of the Common Scoter, *Melanitta nigra* (L.), and the Long-tailed Duck, *Clangula hyemalis* (L.), along the Gulf of Finland and across SE Finland was analysed (BERGMAN & DONNER 1964, 1971). The present study deals with the corresponding migration in the archipelago of SW Finland, along the coast of the Gulf of Bothnia, and in the adjacent mainland areas. The aim has been to compare the headings of flocks using different migration routes, to compare the influence of the west coast of Finland on these migrating flocks with that of the south coast, and to describe and explain the reactions of the flocks over the SW archipelago, an area from which flocks set off to the east as well as to the north.

The methods used are the same as in the study published in 1964: filming of the plan-position indicator display of radar equipment on which the flocks are seen as bright tracks, radar determination of the altitude of migration, and field records.

General remarks. The reactions of the migrating flocks to the landscape and to meteorological factors may be summarized as follows (BERGMAN & DONNER 1964): On approaching the south coast of Finland in daylight and good visibility the flocks avoid flying over land. This leads to high densities of migrating flocks along the coast. If 'trapped' by more or less funnel-shaped

bays, if the visibility is low, and especially at night, they cross the coastline and proceed roughly NE over the mainland. When over the open sea or the mainland well away from the coast they do not compensate for wind drift. The general reactions of the flocks to the landscape and to meteorological factors can be assumed to be the same in the areas now studied as in southernmost and southeastern Finland.

The scanty information available on the spring migration of the Long-tailed Duck and the Common Scoter along the west coast of Finland was reviewed by HILDÉN (1957). The only records published later are those of HARJU & HONGELL (1973). The rapid final stage of the journey — here called the final migration — starts mainly in the second half of May, as in the Gulf of Finland. The diurnal rhythm (with the maximum of optically recorded flocks in the evening, but the true maximum mostly at night) is also the same as on the south coast. It is striking that no final migration of these species has ever been recorded at Lågskär or Signilskär, the bird stations in the channel between Åland and Sweden (sight record reports from 8 springs in the Archives of Societas pro Fauna et Flora Fennica).

Other species. Of the other species migrating in flocks along the west coast of Finland, only the Velvet Scoter, *Melanitta fusca,* sometimes occurs in considerable numbers. Such flocks — especially those belonging to non-Baltic populations, have probably to some extent been included in the radar material of this study. At least the local populations of this species migrates mainly in the morning (cf. VON HAARTMAN et al. 1966) and the main part of the population breeding in the Archipelago Sea and along the Gulf of Bothnia arrives before the final migration of the arctic ducks. This strongly diminishes the proportion of Velvet Scoters recorded on the radar films in the evening and at night.

However, the (mostly non-Baltic) Velvet Scoters migrate in the same direction and along the same routes as the Common Scoters and the Long-tailed Ducks. Therefore the presence of some flocks of Velvet Scoters in the stream of Common Scoters and Long-tailed Ducks doesn't change the results to any appreciable degree. Other species to be considered are *Branta bernicla* (generally a few flocks only), some thousands of *Gavia arctica* (incl. *Gavia stellata*), see especially HILDÉN (1957), unknown numbers of waders and *Sterna macrura,* and a small number of *Stercorarius.* These species generally differ greatly from the ducks considered in this study, migrating mainly in the morning. *Branta bernicla* travels generally in the daytime until around sunset, keeping as long as possible over the open sea, and flies close to the water. Thus its flocks mostly cannot be detected with coastal radar equipment. TÖRNROOS (1956) reported about 20 000 *Branta bernicla* migrating along the westernmost part of Oulunsalo in the northern part of the Gulf of Bothnia especially on May 25—26, 1954. The migration was concentrated to the evening. This is very atypical and makes the determination doubtful. If the flocks were geese at all, such a great number probably depends on wind drift of flocks (*Branta leucopsis* + *bernicla*) which normally migrate over SE Finland and along the Gulf of Finland, respectively (cf. also SALOMONSEN 1958). *Gavia arctica* (and *stellata*) never flies in such dense flocks as the ducks and therefore its echoes never give such distinct tracks on the radar display as those of ducks. Especially during intense migration species other than the two ducks actually form an insignificant part of the migration recorded on the radar films.

The radar films. The films were obtained from:

1. The open sea (area 1) and the coastal area (area 2) in the south part of the Gulf of Bothnia, about lat. 61° 30′ (see Fig. 1) 14—25.5.1969; evening and night migration. Ideal conditions for the analysis of the migration on 18, 19, 22, and 25.5.

2. The open sea (area 3) and the adjacent mainland (area 4) at the Quarken Channel (the narrow middle part of the Gulf of Bothnia), about lat. 62° 30′ (see Fig. 1) 16—30.5.1970; evening and night migration. Ideal conditions on 22, 24, and 27.5.

The migration records on the films were analysed for information on migration intensity and direction of flight. Records obtained in suddenly changing weather conditions (mist, showers, weather fronts) have been used only for determining migration intensity.

Only films showing a stream of migrants were used for determining the heading.

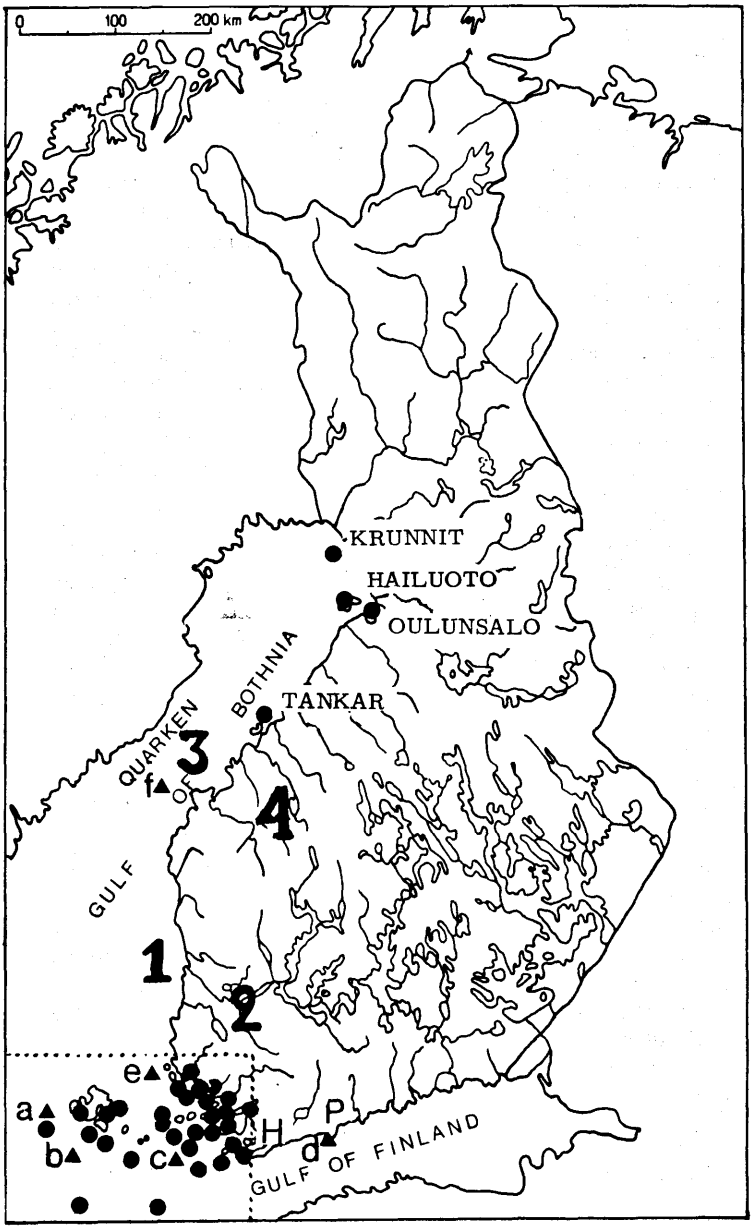

FIG. 1. 1, 2, 3, 4: Areas from which radar films were obtained 1969 or 1970. Bird stations: a Signilskär, b Lågskär, c Jurmo, d Rönnskär, e Isokari (Enskär), f Valsörarna (Valassaaret). Other recording localities cf. p. 134 and Fig. 3 p. 135. H Hangö, P Porkala.

The heading of the migrating flocks

The radar films mentioned allow determination of heading (the direction of flight after correction for drift caused by wind) in areas 2, 3, and 4. In area 1 the direction of flight is strongly influenced by the direction of the coastline and therefore gives no exact information about heading. For a description of the method used for determination of heading see BERGMAN & DONNER (1964). The headings found were:

— Area 2 (night migration over the mainland) 22.6°
— Area 3 (evening and night migration over the open sea) 27.4°
— Area 4 (night migration over the mainland) 31.5°

These values differ significantly from each other ($p < 0.01$) and also (area 4, $p < 0.01$) from the mean headings over the Gulf of Finland (+ the adjacent mainland) and over the mainland of SE Finland (1962: 48.5°; 1963: 49.5°, BERGMAN & DONNER 1964, 1971). These different directions indicate that populations with different headings over the mainland already migrate along different routes at the coasts of Finland. Flocks which have departed from the Gulf of Finland have a heading over SE Finland about 18° further east than flocks flying over the mainland east of the Quarken Channel, and about 22° further east than flocks flying over the open sea immediately north of the narrowest part of the Quarken channel. The headings are shown on Fig. 2.

It may be assumed that birds flying along the Gulf of Bothnia breed in N Norway, N Finland, and especially in the Kola peninsula and adjacent areas of the USSR. All these areas lie N to NE of the northern parts of the Gulf of Bothnia. For the largely marine ducks in question, the shortest possible migration route over mainland areas (without many lakes) is probably the most advantageous. Some of the populations flying along the Gulf of Bothnia may therefore have developed orientation systems which cause them to head more to the north in the southern parts of the Gulf of Bothnia (and over the adjacent mainland) and more towards northeast in the northern half over the gulf and over the mainland from there to the east. The difference between the headings over the mainland in the southernmost part of W Finland and over the mainland at Quarken, as well as the substantial difference between the headings over the open sea at Quarken and over the mainland there, argues strongly for the existence of such a mechanism. This orientation may depend on memory of the landscape in different areas, but may also involve the use of celestial (or/and magnetic?, cf. MERKEL & WILTSCHKO 1965, WILTSCHKO 1973) clues. It is impossible to decide to what degree even the use of such clues is learned, or at least refined by learning during the migration flights of the early years. It may be stressed that young Long-tailed Ducks (and to some extent young Common Scoters) in their first autumn are often found resting solitarily or in small groups in places which are never used by adult individuals in good condition. This was pointed out long ago (HORTLING 1929—31). Thus inexperienced birds, when alone, behave differently from those in flocks including older birds. This shows the importance of tradition and sociability in refining the migration paths.

Some of the 'flyways' used by geese and ducks, especially those nesting in the arctic areas of Canada, include routes that deviate greatly from the general direction of migration. The path of migration of *Branta bernicla hrota* from Labrador to the Atlantic coast (LEWIS 1937) is an example of a route which would hardly be possible without memory of the landscape along the

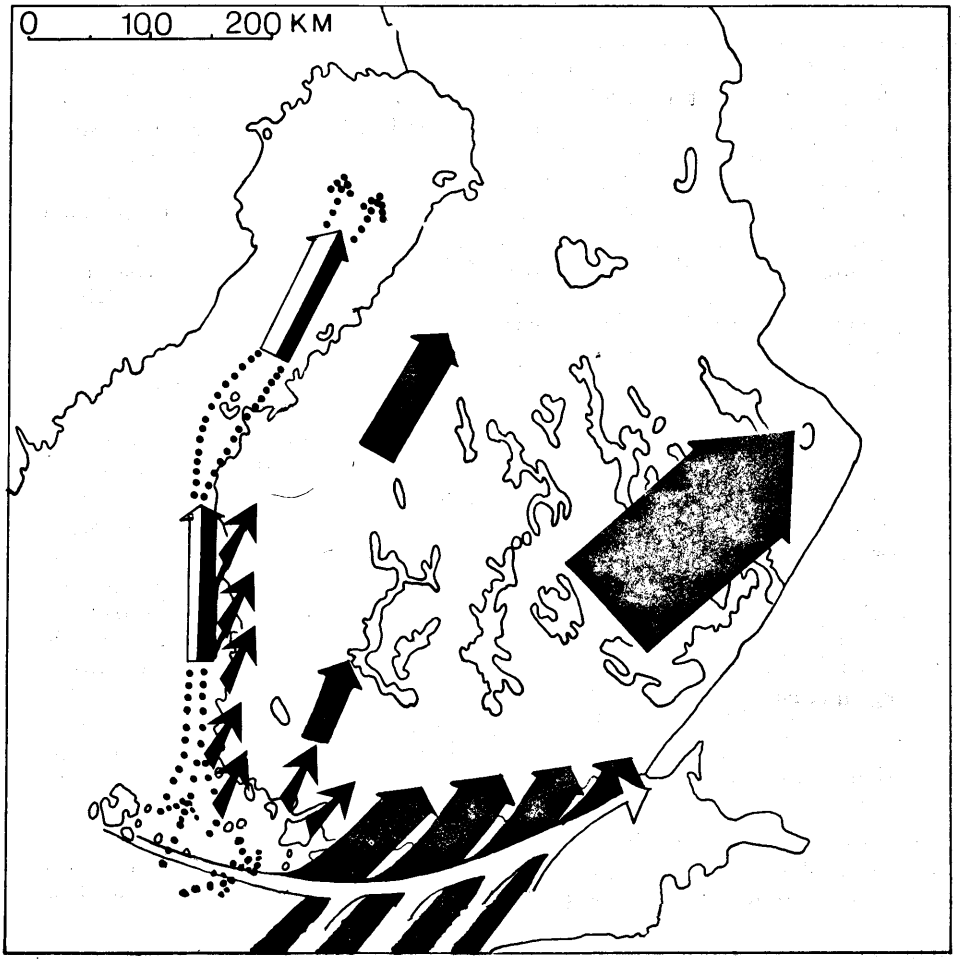

FIG. 2. Directions of the final migration in different parts of Finland (Long-tailed Duck + Common Scoter). White arrows: evening migration. Black arrows: night migration.

route. The very traditional resting grounds of *Branta leucopsis* along its Baltic migration route are also examples on the effect of memory and tradition. Another example from Scandinavia is the migration of the Common Eider, *Somateria mollissima,* from Öresund over the mainland of Scania to the Baltic Sea (MATHIASSON 1962, ALERSTAM, BAUER & ROOS 1974) and from Trondheim fjord in Norway northeastwards over the Scandinavian mountains (FOLKESTAD & MOKSNES 1970). There is now fairly convincing evidence that these Eiders fly directly to the White Sea, a distance of about 1 200 km, without resting in the Gulf of Bothnia, which at this time of the spring is as a rule entirely covered with ice. The personnel of Finnish Military radar stations have reported that bright tracks of extremely high-flying bird flocks at the end of April and beginning of May are seen along a route and at a time

which fully agree with the mentioned evening departure of Eiders from the Trondheim fjord. Over the northernmost part of the Gulf of Bothnia the altitude of flight is already very great (at least 1 500, often about 2 000 m). This indicates that the flocks have flown long distances over mainland areas and they disappear at a great altitude, flying in a straight line towards the closest bays of the White Sea. If not Eiders, they may be gulls, or cormorants. These types of migration seem all to require a considerable memory of where to leave the waterways and proceed across the mainland. For instance, it is not easy for the Eiders (or others!) to find the Trondheim fjord — it involves a local flying towards southeast, or crossing peninsulas, away from the open sea. An innate or learned heading towards ENE is not enough to explain such a sudden deviation from the general direction (NE) of the Norwegian coast.

Migration in the Archipelago Sea

The direction of flight in different areas. Our knowledge of the species considered in this study allows a brief analysis of migration across this area that takes place in calm or almost calm weather. This analysis facilitates an understanding of the mechanism leading to the separation of the flocks into two main categories: those which fly east mainly to the Gulf of Finland, and those which fly along the Gulf of Bothnia. In the final migration in the evening as long as there is daylight the great majority of the flocks in the southern parts of this area fly in directions between ESE and ENE which bring them to the area around the Hangö peninsula and from there towards ENE or NE to the Gulf of Finland. Already along the southern edge of the Åland archipelago they fly mainly towards the Gulf of Finland. A much smaller proportion orientates towards the Gulf of Bothnia. A third group consists of flocks which do not try to find a way to either (or is unable to do so), but still have a strong tendency to northeast. Along the northern edge of the Gullkrona area these flocks (mostly Long-tailed Ducks) react as if flying along a coast or a dense coastal archipelago directed towards E or NE. Most of them are 'trapped' in the NE corner of the Gullkrona area and from there proceed along the long bays of Salo and Paimio into the mainland, just as flocks in the Gulf of Finland sometimes are forced to leave the sea if they happen to fly into the bays at the western side of the Porkala peninsula. Another area, where flocks sometimes leave the archipelago for flying in great altitude in the mainland is the Mynämäki bay in the northernmost part of the Archipelago Sea. It is evident, that in the very center of the Archipelago Sea and from there to the west and to the north, the direction of the evening migration observed has been between NE and NNE, sometimes also N or NNW, with local deviations, but never between ESE and S. The recording localities are given on Fig. 1, the general course of daylight migration in the Archipelago Sea on Fig 3.

The above description is based, except on the radar films obtained from the Hangö area 1961 and 1962, on field records or other descriptions of the migration patterns kindly placed at my disposal from the following parts of the Archipelago Sea:
SW and W Åland (J. Jansson, an ex-ship pilot from W Åland especially mentions May 18 as the normal day of the final migration of the Long-tailed Duck; Rönnskär bird station at Porkala gives the same mean date for the migration maximum); Kökar area May 18 and 20, 1925 (P. Palmgren); NE edge of the main Åland Islands, no evening migration (S. Jaatinen); NE corner of the Gullkrona area, direction and intensity during several springs (M. Rautkari); southern parts of the Gullkrona area own records especially on May 17, 1963; NE edge of Skiftet: the

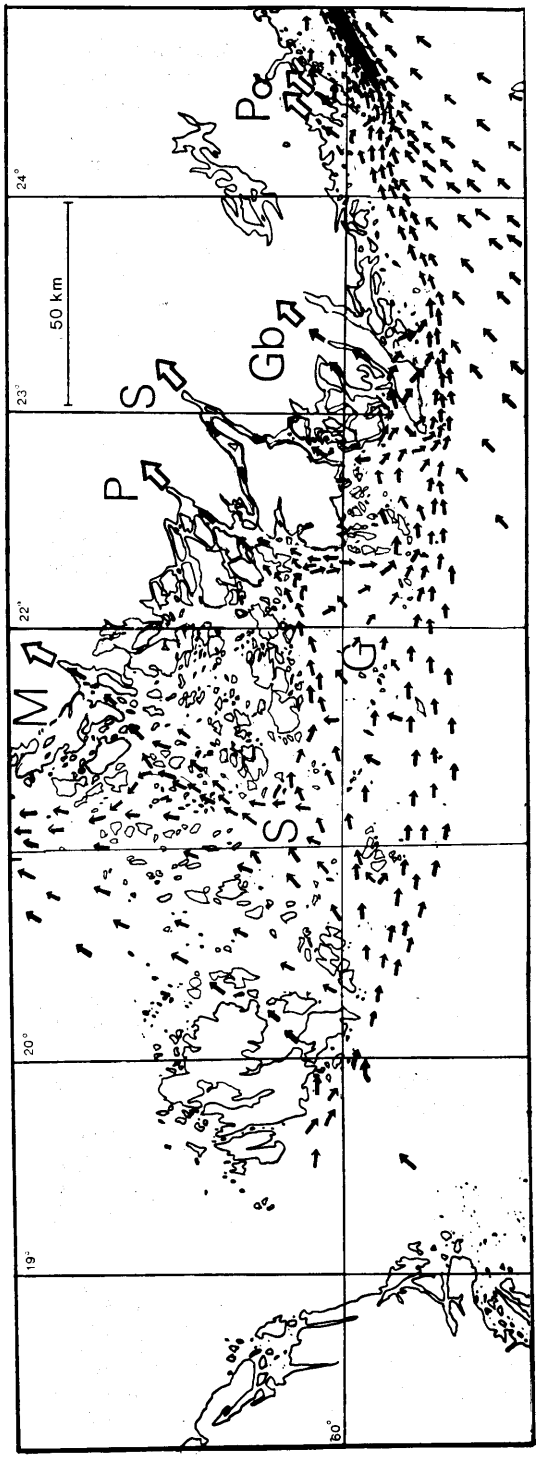

FIG. 3. Direction of the final migration of the Long-tailed Duck in the Archipelago Sea, including Åland, and in the westernmost part of the Gulf of Finland. All directions are valid for calm weather and good visibility. White arrows: funnel-shaped bays along which flocks fly into the mainland (M Mynämäki, P Paimio, S Salo, Gb Gennarby, Po Porkala). S the Skiftet area, G the Gullkrona area.

largest number of Long-tailed Ducks passing during one evening 5 000 (R. Bergman); Communes Kustavi and Askainen: normally no migration of Long-tailed Ducks but sometimes migration from Skiftet into the Mynämäki bay and from there into the mainland (R. Tenovuo); Askainen: Lemsjöholm: No migration of Long-tailed Ducks, but 1938—1967 altogether 15 flocks of Common Scoters recorded, direction of flight NE, N or NNW (L. v. Haartman). The short report about the observations at the Jurmo bird station (KIVIVUORI et al. 1965) may also be mentioned.

In May 1970 and 1971 several ornithologists regularly recorded the visible migration of arctic birds on many localities in the Archipelago Sea, especially on the bird stations Jurmo and Enskär (Isokari), at Kökar, along the southeastern edge of the area, and at the coastal bays. These records (KARLSON 1971, ARJAMAA 1972) confirm the general picture of the migration over the Archipelago sea and gave me additional information about the number of Long-tailed Ducks migrating along its southern edge.

In the evening migration in the SE parts of the Archipelago Sea the Long-tailed Ducks as well as the Common Scoters have a very strong tendency to avoid the bigger islands, changing direction from about NE to SE, locally to S, but not to N or NW, even though, by doing so, they often have to deflect their direction much more from their normal heading (which for the migrants passing through the Gulf of Finland is the same as over the mainland of SE Finland, *viz.* about 43—44°). Flying N or NNW (along conspicuous breaks in the archipelago topography) would bring these flocks close to the Gulf of Bothnia. However, very few, if any, flocks use these openings towards NNE-NNW (as most of the flocks at the NE edge of Skiftet do), but seek for open areas which lead them to the Hangö peninsula. They fly south round this peninsula or across it, reaching the westernmost parts of the Gulf of Finland. Thus, these birds, or at least some individuals in the flock, orientate actively towards the Gulf of Finland. This behaviour suggests a memory of the landscape obtained in earlier years. Only a few flocks fly inland in the evening west of Hangö peninsula, following the long and narrow bays Lindöviken and Gennarbyviken, just as some flocks fly along the bays at Salo and Paimio. At night, and in very misty weather, all the flocks in the region of Hangö peninsula regularly proceed at great height NE and give no sign of searching reactions. Therefore, and because of the short distances, the orientation of the flocks from the Archipelago Sea to the Hangö region can hardly be dependent on celestial clues.

Resting traditions. The Long-tailed Duck has a strong tendency to build up traditions in its use of feeding and resting areas. At least from 1930 to 1939 there were never any resting and feeding flocks in the archipelago between Helsingfors and Porkala. However, at sea off this archipelago they were extremely numerous. In the very late spring of 1940 the flocks appeared in the archipelago in May because there was still ice cover all over the sea (BERGMAN 1951). Every year since then, the flocks have rested in the archipelago, even when there has been no ice at all in the open sea. A similar absence of resting flocks was reported from Tvärminne in the 1930ies (P. Palmgren, pers. communication), from the inner parts of the Gullkrona area (A. Mattsson, pers. communication) and in the 1970ies from areas in the Åland archipelago (reason of the absence unknown; H. Kulves, pers. communication). If the spring is late and there is much ice in March-April, those flocks which rest in the Archipelago Sea generally spend the whole spring predominantly in the southernmost areas, but they use resting areas even closer to the dense parts of the archipelago if when they arrive, there is already plenty of open water. The only slowly changing resting traditions clearly show the important role of me-

mory of the landscape among these birds.

On population size, diurnal rhythm, and geographical distribution

The Long-tailed Duck. The size of the population wintering in the N Baltic along the Swedish coast (Södermanland, Uppland) is of the order of 25 000 individuals (several countings, Leif Nilsson, pers. communication). These birds slowly disappear from their wintering areas during March-May, the majority in April (REGNELL 1967, 1974). The timing of this disappearence agrees well with the arrival of the Long-tailed Ducks in the area of Åland and the Archipelago Sea. My impression of the records of Long-tailed Ducks in the area of Åland and the Archipelago Sea is that the number of birds seen there (estimation: 50 000 birds) is somewhat greater than the number of birds wintering along the Swedish coast in the Södermanland-Uppland area. There is a gap between the resting areas of Uppland and Södermanland, and those along the southern parts of the coast of Sweden (Leif Nilsson, pers. communication). No migration of the final migration type has been recorded along the Swedish coast (REGNELL 1967, 1974). Some flocks stay in the Uppland-Södermanland area until mid-May. Thus there may even be some final migration from this area towards NNE or NE. The flocks flying in the night over W Åland have probably left the Swedish coast in the evening.

Along the Swedish coast migration has been recorded in March-April during the whole light part of the day, but never at night (REGNELL 1967, 1974). In my opinion migration in March-April generally takes place in the morning only. On March 24 and 25, 1964 I recorded migration over the Baltic 20—40 km off the lighthouses Bogskär and Utö between 7.30 and 10^h only (about 1 000 individuals in flocks of 3—50 flying NE or NNE along the water; weather almost calm, sky cloudless, visibility extremely good). However, I should like to stress that even slight disturbances of resting flocks (ships, motorboats, aircraft) tend to cause migration at abnormal times of day, in March-April as well as in the time of the final migration in May. As no final migration has been observed from the area Småland-Öland-Blekinge, it is probable (information given by Leif Nilsson and Sten Regnell, cf. also REGNELL 1967) that the Long-tailed Ducks from the southern parts of the Swedish coast cross the open Baltic mostly in small flocks in March-April in a direction which brings them to the east coast of the Baltic Sea, and to southern Finland. In the final migration the heading over the open sea off Hangö is about 45° (radar films from 1960 and 1961). Such a heading, if held already in March-April, is fully consistent with departure from S Sweden and Gotland. On the east coast of the Baltic, especially around the Estonian islands, and in the Bay of Riga, but also along the south coast of Finland, this migration stream unites with the migration stream along the east coast of the Baltic, composed of flocks which have spent the winter in the S Baltic and in Danish waters.

Altogether the number of Long-tailed Ducks passing the Gulf of Finland is of the order of 1—2 millions (spring population cf. BERGMAN & DONNER 1964). The largest number of migrating Long-tailed Ducks seen in a single day in the autumn on the south coast of Finland is about 500 000 (October 9, 1971, Kyrkslätt Mickelskären, my own records), at the time of the final spring migration in the light part of the day around 300 000 (night migration not considered!). The radar films show

that the number of flocks chosing the Bothnian way is only about 10 % of the corresponding migration over S and SE Finland. About 70 % of the migration seen on the radar films from W Finland proceeds between 22 and 2^h and all information available indicates that in general the Common Scoters strongly predominate there at night. Therefore, it seems probable that only less than 20 000 Long-tailed Ducks migrate the Bothnian way. In which area the flocks there cross the coastline depends greatly on the weather conditions, just as along the Gulf of Finland.

In a considerable part of the Archipelago Sea flocks migrating through the Gulf of Finland as well as flocks migrating the Bothnian way are represented. Field records as well as the time of the day in which flocks on typical migration are recorded, show that both categories of migrants also rest there for a considerable time in the spring. The distance from the southernmost and SW parts of the Archipelago Sea (including Åland) to the coastline in NNE and NE is about 160 km. The air speed of flocks migrating at an altitude of 300—500 m is about 80—90 km/h. If they proceed steadily NE or NNE and the weather is calm flocks which depart from or reach the southernmost parts of the SW archipelago before about 20.30^h arrive at the coastline or the big islands close to the coast before darkness. However, in conditions of good visibility somewhere during the flight over the archipelago they generally change their direction, as already described. The flocks 'trapped' in the NE corner of the Gullkrona area and in some other funnel-shaped water areas constitute exceptions. From resting areas on the NE parts of Skiftet and on the Gullkrona area the flocks mainly depart directly towards the Hangö peninsula and the Gulf of Finland, from their western parts also towards the Gulf of Bothnia. These flocks arrive in the Gulf of Finland and the Gulf of Bothnia before darkness. Because many flocks do not start from their resting areas until after 20.30^h there among the flocks resting along the southern edge of the Archipelago Sea may be even flocks which not before dusk (at about 22.30^h or later) reach the denser archipelagos, before which the majority of the earlier flocks as long as there is daylight begin to orientate towards east or north. Such flocks may proceed over the big islands and over the mainland, as the flocks do in the night in S and SE Finland. If the landscape over large areas of the Archipelago Sea is hidden by mist, but weather conditions otherwise are favourable, there may also be some migration in the evening, which independent of the landscape proceeds NE or NNE over the innermost parts of the Archipelago Sea and from there further over the mainland. However, such weather conditions are very uncommon. Because migration over the mainland, in the evening as well as at night, always proceeds at a great altitude this migration over SW Finland has escaped notice.

The Common Scoter. The resting areas and thus the migration of this species over the whole archipelago area of southern Finland is strongly influenced by the long distance many of them fly without interruption before they arrive in Finnish waters. At least a considerable part of these birds have to fly over the mainland of S Sweden, and over Estonia, respectively, to reach the Baltic south of Åland, or the archipelago areas of SW and S Finland. Migration over S Sweden generally takes place at night, but no information is available on its intensity or its exact direction. Generally, these ducks head approximately NE. Because the wind strongly influences the path of such a long mainland flight, the flocks

on different nights or mornings after the flight over Sweden (and Estonia, respectively) may alight for rest in very different areas. Generally the flocks rest during the day on wide stretches of water, even on the open sea. During this short resting the Common Scoter seems to be independent of food: the birds may spend the whole day on waters where the depth excludes diving to the bottom.

On June 3, 1961 more than 100 000(!) Common Scoters were recorded resting on the open sea off the southernmost parts of the west coast of Finland; when disturbed by the boat they flew off N or NNE along the water (A.-G. Kranck, pers. communication). In 1969 and 1970 the total number of Common Scoters using the Bothnian route was hardly greater than 100 000 individuals. The unbroken flight of the Scoters from the west coast of Sweden to the waters off the Finnish coast is about 600 km; the distance regularly flown by Long-tailed Ducks, Common Scoters, and *Branta bernicla* from the Gulf of Finland to the White Sea is 800—900 km, *Branta leucopsis* migrates without breaks at least from Estonia to the White Sea area (unbroken flight about 1 200 km), and the Eiders from Trondheim fjord (cf. p. 133) also about the same distance without any break. Obviously such long flights are no problem energetically.

Generally only small flocks of Common Scoters occur among the Long-tailed Ducks flying ENE along the southern margin of the Archipelago Sea in the evening. Some individuals or groups fly with the Long-tailed Ducks, others travel in unmixed flocks. The lack of records of greater numbers migrating over the Archipelago Sea is obviously due to the time of the day at which most flocks of this species arrive from the southwest. Most flocks appear to cross over the Archipelago Sea around and after midnight and proceed into the mainland. At that time there is usually no one keeping watch at the bird stations. The radar films from area 2, as well as those from S Finland, show evidently that this type of migration is typical for the Common Scoter. Judging from my own observations (Hangö region May 1960 and 1961, Gullkrona area May 17, 1963) the flocks seen in the SE parts of the Archipelago Sea behave in the same way as the Long-tailed Ducks during their final migration in the same areas. However, different resting areas may cause local differences in the flight paths.

Possible effects of wind drift. The position of the stream of flocks — Long-tailed Ducks as well as Common Scoters — migrating along the south coast of Finland, or off it, depends greatly on the drifting effect of the wind (cf. BERGMAN & DONNER 1964, especially the Figures 16 and 17, pp. 38 and 39). There is no doubt that effects of the same type occur even in SW Finland, especially along the southern edge of the Archipelago Sea, and along the northern edge of the Gullkrona area. Especially if the visibility is low wind drift may also bring flocks off their normal route, even fully off the archipelago, or bring flocks from the southern edge of the archipelago or from the open Baltic to the Gullkrona area. However, the records available are much too sparse to allow any analysis. It seems me also very probable that in springs with strong east winds predominating almost all those flocks of the Long-tailed Duck, which use the Bothnian way, reach the northern part of the Gulf of Bothnia; if strong west winds and misty weather predominate probably almost all flocks in spite of the light nights may drift into the mainland even before the Quarken area.

Conclusion. It can be concluded that for Common Scoters as well as for

Long-tailed Ducks resting on as well as migration over the Archipelago Sea area diminishes the risk of drifting away from their normal routes running towards the coasts of the Gulf of Finland and the Gulf of Bothnia. Especially for the Long-tailed Ducks the Archipelago Sea acts as a combination of familiar orientation clues and a stopping filter. Thus normally in this area relatively few flocks of this species proceed across the coastal line. However, wind drift, mist, and cloudy weather may increase their numbers considerably. The directions of the final migration during the evening in different parts of the Archipelago Sea are given in Fig. 3.

On the effect of the coastline

Differences in the reactions on the south and west coasts. During a typical night migration in the Gulf of Finland the flocks cross the coastal line. Only in bright moonlight they to some extent concentrate in a narrow zone off the coast. However, along the coast of the Gulf of Bothnia, south of the Quarken channel, migration parallel with the coast is very typical even at night, providing that visibility is good and that the wind does not drift the flocks towards the open sea. In nights with intense migration along the coast in the Bothnian area there is considerable migration over the adjacent mainland as well. These differences between the reactions of the flocks along the Gulf of Finland and on the Bothnian coast may be interpreted as follows.

On the west coast of Finland the nights in the period of the final migration are lighter even in the southernmost part of the Gulf of Bothnia than in the Gulf of Finland. The radar films obtained for this study refer to areas around lat. 61°30', and 62°30', respectively. The latitude at which the flocks off the south coast of Finland begin to react to the coast, is about 59° 50'. Another important factor is the direction of the coastline: the south coast of Finland runs mainly WSW-ENE, while the direction of the southern part of the west coast is about S-N. Until about 01^h the reflection of the evening and night glow from the waters close to the coastline in the front of the migrating flocks is much greater when the coast is directed mainly towards the north than when the coast runs ENE. Thus on the west coast the bright contrast between land and water even at night may prevent many flocks from changing their flight into the direction of their general heading which would bring them away from the coastal region.

North of the Quark the direction of the coast and the heading of the flocks flying over the sea are about the same. In this area, therefore, the flocks mostly proceed to the northern or northeastern end of the gulf before they cross the coastal line. In the southern half of the Gulf of Bothnia even a small deterioriation of visibility at night causes the flocks to cross the coastline and continue their flight over the mainland. Further north obviously wind drift towards the coast combined with low visibility causes the birds to cross the coastline. In the northernmost regions crossing of the coastline is normal and probably independent of weather conditions, but the radar information from this area is too incomplete for an analysis.

The heading of the flocks over the open sea somewhat to the north of the narrowest part in the Quark is 27.4° but on the adjacent mainland 31.5°. The probable explanation (cf. p. 132) is that flocks belonging to populations breeding to the east of the others, when proceeding N and NNE along the coast, tend increasingly to change direction towards their breeding area in the northeast. These flocks may cross the coastline more readily and earlier than the others.

The direction of flight at different distances from the coast. Radar films from the southern part of the Gulf of Bothnia (area 1) obtained during good weather conditions (weak tail-wind, weak sidewind or clam, sky almost clear, visibility good) show that the flocks react to the coast as soon as they can see it clearly. This distance is naturally dependent on the altitude at which the flocks are flying. In the weather conditions mentioned about 50 % of those flocks which gave bright tracks on the radar display flew 20—55 km (mean 36 km) seaward of the outermost islands. Their mean direction of flight (ground direction, no correction for wind drift) was 0.5°, which is close to the general direction of the coast in this region. However, only flocks flying at relatively high altitudes are recorded at these distances from the coast. Between 20 and 5 km off the coast the radar records flocks even at low altitudes and there the mean direction of the flocks was 12° which brings many flocks closer to the coast. Flocks flying less than 5 km seaward of the islands or peninsulas react strongly to the landscape, showing sudden local changes in the direction and even altitude of their flight. These observations do not contradict earlier findings that the flocks fly at higher altitudes over the archipelago and the mainland than over the open sea. However, if the flocks have little or no tendency to deviate to a direction that would lead them across the coastal line, the flocks which fly higher can react to the sight of the coast at a much greater distance than flocks flying at low altitudes. Flocks flying at high altitudes are also able to see a much longer strech of the coast than those flying lower. Especially, pronounced peninsulas, and islands off the coast, can be seen much earlier from altitudes of 100—200 m than from some 10 m only. Flocks which depart from resting of feeding areas fly at relatively low altitudes at first. Because from that level they cannot see distant peninsulas or islands ahead of them, many of these flocks fly for several kilometres relatively close to the coastline, or in directions which bring them closer to the coast. These flocks (of which many of the smaller ones during their flight unite to bigger ones) account for a great part of the tracks seen on the radar display 5—20 km off the coast. On approaching peninsulas or islands they slowly rise to greater altitudes and at the same time change their direction of flight some degrees to the left, away from the coastline. From the new altitude even very distant parts of the coast are visible and so after a short flight more or less away from the coast they change into a migration parallel with the general direction of it.

Flocks coming from the Archipelago Sea continue over the open Gulf of Bothnia without any change in altitude (generally at least 300 m) and are therefore able to see the Bothnian coast at very great distances as long as there is daylight and good visibility. The few flocks of Long-tailed Ducks which proceed over W Åland during the night may reach the Quarken region without making any optical contact with the southern half of the west coast of Finland. Even Common Scoters may do so.

The Long-tailed Duck during its long resting and migration prefers shallow areas (depth 3—12 m) with rich bottom fauna of especially *Mytilus edulis*. Resting at open sea is therefore uncommon. This is probably one of the reasons why the great majority of the Long-tailed Ducks fly to the Gulf of Finland and not along the Gulf of Bothnia, and why the majority of the migrants mostly leave the coast already somewhere before the Quarken region — north of which there is no *Mytilus* at all. Another reason for preferring

the Gulf of Finland is the very late melting of the ice in the northern half of the Gulf of Bothnia. There may be large areas of unbroken ice until about May 20. Because the Common Scoter does not stay for any long time along its migration route it is not as dependent on feeding areas along the route as the Long-tailed Duck is. Possibly therefore it to a greater extent than the Long-tailed Duck uses the route along the Bothnian coast.

The migration route over land from the northern parts of the Gulf of Bothnia to the White Sea is about 200 km shorter than from the Gulf of Finland (the 'waterway' over the lakes Ladoga and Onega is used only by flocks drifted away from the normal route over SE Finland). However, in order to use this shorter route the birds belonging to populations breeding east of the White Sea must change their general NE heading to a more northerly one and then back to NE (or ENE) at certain points of their route. Though this should be possible based on tradition and memory of the topography, it may under unfavourable weather conditions lead the birds astray. This factor, together with the less favourable feeding situation in the northern half of the Gulf of Bothnia, may have led to a dominance of the migration route through the Gulf of Finland and over SE Finland.

The open sea in the Quarken region is shallow, the Long-tailed Ducks are there able to dive to the bottom even far from the coast and the archipelago. HILDÉN's (1957) opinion is that the main migration route of the Long-tailed Ducks in the Quarken region runs along the middle of the Quarken channel. This seems to me very probable, but because the radar does not give information about the species (Scoters or Long-tailed Ducks) it cannot be verified. According to HILDÉN (1957) no migration of Long-tailed Ducks occurs over the islands of Valsörarna or along the strait between these islands and the dense archipelago along the east coast at the Quark. As already mentioned the main part of the flocks flying along the southern part of the Bothnian coast mostly fly into the mainland already before the Quarken region. Those flocks which continue as far as to the Quark have flown well away of the coast (cf. p. 141). At the Quarken region flying 20—50 km off the coast probably brings most of the flocks to the open sea west of Valsörarna. In this area the flocks even at low altitudes have visual and regulating contact with the coast and the islands in the west as well as in the east. The migration there has been recorded on the radar films (area 3). At the lighthouse Tankar about 100 km NE of the narrowest part of the Quarken channel migration of Long-tailed Ducks occurs at least sometimes (cf. HARJU & HONGELL 1973). However, flying from the middle of the Quarken channel in a heading typical for the ducks in this region (27—28°) does not bring the flocks close to the coast at Tankar. Wind drift, or possibly a tendency to change the direction of flight towards NE may explain the occurrence of Long-tailed Ducks flying along the coast in this area. In the Quarken region the Common Scoter has been recorded in considerable numbers especially between Valsörarna and the coast (HILDÉN, 1957). It may even be mentioned that I on May 15, 1969 in the mainland at Kauhava about 60 km away from the coast of the Quarken region recorded a strong migration of Common Scoters and Long-tailed Ducks ($23—24^h$ 24 flocks of Common Scoters and 8 flocks of Long-tailed Ducks heard). These flocks obviously crossed the coastline already about 100 km south of the Quarken region.

The different, partly antagonistic effects and reactions described above fully explain why there is generally a

stream of flocks flying at high altitude at a relatively constant, but great distance off the southern part of the Bothnian coast, and why a considerable proportion of those flocks that migrate closer to the coast fly at lower altitudes and show a greater dispersion of their flight direction than the flocks recorded at sea. Because radar is unable to detect low-flying flocks at great distances the radar films do not give information about flocks flying low over open sea.

When applied to the evening migration along the Gulf of Finland, these facts lead to a slight revision of the picture given by BERGMAN & DONNER in 1964: When visibility is good deflection of the flight direction of the flocks begins at a greater distance off the coast than is shown on the maps in the paper mentioned. However, there is also a tendency not to fly out of sight of the coast. During the autumn migration this is particularly striking. This reaction will be discussed in another paper.

Summary

The Long-tailed Duck, *Clangula hyemalis*, arrives in Finnish waters in March-April migrating mainly in the morning. The flocks rest southwest and south of Åland, south of and also in the Archipelago Sea of SW Finland (birds wintering chiefly in the N Baltic off the Swedish coast), and especially off the south coast (birds wintering chiefly in the S Baltic, S Sweden, and in Danish waters) until the second half of May. Then they suddenly depart mainly in the evening and at night for the final migration to the breeding areas. From resting areas SW and S of Åland and along the southern edge of the Archipelago Sea the final migration in the evening proceeds mainly E or ESE to the Gulf of Finland, from resting areas in the SE parts of the Archipelago Sea the flocks set off in the evening in directions between east and south to the Hangö region and from there to the Gulf of Finland; from Åland and the W parts of the Archipelago Sea flocks depart even NNE or N, flying along the widest stretches of open water to the Gulf of Bothnia. The orientation of the flocks implies a memory of the landscape along the migration routes, thus a fraction of the population uses the way through the Gulf of Bothnia as its normal migration route. Along the southern flank of the central islands of the eastern half of the Archipelago Sea some flocks in the evening fly east proceeding inland along bays. Over the Archipelago Sea the flocks flying along its southern edge, along the main islands, and along bays, generally compensate for wind drift. During night migration and in misty weather most of the flocks fly about NE, some NNE or N, but are unable to compensate for wind drift. In daylight the Archipelago Sea and its islands act as a combination of familiar orientation clues, and a stopping filter. Therefore most flocks have passed this area avoiding its dense parts before dusk and only a few flocks proceed there into the mainland.

The Common Scoter, *Melanitta nigra*. After their night migration across S Sweden and over the N Baltic the flocks spend the day resting in many different coastal areas of Finland, and even at the open sea. Sometimes they continue as far as the southernmost part of the Gulf of Bothnia without resting. The reactions of the Common Scoter to the landscape are almost identical with those of the Long-tailed Ducks. Flocks resting for the day in different parts of the Archipelago Sea depart in the same directions and at the same time as the Long-tailed Ducks in the same areas do. During night migration they cross the coastline to some extent.

Close to the southern part of the Gulf of Bothnia the heading of the migrating flocks (Long-tailed Ducks + Common Scoters) over the mainland is 22.6°, over the mainland east of the Quarken channel 31.5° but on open sea somewhat north of the Quarken channel 27.4° (Fig. 2). A probable explanation of this is that some populations follow a migration path which curves somewhat to the east in the region of the northern Gulf of Bothnia. The heading at open sea in the Quarken region normally brings flocks to the northernmost part of the Gulf of Bothnia before they cross the coastline. All headings are significantly more northoriented than those of flocks flying from the Gulf of Finland across SE Finland (42.7—49.5°). The direction of the west coast of Finland, the light nights, and eventually a northwardly increasing tendency for a part of the populations to branch off northeastwards explain the fact that on the Bothnian coast migration at night occurs as a stream of flocks 5—50 km off the coast as well as across the coastline into the mainland, and especially north of the Quarken region even at open sea. The effect of low visibility and wind drift are largely the same as along the S coast of Finland. These factors may greatly affect the numbers of flocks reaching the northern parts of the Gulf of Bothnia.

The number of Long-tailed Ducks migrating along the Bothnian route is less than 20 000, that of the Common Scoters of the order of 100 000, but around 1960 the number of Common Scoters was greater.

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Selostus: **Allin ja mustalinnun kevätmuutto Saaristomerellä ja Länsi-Suomen rannikolla.**

Tutkimus perustuu Saaristomeren osalta maastohavaintoihin sekä Hangon seudulla suoritettuihin tutkahavaintoihin. Useat henkilöt ovat hyväntahtoisesti antaneet havaintojaan käytettäväkseni. Pitkin länsirannikkoa tapahtuvaa muuttoa on seurattu tutkalla, jonka kuvaa on filmattu kahtena kevätmuuttokautena. Alueet, joista on tutkahavaintoja (1, 2, 3, 4) tai maastohavaintoja, on merkitty karttaan s. 131.

Alli. Useimmat maalis—huhtikuussa Ruotsin itärannikolta tulleista korkeintaan 60 000 allista oleskelevat Saaristomeren eteläosissa Kihtiä ja Gullkronan selkää myöten ja muuttavat toukokuun lopulla iltaisin Hangon seudun kautta Suomenlahdelle ja vasta sieltä koilliseen. Pohjanlahden suuntaan muuttavien allien lukumäärä on korkeintaan vain 20 000:n suuruusluokkaa. Lisäksi joitakin tuhansia alleja joutuu, lennettyään saarijonoja pitkin, illalla koillisen Saaristomeren suppilomaisiin lahtiin, joista lento useimmiten jatkuu mantereelle. Parvet nousevat tällöin niin korkealle että jäävät mantereella havaitsematta. Koska useimmat alliparvet suurimmaksi osaksi klo 18 jälkeen tapahtuvan muuttolentonsa aikana ennättävät ennen hämärän tuloa joko Suomenlahdelle tai Selkämerelle, lajin yömuutto Saaristomeren alueella on vähäistä. Tästä seuraa, että tältä alueelta tapahtuu hyvän näkyvyyden vallitessa tuskin lainkaan yömuuttoa sisämaahan. Kuvassa s. 135 on kaavamaisesti esitetty allin lentosuunnat ja suhteellinen muuttotiheys Saaristomerellä ja läntisellä Suomenlahdella.

Mustalintu. Joitakin tuhansia mustalintuja muuttaa Saaristomeren eteläosasta kohti Hangon seutua allien tapaan. Lounais-Suomessa mustalinnut muuttavat yleensä useammin sisämaahan kuin allit. Tämä johtuu ilmeisesti siitä, että mustalintuja saapuu lounaasta saariston ylle pitkin yötä, jolloin ne eivät hevin tunnista maiseman yksityiskohtia. Länsirannikon eteläosien kautta muuttaa ainakin n. 100 000 mustalintua, joista osa lentää sisämaahan vasta Perämeren pohjukassa.

Selkämerellä alli- ja mustalintuparvet lentävät rannikon suuntaisesti. Tyynellä kirkkaalla säällä parvijono on tihein 30—40 km:n päässä rannikosta. Tätä muuttoa jatkuu aamuyöhön asti. Osa parvista kääntyy kuitenkin hämärässä sisämaahan, etenkin niemien kohdalla ja kohdatessaan Vaasan eteläisen saariston. Ne allit, jotka ovat lentäneet Merenkurkkuun asti, karttavat ilmeisesti muita parvia enemmän rannikkoa (oletettavasti nämä parvet kuuluvat kantoihin, jotka pesivät lähes suoraan pohjoisessa, idempänä pesivät ovat kääntyneet sisämaahan todennäköisesti jo Selkämeren alueella). Se, että avomerellä Merenkurkun kapeimmasta kohdasta etelään on sopivia ruokailualueita, saattaa osaltaan aiheuttaa, etteivät allit yleensä lennä tällä seudulla lähellä Suomen rannikkoa (tutkahavainnot eivät ole sitovia, mutta tukevat HILDÉNin käsitystä allien muuttoreitistä Merenkurkussa). Mustalinnut, jotka eivät muuton aikana levähdä ja ruokaile yhtä selvästi kuin allit, lentävät Merenkurkussa selvästi lähempänä rannikkoa.

Selkämeren eteläosasta tai Saaristomeren pohjoisosasta yöllä sisämaahan muuttavien mus-

talintu- ja alliparvien lentosuunta on tyynellä säällä 23°. Juuri ennen Merenkurkkua sisämaahan kääntyvien parvien lentosuunta on mantereen yllä 32°, ja Perämeren eteläosan yllä parvien lentosuunta on keskimäärin 27° (kartta sivulla 133). Sisämaahanmuutto suuntautuu siis pohjoisempana itäisempään suuntaan kuin etelämpänä, mutta kaikkialla länsirannikon tuntumassa ovat maisemasta riippumattomat yölliset lentosuunnat pohjoisempia kuin vastaavat lentosuunnat Suomenlahdella ja Kaakkois-Suomessa (45—49°).

Yön valoisuus sekä sangen pieni kulma länsirannikon pääsuunnan ja sen suunnan välillä, johon parvet pyrkivät lentämään aiheuttavat, että muuttosuunta noudattelee yölläkin rannikkoa sangen usein. Suomenlahdella muutto kääntyy pimeän aikana sisämaahan. Sumu ja rannikkoa kohti puhaltava tuuli voivat kuitenkin länsirannikollakin aiheuttaa koko yömuuton suuntautumisen sisämaahan. Voimakas idänpuoleinen tuuli voi vastaavasti aiheuttaa parvien ajautumisen etäämmälle rannikosta.

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