Correlation between Coastal and Inland Migratory Movements

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(Med et dansk resumé: Sammenhængen mellem kysttræk og indlandstræk)

INTRODUCTION

Visible and radar observations of the bird migration were carried out in the centre of Zealand in the spring of 1971 (RABØL and HINDSBO 1972). Simultaneously, visible observations were made at Gilleleje and Nivå on the north and east coast of Zealand (Fig. 1).

The main purpose of the present investigation is to compare and correlate the inland and coastal migratory movements. The migration observed in the inland area is considered as representative of the migration in the recruitment area of the two coastal observation sites.

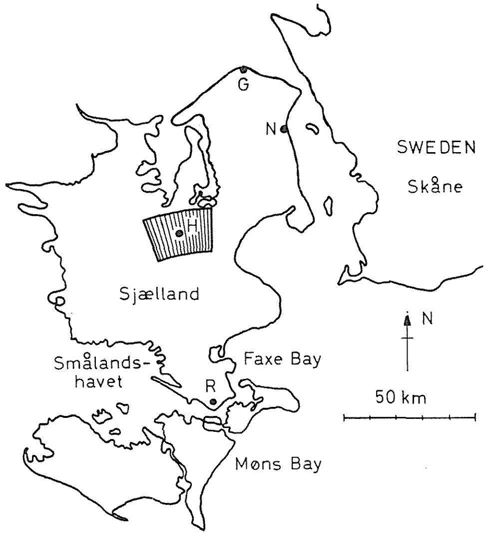
The visible and radar inland migration could be considered as more or less identical to movements in lower (below 100 m) and higher (above 100 m) altitudes, respectively. May the coastal movements be best described by means of the low or high altitude migration in the recruitment area? As pointed out by e.g. RABØL and HINDSBO (1972), and ALERSTAM and ULFSTRAND (1972) the low altitude migration in the inland overcompensates for winddrift, whereas the high altitude migration is drifted by the wind.

In close connection with the above mentioned evaluation, the correlation between the coastal migratory direction and the wind direction is outlined.

MATERIAL AND METHODS

In the period of March 1 to May 7 1971 the visible migration was studied at three sites: Hvalsø, Gilleleje and Nivå. Simultaneous radar observations were carried out, and the radar counting area is shown in Fig. 1.

Fig. 1. The three observation sites at Hvalsø (H), Gilleleje (G), and Nivå (N), the radar station (R) in southern Zealand, and the radar counting area in the Hvalsø area.
Observationsstederne ved Hvalsø (H), Gilleleje (G) og Nivå (N). R viser radarstationens placering. Den firkantede figur ved H er radar-optællingsområdet for indlandstrækket.



Tabel 1. Skylark *Alauda arvensis,* March 8 to April 23 (n = 31), and finch sp. *Fringilla sp.,* March 22 to April 30 (n = 27). These intervals constitute the main migratory periods. Ratios are Spearmann rank correlation coefficients between different combinations of site, mode of registration, and directional sector. Total means migration in all directions. N-, E-, and W-coa. under the headings of Nivå and Gilleleje refer to coasting. One and two underlinings mean p less than 0.05 and 0.01, respectively.
Sanglærke og finke sp. Brøkerne er korrelations-koefficienter. De fleste er positive, hvilket viser en sammenhæng mellem stort træk det ene og andet sted. N-, E-, og W-coa. betyder kystfølgende træk mod N, Ø og V. Understregede korrelations-koefficienter er statistisk signifikante.

Spearmann Rank Correlation Coefficients			Visible							Radar			
			Nivå		Gilleleje	Hvalsø				Hvalsø			
			Total	N-coa.	E-coa.	Total	NW-NNE	N-E	NNE-ESE	Total	NW-NNE	N-E	NNE-ESE
Skylark (Alauda arvensis)	Gilleleje	Total	0.72			0.66				0.26			
		W-coa.		0.62	0.31	0.52	0.35	0.27	0.21	0.44	0.17	0.51	0.52
		E-coa.				0.44	0.31	0.46	0.50	0.10	0.28	0.11	0.02
	Nivå	Total				0.72				0.14			
		N-coa.				0.71	0.61	0.72	0.60	0.13	0.09	0.16	0.13
Finch sp. (Fringilla sp.	Gilleleje	Total	0.43			0.45				0.24			
		W-coa.		0.52	-0.49	0.37	0.53	0.36	0.16	0.35	0.08	0.36	0.44
		E-coa.				0.25	0.10	0.30	0.26	0.15	0.20	-0.01	-0.14
	Nivå	Total				0.81				0.08			
		N-coa.				0.86	0.76	0.84	0.77	0.14	0.04	0.09	0.06

The observation methods are described by RABØL and HINDSBO (1972). In summary, the visible migration was studied during the first four morning hours on 50 single days. The visible observations were booked according to species, number, direction and altitude. The PPI-screen of a surveillance radar (L-band) was filmed continously, and the movies were analysed for bird echo intensities and directions. Each morning the one to four main directions were separated and the corresponding intensities were estimated in an exponential scale ranging from 0 to 9.

Some other comments on the methods and concepts of the present paper should be given:

1) The coastal movements are grouped in four categories: E- and W-coasting at Gilleleje, and N- and S-coasting at Nivå. E-coasting means the movements in the directional sector NNE to SSE incl., W-, N-, and S-coasting are correspondingly the movements in the sectors SSW to NNW incl., WNW to ENE incl., and ESE to WSW incl., respectively. In the Chaffinch *Fringilla coelebs* and the Brambling *Fringilla montifringilla* the designation coasting is an appropriate term because 95-99% of the birds actually follow the coastline. In the Skylark *Alauda arvensis* the term coasting should not be perceived too strictly because of the great directional scatter (Table 2).

2) Spearmann rank correlation coefficients (SIEGEL 1956) are widely used. The two variables in the correlation analysis are always daily bird numbers (intensities). Much information is of course lost when a simple correlation coefficient is used to describe a complex behavioural situation. As the scope of the paper is gross lines and not details the use of the correlation coefficient is, however, assumed to be an appropriate tool.

3) As shown in Table 1 different directional sectors are used in the correlation analyses. The meaning and evaluation of these sectors is as follows: Coastal movements are supposed to originate through deflection of a more or less unidirected and broadfrontet inland migration – e. g. ULFSTRAND (1960), CHRISTENSEN and ROSENBERG (1964), GRUYS-CASIMIR (1965), and EVANS (1966). The coastal movements at a given point in one of the two opposite coastal directions are supplied by a *deflecting coastline* which picks up and accumulates the inland migration. Fig. 9

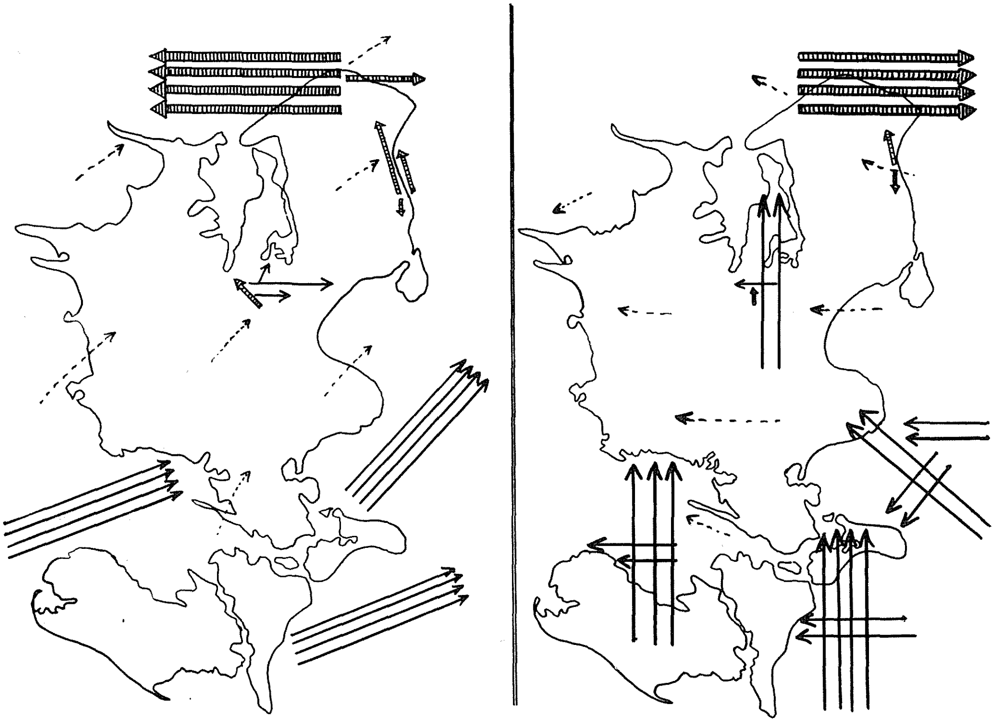


Fig. 2. Visible migration (barred arrows) and radar migration (black arrows) at Zealand on April 19 (left) and 23 (right). Wind direction at the earth surface indicated by hatched arrows. On both days the great majority of migrating birds was finches. Total number of migrating birds at Hvalsø, Gilleleje and Nivå on April 19 and 23 was 356, 87800, 1760, and 163, 32650, 445, respectively. Radar intensities on April 19 and 23 at Hvalsø, in Faxe Bay, Møns Bay, and Smålandshavet (fig. 1) were (E 6-7 +NE 4), NE 9, ENE 9, ENE 9, and (N 8 +W 3-4), (NW 8 +SW 7 +W 7), (N 9 +W 7), (N 8-9 +W 6-7), respectively. Especially the visible movements at Gilleleje display the typical headwind-coasting, and the radar migration clearly drifts with the wind.
To typiske trækdage, 19. april (venstre) og 23. april (højre). De sorte pile viser radartrækket, og de tværstribede det synlige træk. Stiplede pile viser vindretningen. Begge dage sås et stort synligt finketræk. Især kysttrækket ved Gilleleje viser den generelle tendens til træk i den kystretning, der forløber mest mod vinden. Radar-trækket derimod drifter noget for vinden.

shows the probable deflecting coastlines for the E- and W-coasting at Gilleleje and the N-coasting at Nivå. The reasonable presumption is that the bird will either emigrate or follow that direction along the coast which coincides most closely with the original inland direction. With emphasis on the size of the recruitment areas of the different directions, the inland directional sector from NW to NNE incl., should thus produce the E-coasting at Gilleleje. The corresponding sectors for the W-coasting at Gilleleje and the N-coasting at Nivå should be N to E incl., and NNE to ESE incl., respectively.

As the visible migration is noted according to 16 directions (N, NNE, – – – , NNW) the intensities of the sectional parts are easily calculated. However, the radar sectors cause problems. Just one to four daily directions were distinguished, and it is intuitively clear that a direction as NNW does *not* mean that *all* bird echoes are moving NNW. NNW is of course to be considered as a mean direction with a certain variation. This variation is not known but could be reasonably estimated as follows: The distribution is supposed to follow a circular normal distribution with NNW as the mean vector direction and 0.7 as the mean vector concentration (corresponding to an angular standard deviation on about 45°). A radar direction as NNW is thus supposed to consist of several directions the relative weights of which is

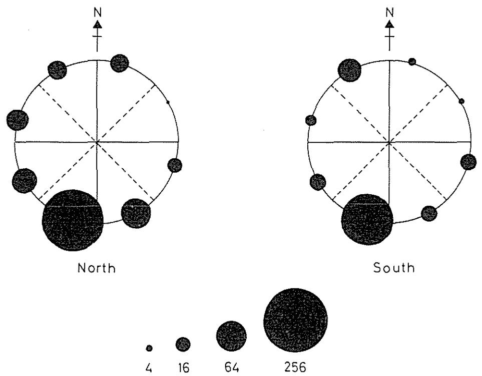


Fig. 3. Skylark *Alauda arvensis*, Nivå, March 9 to April 20, 1971 (n = 29). The amount of N- and S-coasting as a function of wind direction. No attention is paid to wind force which seems to be insignificant in the present context. N-coasting means movements between WNW and ENE, and S-coasting movements between ESE and WSW. E- and W-directions are omitted. During whole period 1380 Skylarks N-coasting, whereas 752 S-coasting. Mean number of birds per day calculated for each of the eight wind direction sectors 1) N to NNE-NE, 2) NE to ENE-E, – – – 8) NW to NNW-N. The scale should be noted. Number of days per sector is 2,2,4,4,2,10,3, and 2. The very small number of days in most sectors warns against considering the figure too strictly.
Sanglærke, Nivå. Størrelsen af N- og S-trækket som funktion af vindretningen. Der er skelnet mellem 8 forskellige vindretnings-sektorer, og for hver af disse sektorer er udregnet det gennemsnitlige antal trækkende fugle pr. dag N- eller S-på langs kysten.

calculated following Table E in BATSCHELET (1965): NNW (0.30), NW and N (0.18), WNW and NNE (0.09), W and NE (0.05), WSW and ENE (0.02), and SW and E (0.01). The sum of all these ratios is of course 1.00. The sector from N to E incl. thus »contains» a ratio of the total (»NNW») intensity on 0.18 (N) + 0.09 (NNE) +0.05 (NE) +0.02 (ENE) +0.01 (E) = 0.35.

Primarly, it was just intended to compare the coasting with a) the total inland intensity and b) the inland intensity in the »appropriate» sector. More or less by accident it appeared that a slightly different procedure could alter this scope in a much more informatory way: For all three groups of coasting (Table 1) the correlation coefficients of a) the total intensity, b) the intensity in the sector NW to NNE incl., c) the intensity in the sector N to E incl., and d) the intensity in the sector NNE to ESE were calculated. Through inspection of the correlation coefficients it is now possible – with some caution – to find the most important inland direction (or directional sector) for a large coastal movement.

4) It is not possible to determine the species involved in the radar migration. Most of the echoes are, however, considered to reflect migrating finches. The comparison of the visible and radar migration in Table 1 and Fig. 7 thus make good sense in the finches. In the Skylark Table 1 should be considered with some caution, since the Skylarks, apart from a few days, constitute a minor part of the bird echoes.

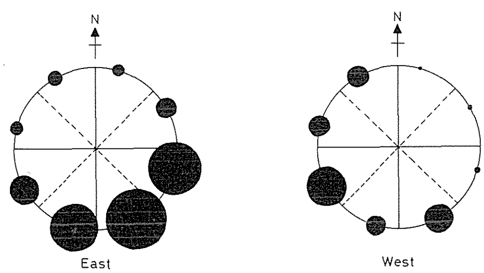


Fig. 4. Skylark, Gilleleje, March 9 to April 20, 1971 (n = 31). Amount of E (NNE to SSE) and W (SSW to NNW) coasting as a function of wind direction. 2502 Skylarks E-coasting, and 937 W-coasting. Number of days per sector was 5, 3, 4, 3, 5, 5, 4 and 2. Same scale as in fig. 3 which also should be consulted for further explanation.
Sanglærke, Gilleleje. Størrelsen af Ø- og V-trækket som funktion af vindretningen.

RESULTS

The presentation of the results is divided in four parts:

1) Fig. 2 shows two typical examples of the influence of the wind direction on the migratory pattern. As the overall standard direction is approximately NNE-NE, it is obvious how the visible (low altitude) migration overcompensates the winddrift (contains a headwind component), while the radar (high altitude) migration on the contrary is drifted by the wind (and/or contains an active downwind component).

2) Especially the coastal movements of the finches (Figs. 5 - 6) can be described as being *directed into the offshore wind.* The Skylark movements at Gilleleje (Fig. 4) seem to exhibit the same pattern, whereas the N-coasting of Skylark at Nivå (Fig. 3) does not fit into this picture.

3) Concerning the total number of inland birds (intensities) the coastal movements are better correlated with the visible (low altitude) than with the radar (high altitude) migration in the recruitment area (Table 1, Fig. 9). This especially holds true for the N-coasting at Nivå.

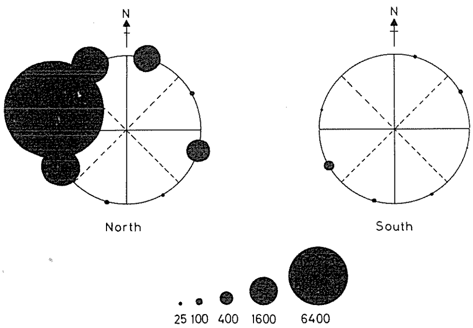


Fig. 5. Finch sp. *Fringilla sp.*, Nivå, March 15 to May 7, 1971 (n = 36). Amount of N- and S-coasting as a function of wind direction. 115,000 finches N-coasting and 1,300 S-coasting. Number of days per sector was 2, 2, 5, 8, 2, 11, 4 and 2. For further explanation see caption to Fig. 3.
Finke sp., Nivå. Størrelsen af N- og S-trækket som funktion af vindretningen.

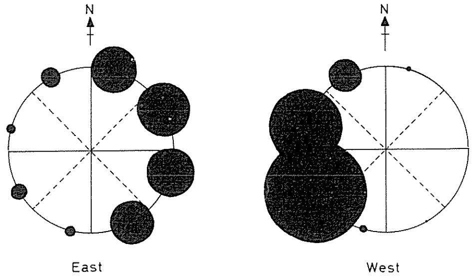


Fig. 6. Finch sp., Gilleleje, March 15 to May 7, 1971 (n = 40). Amount of E- and W-coasting as a function of wind direction. 128,000 finches migrating W, and 85,000 E. Resemblance with Fig. 2 in Christensen & Rosenberg (1964) is very striking. Number of days per sector was 6, 3, 4, 9, 6, 6, 3 and 3, respectively. Same scale as in Fig. 5.
Finke sp., Gilleleje. Størrelsen af Ø- og V-trækket som funktion af vindretningen.

4) Movements in certain inland directions (or directional sectors) are clearly correlated with the different groups of coasting. Table 1 informs about the correlation coefficients of the sectors NW to NNE incl., N to E incl., and NNE to ESE incl. Fig. 7 shows the inland mean directions on days with strong coastal movements. The three groups of coasting should be presented separately:

N-coasting Nivå: Table 1 shows that there are no clear differences between the inland directions as regards their association with N-coasting at Nivå. However, Fig. 7 points towards an association with a »ENE«-directed inland radar migration and »N«-directed inland visible migration.

W-coasting Gilleleje: 1) Skylark: Seems to be associated with »NW« inland visible and »NE« inland radar migration (Table 1). 2) Finch sp.: Seems to be associated with »NNW-N« inland visible and »NE-ENE« inland radar migration (Table 1), or »NNW-N« inland visible and »ENE-E« inland radar migration (Fig. 7).

E-coasting Gilleleje: 1) Skylark: Seems to be associated with »ENE« inland visible and »NNW-N« inland radar migration (Table 1). 2) Finch sp.: Seems to be associated with »NE« inland visible and »NNW« inland radar migration (Table 1), or »NNE-NE« inland visible and »NNW-N« inland radar migration (Fig. 7).

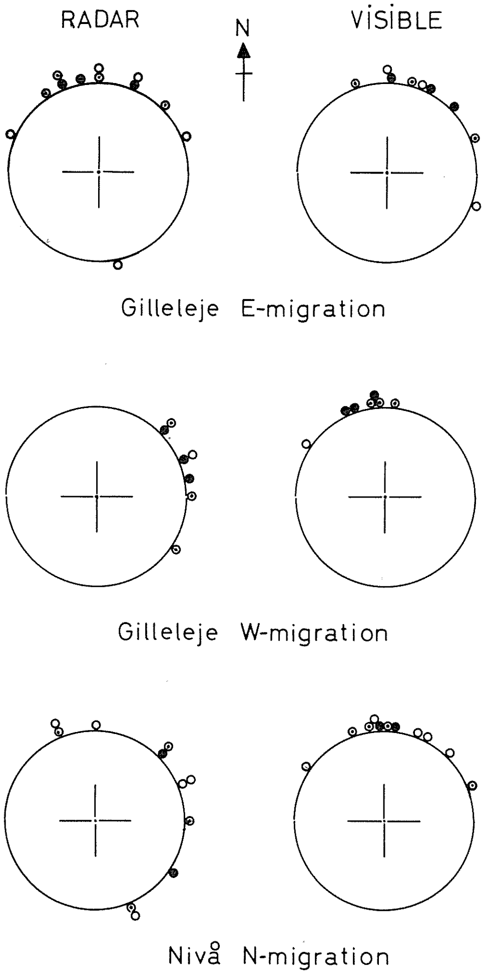


Fig. 7. Mean directions at Hvalsø for visible migration of finches and radar migration on days with at least 1,000 finches E- or W-coasting at Gilleleje or N-coasting at Nivå. Black circle means more than 10,000 coasting finches, dotted circle 2-10,000 finches, and white circle 1-2,000 finches.
Gennemsnitsretninger ved Hvalsø af det synlige træk og radartrækket på dage med over 1,000 kysttrækkende finker ved Nivå eller Gilleleje. Bemærk forskellen mellem indlands-trækretningerne i forbindelse med stort Ø- og V-gående træk ved Gilleleje. N-trækket ved Nivå finder sted i stort set samme situation som V-trækket ved Gilleleje.

DISCUSSION

When comparing the Skylark and the finches some obvious *differences* are found: 1) The tendency to follow coastlines is stronger and the directional dispersion less in the finches (Table 2, Fig. 8). 2) The relative amount of E- and W-coasting at Gilleleje, and N- and S-coasting at Nivå are not the same (Table 1, Figs. 3-6). These patterns indicate that the standard direction is more northern (»NNE«) in the finches than in the Skylark (»NE-ENE«).

However, the *similarities* are so marked, that the following general consideration could be made: For a large coastal movement to occur the optimal condition in the recruitment area is when the visible mean direction forms a small angle to the deflecting coastline, and the mean radar

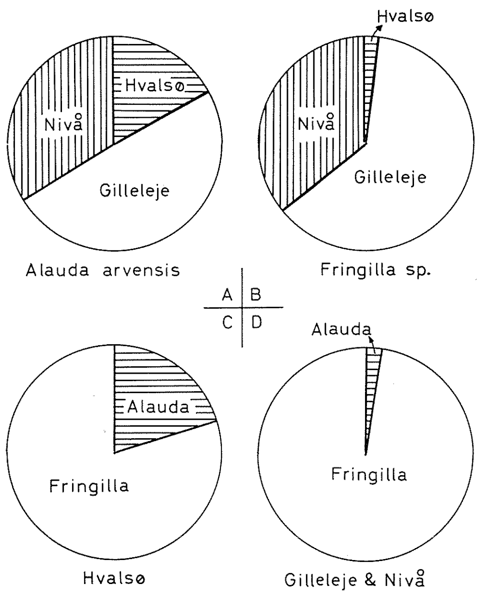
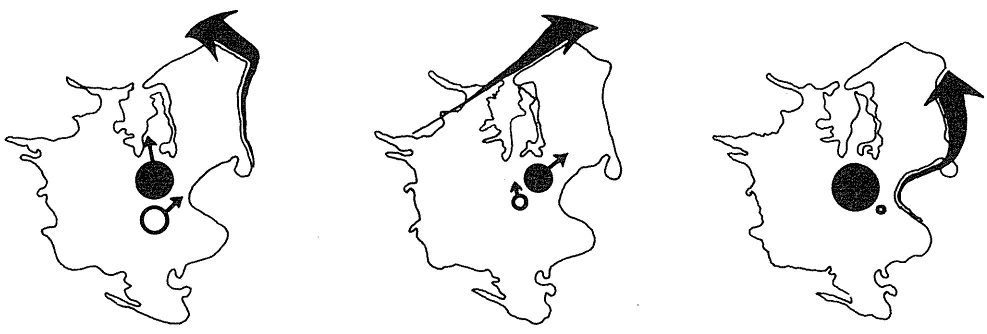


Fig. 8. Ratios of Skylark (A) and finches (B) at the observation sites. C and D show the ratio of species inland and at the coasts. Total number of Skylarks at Hvalsø, Gilleleje and Nivå was 1,360, 4,000 and 2,700, respectively. Corresponding figures for the finches were 6,730, 204,000 and 117,000, respectively.
A og B viser relative antal Sanglærker og finker på de tre poster. C og D viser forholdet mellem antallet af Sanglærker og finker på indlandsposten og de to kystposter.

Table 2. Skylark and finch sp., April 5 1971. Number of birds migrating in different directions at the three observation sites. The example shown is typical. Directional dispersion is less and tendency to follow coastlines is stronger in the finches. Wind direction and force (Beaufort) ESE 4 (Hvalsø), ENE 3 (Gilleleje), and E 3 (Nivå).

Sanglærke og finke sp., 5. april 1971. Typisk eksempel der viser den større spredning i Sanglærkens trækretninger og dens mindre tilbøjelighed til kystfølgende træk.

Species	Direction / Site	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Skylark	Gilleleje			1	2	24	5	11					1			1	1
(Alauda	Nivå	5		11	1	13	6	2				2		3			
arvensis)	Hvalsø				1	8	1	15	1	1			1				
Finch sp.	Gilleleje					5465			5								
(Fringilla	Nivå	3055															
sp.)	Hvalsø			93	75	97											



W-coasting Gilleleje

E-coasting Gilleleje

N-coasting Nivå

Fig. 9. Correlation and most important inland directions compared with coastal movements at Gilleleje and Nivå. Degree of correlation with total visible inland migration is shown by black circle. White circles show total inland radar migration. Area of the circles is a measure of relative importance. W-coasting at Gilleleje is associated with »NNW-N« visible and »NE-ENE« radar inland direction. E-coasting at Gilleleje is associated with »NE« visible and »NNW-N« radar inland direction. According to Table 1 none of the three inland sectors are better correlated with the Nivå N-coasting than the total inland migration. According to Fig. 7 a »N« visible and a »NE-ENE« radar inland direction are associated with a great Nivå N-coasting.

Sammenhængen mellem indlandstrækket og kysttrækket (V-træk Gilleleje, Ø-træk Gilleleje, N-træk Nivå). De tre pile viser, hvordan man kan forestille sig at kysttrækket bygges op. Hvide og sorte cirkler viser sammenhængen mellem kysttræk og indlandstræk. Hvide cirkler angiver radartrækket, sorte cirkler det synlige træk. Arealet af cirklerne er udtryk for graden af sammenhæng. Vi ser, at alle tre former for kysttræk passer bedst sammen med det synlige indlandstræk. For Ø- og V-trækket ved Gilleleje er endvidere vist hvilke retninger i indlandstrækket, der er mest betydningsfulde for et stort kysttræk.

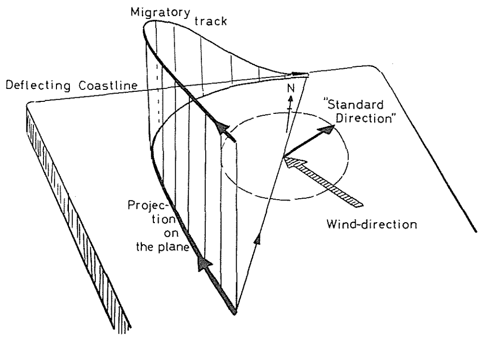


Fig. 10. Model showing optimal migratory pattern in the inland (recruitment area) for a large coastal migration. Birds are heading in the »standard direction«, and high altitude migration is drifted by the wind in a track perpendicular to deflecting coastline. When approaching the coast migratory altitude decreases and birds gradually bend into the wind; the angle between track and coastline then diminishes until the birds actually follow the coast.
Model der viser den mest gunstige betingelse for »fødslen« af et stort kystfølgende træk. Det høje træk inde over land driver ud mod kystlinien. I nærheden af kysten går fuglene ned i trækhøjde og bøjer af for senere at følge kysten i modvindsretningen.

direction a much greater angle (near 90°). For the W-coasting at Gilleleje it is supposed that the deflecting coastline is both the WNW-ESE-coast east of Gilleleje and the N-S-coast at and north of Nivå (cf. Fig. 9).

These observations have probably something to do with the following considerations: 1) The *inclination to follow* a coastline is presumably proportional to (90° - v) or cos v, where v is the acute angle between the inland and coastal direction. 2) However, the number of birds attaining the coastline is maximum when v is 90°. The optimal condition for a large coastal movement would be when the two tendencies »cooperate« in the sense that the high altitude migration decreases in altitude when approaching the deflecting coast. We then have a situation with many birds concentrated near the coast and moving in a direction first close to the coastal direction and then following the coast in the »headwind-direction«. We have no direct proof for such a development. Nevertheless, the consideration is presented in a model in Fig. 10. This model should not be perceived too strictly but especially as a sort of inspiration for future investigations.

CONCLUSION

Concerning the inland migration RABØL and HINDSBO (1972) concluded: »It seems like birds migrating in higher altitudes cannot compensate completely for the wind drift, whereas the contemporary (and/or subsequent?) low altitude migration on the contrary overcompensate for the wind drift«. The on-coast drift and the headwind coasting shown in the present paper fit well into this picture. It cannot be emphasized too much that the reactions to the wind are altitude dependent, and that a certain mode of migration (e.g. a high altitude NNE-movement in the spring) should not be considered as more correct than movements which do not coincide with the concept of the standard direction. In fact, both the concept of standard direction and superficial energetical assumptions for a long time seem to have prevented a balanced appreciation of the cooperation of the different modes of migratory reactions. Obviously, an energetical assumption makes the presence of a downwind component probable and useful – and a headwind component improbable and adverse. However, natural selection also works in other fields than just flying speed, and a very important field should be to evolve mechanisms which counteract the wind-drift. Such mechanisms would be navigational abilities and/or a low altitude headwind component.

SUMMARY

The intensities and directions of coastal movements are compared to the intensities and directions of the simultaneous visible (low altitude) and radar (high altitude) migrations in the inland recruitment area.

The coastal movement is maximum when the low altitude inland mean direction forms a small angle to the deflecting coastline, and the high altitude inland

mean direction forms a much greater angle (near 90°). These tendencies are combined into a single model (Fig. 10).

ACKNOWLEDGEMENTS

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DANSK RESUME

Enhver der har set på kysttræk af landfugle er bekendt med de store daglige variationer i trækket. Trækket er snart størst i den ene kystretning, snart i den anden kystretning. Det er stort med nogle vindretninger, og det er ringe med andre vindretninger.

Man kan nu prøve at undersøge:

1) Er der noget system i de forskelligartede reaktioner?, og

2) Kan man forklare årsagen til et stort kystfølgende træk i den ene af de to retninger langs kysten?

Det første spørgsmål er ret nemt at besvare: Det kystfølgende træk er næsten altid størst i den retning, der forløber mest mod vinden. Mere sekundært er det også (alt andet lige) størst i den retning, der er mest i overensstemmelse med den for årstiden forventede normaltrækretning (NØ om foråret). Kysttrækket er i reglen også størst med fralandsvinde (fig. 4-6).

Det andet spørgsmål er straks meget sværere at besvare. Man kan dog simpelthen postulere, at fuglene i de lavere trækhøjder har en instinktiv tilbøjelighed til træk mod vinden – ved siden af nogle andre tendenser, såsom tilbøjeligheder til at følge kyster, trække i normaltrækretningen, o.l. Funktionen af dette modvindstræk kunne så være at modvirke den vindafdrift, som fuglene modtager i de større trækhøjder. Fra radar-observationer af fugletrækket foretaget herhjemme og i udlandet ved man nemlig, at det højeregående træk indeholder en medvindskomponent, der må være forårsaget af enten en passiv drift for vinden eller en egentlig (aktiv) tendens til træk med vinden.

I denne afhandling prøver vi at bevæge os et lille stykke ned i spørgsmål 2). I foråret 1971 undersøgte vi sammenhængen mellem indlandstrækket på Sjælland (Hvalsø) og a) et stort N-gående kysttræk ved Nivå, b) et stort Ø-gående kysttræk ved Gilleleje, og c) et stort V-gående kysttræk ved Gilleleje. Der var klare tendenser til, at kysttrækket var størst, når det synlige (lave) indlandstræk forløb i en retning, der dannede en lille (spids) vinkel til kystlinien, medens det *samtidige* radar (høje) indlandstræk stod omtrent vinkelret på kysten. Ø-trækket ved Gilleleje var således størst, når det synlige indlandstræk gik »NØ« og radar indlandstrækket »NNV« (figs. 7 og 9). V-trækket ved Gilleleje var størst med synligt indlandstræk mod »NNV« og radar indlandstræk mod »NØ« (figs. 7 og 9). N-trækket ved Nivå var mere uklart sammenhængende med retningerne i indlandstrækket. Fig. 7 tyder dog på sammenhæng med synlige indlandsretninger omkring »N« og radar indlandstræk omkring »ØNØ« (bemærk ligheden med Gilleleje V-trækket). Som vist i modellen på fig. 10 kan man forestille sig den bedste baggrund for et stort kysttræk: En højtgående afdrift vinkelret ud mod kysten, i nogen afstand fra kysten fald i trækhøjde og afbøjning af trækket ind i et kystfølgende træk mod vinden. Afdriften skaber en koncentration af fugle i kystzonen, og den lille vinkel mellem det lave indlandstræk og kystlinien gør, at de fleste fugle følger kysten, når de kommer derud (ringe udtræk).

Hermed har vi overfladisk set besvaret spørgsmål 2). Tilbage bliver spørgsmålet om det modvindsprægede kystfølgende træks funktion. Betyder denne form for afdrift-kompensering overhovedet noget som helst? – eller er der tale om en minoritet af instinktsvækkede fugles ret så ligegyldige tomgangsbevægelser (CHRISTENSEN og ROSENBERG 1964)? Vi kan ikke i dag besvare dette spørgsmål simpelt. Det er imidlertid helt klart, at trækfuglene på den ene eller anden måde må kompensere for vind-afdriften, og dette kan *kun* gøres a) ved navigation mod »målområder« på trækruten og/eller b) gennem et mere eller mindre stereotypt modvindstræk. Begge disse muligheder vækker følelsesmæssig modstand hos de fleste trækforskere. De fleste tror ikke på eksistensen af navigation i fuglenes »trækprogram«. De mener, at navigation, herunder det »medfødte« kendskab til trækrutens forløb, er en så usandsynlig og kompliceret process, at den ikke kan rummes i en trækfugl. Modvindstræk er også et upopulært begreb, fordi det ud fra (for?) simple energimæssige betragtninger er såvel uforventeligt som uhensigtsmæssigt. Det sætter jo trækhastigheden ned. Hertil er at svare, at den naturlige udvælgelse også arbejder på andre fronter end udi forøgelsen af trækhastigheden. Det vigtigste for en trækfugl er at være i overensstemmelse med sin trækrute. Hvis den drifter væk fra trækruten, skal den kunne finde tilbage igen. Det er heller ingen ubetinget fordel for en trækfugl at ankomme hæsblæsende i en gunstig medvind til et endnu snedækket yngleområde. For mig er der ingen tvivl om, at navigation eksisterer, samt at modvindstrækket har en vigtig funk-

tion. Begge dele hjælper trækfuglene til at være i overensstemmelse med deres trækrute.

REFERENCES

ALERSTAM, T. and S. ULFSTRAND, 1972: Radar and field observations of diurnal bird migration in South Sweden, Autumn 1971. – Ornis Scand. 3: 199 - 139.

BATSCHELET, E., 1965: Statistical methods for the analysis of problems in animal orientation and certain biological rhythms. – Washington D.C., A.I.B.S. Monograph.

CHRISTENSEN, N.H. and N. ROSENBERG, 1964: Bogfinkens (*Fringilla coelebs* (L.)) forårstræk. – Dansk Orn. Foren. Tidsskr. 58: 13-35.

EVANS, P.R., 1966: An approach to the analysis of visible migration and a comparison with radar observations. – Ardea 54: 14 - 44.

GRUYS-CASIMIR, E.M., 1965: On the influence of environmental factors on the autumn migration of Chaffinch and Starling: a field study. – Arch. Neerl. Zool. 16: 175 - 279.

RABØL, J. and O. HINDSBO, 1972: A comparison of the bird migration recorded by radar and visible field observations in the middle of Sjælland, Denmark, Spring 1971. – Dansk Orn. Foren. Tidsskr. 66: 86 - 96.

SIEGEL, S., 1956: Non-parametric statistic for the behavioral sciences. – Mc. Graw-Hill, New York.

ULFSTRAND, S., 1960: Some aspects of the directing and releasing influence of wind conditions on visible bird migration. – Proc. XII Int. Orn. Congr. (Helsinki 1958): 730 - 736.

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