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The autumn migration of the chaffinch *Fringilla coelebs* over the Baltic coast in Poland*

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The routes and dynamics of migration are described, as well as long-term trends of changes in numbers of the chaffinches on the Polish Baltic coast. A trial has been undertaken to distinguish geographic populations among chaffinches on passage, and areas of their breeding and wintering have been determined. The data used included results from visual observation of migration, and from ringing carried out on the southern Baltic coast, mainly in the years 1961-1973, as well as results of observation from the coast of Sweden. Chaffinches were found to migrate in 6 waves occurring at approximately the same dates each year. Chaffinches breeding in the areas under study start on migration before the onset of passage of transmigrating chaffinches. Chaffinches breeding along the south-eastern coasts of the Baltic leave at an earlier date, for more distant wintering grounds, and in a more south-deviated standard direction than those from the areas situated farther north, where the eastern Baltic and the Scandinavian populations mix together.

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Осенняя миграция зяблика *Fringilla coelebs* через Балтийское побережье в Польше.

Описано пути и динамику миграции, а также многолетние направления перемен численности зябликов на польском побережьи Балтийского моря. Предприято попытку выделения географических популяций перелетающих зябликов и установлено места их гнездовья и заимовок.

Употреблено результаты визуальных наблюдений перелетов и кольцевания осуществленных на южном побережьи Балтийского моря, особенно в годах 1961-1973, а также результаты наблюдений у берегов Швеции.

Удостоверено, что зяблики перелетают в шести волнах, выступающих ежегодно приблизительно в тох же сроках. Зяблики гнездящиеся на территории исследований улетают перед начинающейся миграцией. Зяблики гнездящейся вдоль восточных верегов Балтийского моря перелетают на отда-

* Papers Baltic Operation No 50.

ленные зимовки ранше и в более южном стандартном направлении, чем зяблики с мест лежащих возле Ботнического залива, на территории смешания популяций восточно-балтийской и скандинавской.

Анализировано интенсивность перелета в зависимости от времени дня и в отделных часах дневного пика перелета и установлено районы остановки мигрующих зябликов.

INTRODUCTION

The aim of the present paper is to describe the course of the autumn migration of chaffinches across the Baltic coast in Poland, and to analyse the population composition of chaffinches on migration, as well as to establish their breeding and wintering areas.

Northern-European chaffinches winter mainly in western Europe, starting from the Netherlands, Belgium and France, and only relatively small numbers of them winter in areas located nearer to their breeding grounds. The chaffinches of Sweden and Norway migrate chiefly to the British Isles, passing across

Denmark, Germany and the Netherlands, or across the North Sea. The chaffinches from areas east of the Baltic winter primarily on the Iberian Peninsula and in France (TINBERGEN 1941, DEELDER 1949, GOODACRE 1959, PAYEVSKY 1967a, 1971, PERDECK 1970, v. HECKE and VERSTUYFT 1972).

Chaffinches normally migrate in a broad front (v. SCHWEPPENBURG, after v.DOBBEN 1953, NEWTON 1972). The average direction of their flight, if not influenced by the relief and cover of the ground, and not affected by winds and a limited visibility, is called the standard direction. It may vary with the different stages of migration (v.SCHWEPPENBURG 1933, after v.DOBBEN 1953, GRUYS-CASIMIR 1965, PERDECK 1970).

If birds flying in a broad front encounter an area over which their flight is more difficult (because it is difficult to keep the right direction of flight, or more energy is required for the flight, ALERSTAM and PETTERSSON 1977), or more dangerous, they often change the direction of their migration and fly on along the borderline of this area, forming a narrow, strongly congested flight stream. The border of the adverse habitat thus constitutes a barrier for these birds, referred to as the leading-line (v.SCHWEPPENBURG 1922, 1929, after v.DOBBEN 1953). Areas avoided by chaffinches are tree-less areas, first of all seas (DEELDER 1949, GRUYS-CASIMIR 1965). A concentrated migration of birds of this species can often be observed also along the south-eastern Baltic coast.

Whether the birds will cross the leading-line, or change the direction of flight and fly along it, depends, among other things, on the strength and direction of the wind and the angle formed by the leading-line and the standard direction. The smaller the angle, the stronger the tendency not to cross the leading-line and to continue migrating along it (DEELDER 1949, GRUYS-CASIMIR 1965, ALERSTAM and PETTERSSON 1977).

The spring migration of the chaffinch across the Baltic coast in Poland has been described by BUSSE (1976). There have only been some sketchy notes on the autumn migration of this species across these areas (TISCHLER 1941, JABŁOŃSKI 1961, BUSSE, GROMADZKI and SZULC 1963, OKULEWICZ and TOMIAŁOJĆ 1964, BUSSE and GROMADZKI 1969). A wealth of information has been gathered on the Courland Spit along which the same migration route runs as along the Polish coast. The data have been published in a very synthetic form, by DOBRYNINA (1963) and PAYEVSKY (1967a).

MATERIAL AND METHODS

Material

The basic material used in the paper consisted of:

a) results from visual observation of passage (2280 days of observation) and ringing of the chaffinch during the Operation Baltic in the years 1961-1973 (Figs 1-4, Tables 1-3);

Table 1. Observations of chaffinches on passage. Observations at different bird stations are separated with a line. For abbreviations of bird station names see Figure 1.

Station	Year	Period	Number of chaffinches observed	Passage in particular directions (%)								Observers
				NW	W	SW	S	SE	E	NE	N	
NP	1961	15.09 – 14.10	3 850			83.8	14.3	0.3	1.1	0.5	0.1	P. Busse
	1963	17.08 – 15.10	25 056		0.3	96.3	3.1			0.2	0.1	P. Busse, R. Hołyński
	1964	17.08 – 13.10	9 317		1.8	97.6	0.4	0.1				R. Halba
	$\bar{x}$				0.7	95.1	3.7	0.1	0.1	0.2	0.1	
MW I	1961	15.09 – 14.10	356 125		99.6	0.3			0.1			L. Tomiałojć
	1962	1 – 30.09	11 352	0.2	99.2	0.2			0.2	0.2		J. Witkowski
	1963	17.08 – 30.10	73 139		99.9				0.1			M. Gromadzki, W. Kania
	1964	17.08 – 20.10	63 163		99.7	0.3						P. Busse
	1965	17.08 – 25.10	46 459		99.8				0.2			C. Nitecki, R. Hołyński, L. Tomiałojć
	1966	17.08 – 25.10	66 498		99.3				0.7			W. Kania
MW II	1967	17.08 – 26.10	48 790		99.9				0.1			P. Busse, J.M. Kozłowski
	1968	17.08 – 25.10	19 639		99.4				0.6			W. Kania, P. Busse
	1969	17.08 – 25.10	44 971		99.9				0.1			S. Strawiński, W. Kania, P. Busse
	1970	17.08 – 15.11	28 255		99.8				0.2			P. Busse, W. Kania, M. Gromadzki, B. Olech, J. Weiner
	1971	20.08 – 7.11	72 026		100.0							W. Kania, P. Busse, R. Hołyński, M. Wieloch
	1972	3.10 – 16.11	9 262		99.7				0.3			P. Busse, R. Hołyński, M. Goc
	1973	26.08 – 16.11	68 534		100.0							M. Goc, M. Waydowska, P. Busse, W. Kania, A. Petryna
MWI/II	$\bar{x}$				99.7	0.1			0.1			
Ś	1963	1 – 30.09	6 795	0.1	95.4	0.3	1.8		0.5		1.8	J. Okulewicz
GW	1962	1 – 30.09	27		100.0							L. Tomiałojć

Ż	1962	1 – 30.09	361	11.1	11.6	27.7	28.8	1.4	14.7	0.3	4.4	M.Gromadzki
H	1961	15.09 – 14.10	327	29.1				7.9				C.Nitecki
	1962	1.09 – 30.10	4 321	91.9		1.1		7.0				P.Busse, M.Gromadzki
	1963	1.09 – 15.10	2 658	86.6		0.1		13.3				B.Olech
	1964	6.09 – 15.10	1 458	69.9		0.1		30.0				W.Kania
	1965	6.09 – 15.10	713	84.2				15.8				M.Gromadzki
	1966	6.09 – 15.10	2 444	76.5				23.5				J.M.Kozłowski, W.Górski
	1967	8.09 – 15.10	988	54.8				45.2				C.Brożek, J.M.Kozłowski
	1969	6.09 – 15.10	574	88.6				11.4				W. Fryc-Weiner, J. Weiner
	$\bar{x}$			82.4		0.4		17.2				
Ł	1962	11.09 – 10.10	575		0.7	80.5	0.3	3.8	14.4		0.2	C.Nitecki
	1963	6.09 – 10.10	7 484		89.0		0.4	0.6	9.9			B.Jabłoński
B	1961	16.09 – 14.10	24 750			99.9				0.1		M.Gromadzki
	1962	10.09 – 10.10	22 462			99.4				0.6		B.Olech
	1963	6.09 – 15.10	28 828			99.9				0.1		P.Busse
	1964	6.09 – 7.10	9 626			100.0						C.Nitecki
	1965	7.09 – 15.10	5 006			99.5				0.5		W.Kania
	1966	6.09 – 15.10	41 311			100.0						P.Busse
	1967	17.08 – 25.10	37 382			99.7				0.3		B.Olech, W.Kania
	1968	17.08 – 25.10	2 813			98.6				1.4		B.Wiatr
	1969	17.08 – 25.10	9 979			98.7				1.3		E.Miara-Górska, R.Hołyński W.Petryna
	1970	6.09 – 10.10	4 984			99.7				0.3		R.Hołyński, M.Goc
	1971	19.08 – 22.10	3 322			97.7				2.3		A.Petryna, W.Kania
	1972	14.08 – 27.10	1 139			93.3	0.3			6.4		
	1973	14.08 – 17.10	2 771			99.6				0.4		A.Petryna
	$\bar{x}$					99.7				0.3		
D	1961	15.09 – 15.10	40 069			99.7			0.3			B.Jabłoński
W	1962	11.09 – 10.10	4 017	19.5	12.2	14.2	24.8	21.2	0.7		7.2	B.Jabłoński
	1963	6.09 – 10.10	2 728	0.2	14.2	65.4	15.3	1.2	2.4	1.2	0.1	C.Nitecki
	1964	6.09 – 15.10	14 241	0.3	37.7	24.5	24.8	0.1	9.5	1.6	1.7	M.Gromadzki, B.Jabłoński
	$\bar{x}$			4.0	29.7	27.8	23.6	4.2	6.9	1.2	2.5	

Table 2. Number of chaffinches caught during Operation Baltic. The thick line separates data from bird stations at different localities. In the years 1961-1963 a much smaller number of nets were used than in later years (Busse, Kania 1970).

Year / Station	Number of chaffinches ringed														Chaffinches of which local, short-term recoveries have been obtained	
	61	62	63	64	65	66	67	68	69	70	71	72	73	Total	*N*	%
NP	53	42	63	251		2			·					411	13	3.2
MWI ▌IV	31	26	140	239	92	182	66	38	90 ▌	70	34	13	56	1077	57	5.3*
MW II					160	321	226	134	248	373	80	72	79	1693	66	3.9*
N		109												109	2	1.8
BG		32												32	—	—
GW ▌Ś	25	19 ▌	23											67	3	4.0
Ż		23												23	1	
H	89 ▌	140	61	198	53	137	6	70	99	93	34	45	118	1143	115	10.0**
$Ł_{62}$		118												118	—	—
$Ł_{63}$			95											95	8	8.4
B	3	5	25	50	8	63	41	7	85 ▌	20	31	13	41	392	39	10.0**
BII ▌J							23 ▌	16	56					95	?	
D ▌W ▌Sd	3 ▌	171	235	291	97	24	▌	7						828	25	3.1
Total	204	685	642	1029	410	729	362	272	578	556	179	143	294	6083	329	5.5

* The difference between MW I/IV and MW II is not significant ($P = 0.10$).

** The differences between MW I/IV and MW II, and H and B are significant ($P < 0.001$).

b) unpublished daily totals of chaffinches caught on the Courland Spit in the years 1961-1973 (LYULEEVA, PAYEVSKY, pers. comm.);

c) results from visual observation of chaffinches on passage across Ottenby and Falsterbo (EDELSTAM 1972, ULFSTRAND *et al.* 1974),

d) recoveries of chaffinches ringed on the Courland Spit in the years 1957-1967 (PAYEVSKY 1971);

e) unpublished recoveries of chaffinches ringed on the Courland Spit in the years 1968-1973 and found in Finland (SAUROLA, pers. comm).

Methods

The methods used for data collecting during the Operation Baltic have been presented in a separate paper (BUSSE and KANIA 1970a), and in this paper

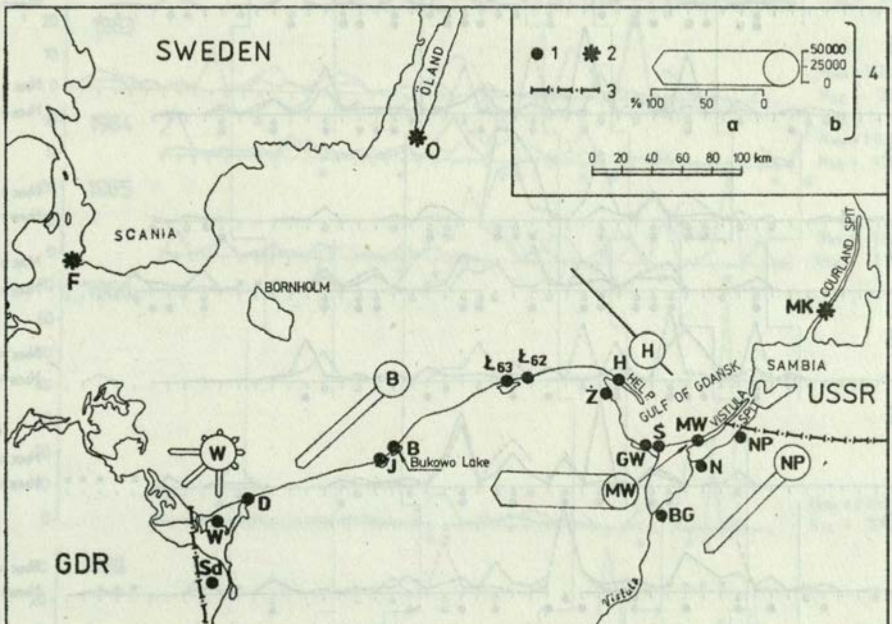
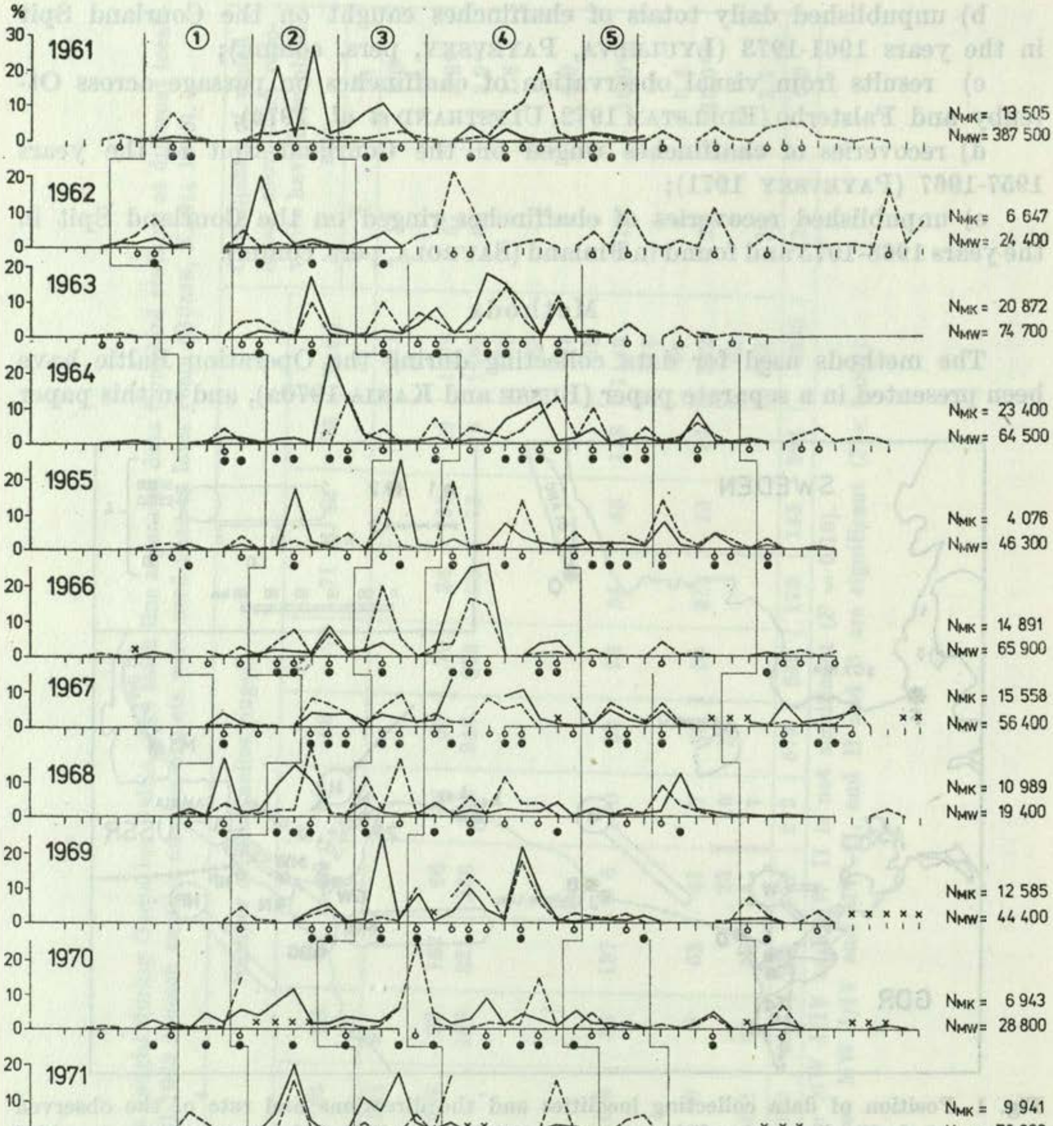


Fig. 1. Position of data collecting localities and the directions and rate of the observed passage of chaffinches at localities where material was collected for many years. 1 — bird stations of Operation Baltic; 2 — bird stations abroad the data of which have been used; 3 —state frontiers; 4 — average distribution of passage directions (a) and average number of individuals (b) observed in the period 11 Sept.- 15 Oct.; B — Bukowo (54°21′ N, 16°17′E); BG — Biała Góra (53°53′N, 18°53′E); D — Dziwnów (54°02′ N, 14°45′E); F — Falsterbo (55°23′N, 12°50′E); GW — Górki Wschodnie (54°20′N, 18°47′E); H — Hel (54°46′N, 18°38′E J — Jamno (54°19′N, 16°10′E); Ł — Łeba (54°45′N, 17°35′E); MW — Vistula Spit (54°21′N, 19°19′E); N — the Nogat Mouth (54°15′N, 19°22′E); NP — Nowa Pasłęka (54°23′N, 19°44′E); O — Ottenby (56°12′N, 16°24′E); MK — Rybachi (55°08′N, 20°42′E); Ś — Świbno (54°20′N, 18°55′E), Sd — Świdwie (53°34′N, 14°22′E); W — Wapnica (53°54′N, 14°23′E); Ż — Żelistrzewo (54°39′N 18°26′E). Abbreviations and geographic coordinates concern bird stations and not the localities of the same name, situated near by.


%
1961
N_MK = 13 505
N_MW = 387 500
1962
N_MK = 6 647
N_MW = 24 400
1963
N_MK = 20 872
N_MW = 74 700
1964
N_MK = 23 400
N_MW = 64 500
1965
N_MK = 4 076
N_MW = 46 300
1966
N_MK = 14 891
N_MW = 65 900
1967
N_MK = 15 558
N_MW = 56 400
1968
N_MK = 10 989
N_MW = 19 400
1969
N_MK = 12 585
N_MW = 44 400
1970
N_MK = 6 943
N_MW = 28 800
1971
N_MK = 9 941
N_MW = 78 000
1972
N_MK = 2 554
N_MW = 22 200
1973
N_MK = 20 504
N_MW = 68 200
①
②
③
④
⑤
⑥
11 13 15 17 19 21 23 25 27 29 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
SEPTEMBER
OCTOBER

their general description only, and some details not included in that paper are given.

In 1961, an observation was conducted during hourly checking of nets, and its duration was not strictly specified, though it lasted in general about 15 minutes.

In the years 1962-1973, the observation was carried out from fixed posts at hourly intervals throughout the day. The observation posts chosen assured

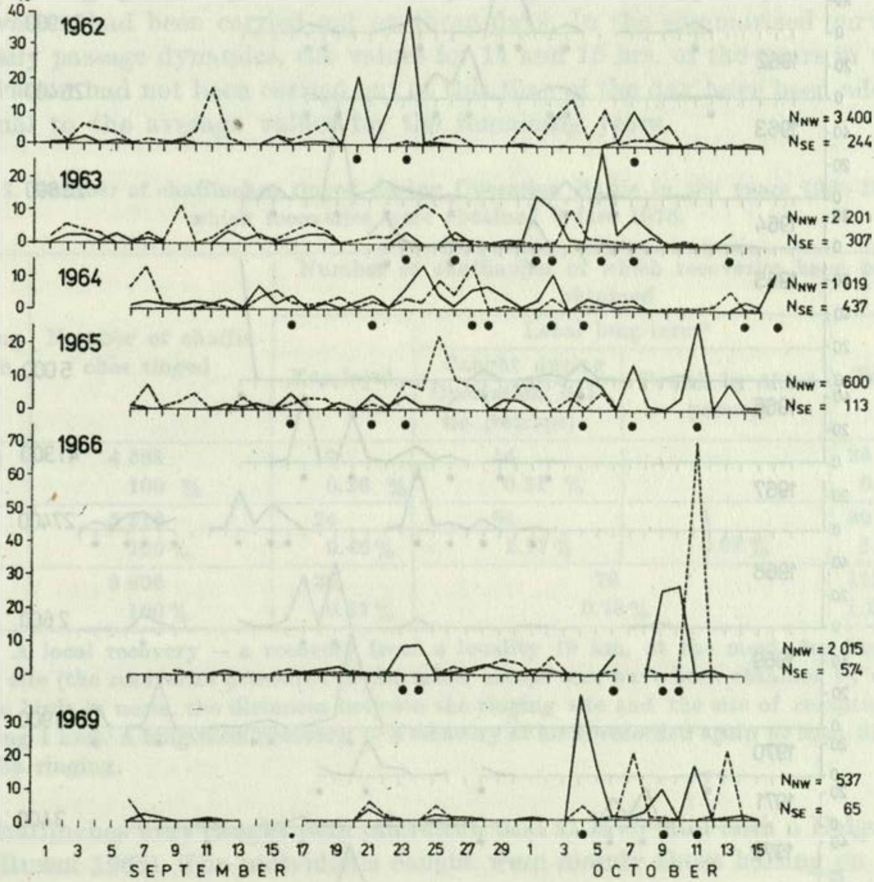


Fig. 3. Dynamics of passage of chaffinches across H in the directions: NW (———) and SE (- - - -). Gaps on the axis of abscissae – days without observation; ● – passage peaks; N – the number, assumed as 100%, of chaffinches observed during passage in the direction NW or SE in the period 6 Sept.-15 Oct.

Fig. 2. Dynamics of passage of chaffinches across MW (———) and MK (- - -). Gaps on the axis of abscissae – days without observation at MW; x – days without capturing at MK; ● – peaks at MW; ○ – peaks at MK; vertical lines – wave boundaries; figures in circles – wave numbers; N – number of chaffinches adopted as 100%: observed (MW) or caught (MK) 11 Sept.–25 Oct.

the best visibility of the passing birds. The only time points without observation were 14 hrs. in the years 1962-1964 and 15 hrs. in 1965, and at some observation posts also in the years 1966-1967.

From 1962 on, the observation time allowed was 15 minutes, but when the passage rate was very high, this time was sometimes reduced to 5 or 10

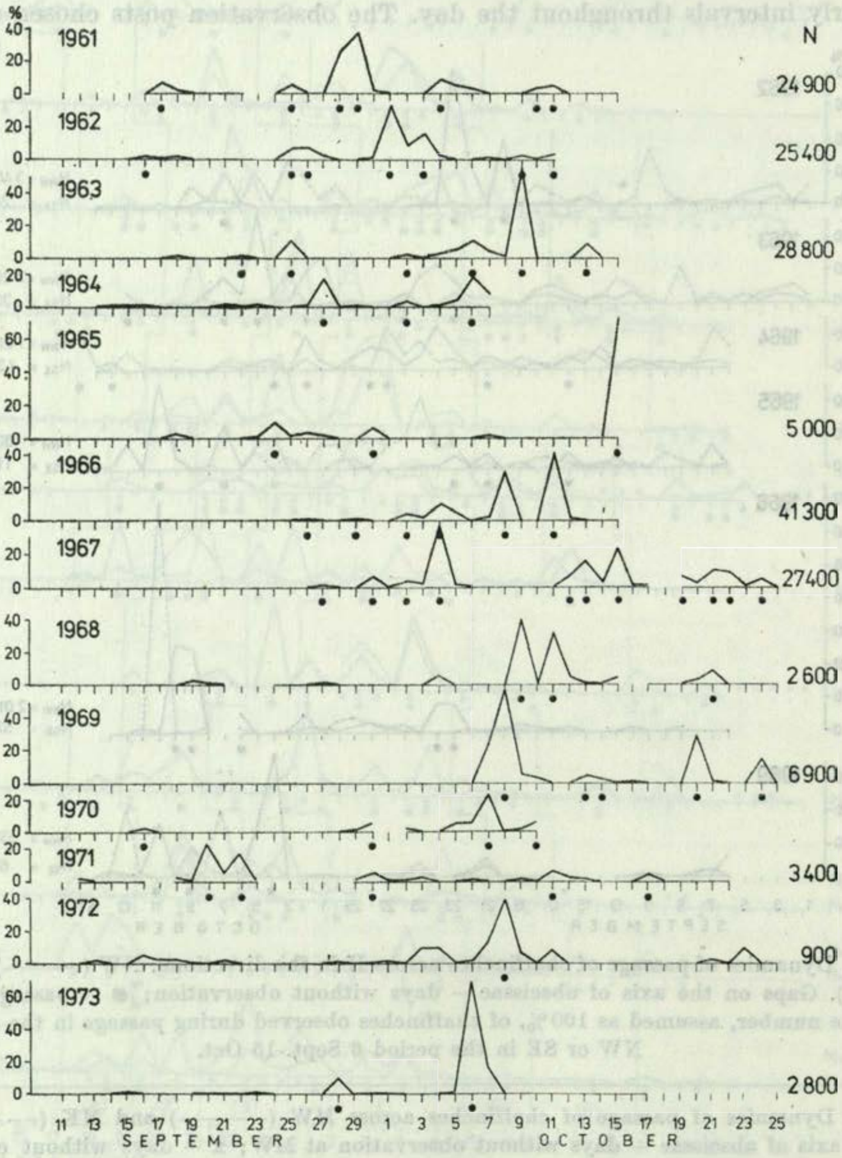


Fig. 4. Dynamics of passage of chaffinches across B. Gaps on the axis of abscissae – days without observation; ● – peaks of passage; N – the number, adopted as 100%, of chaffinches observed in the period 11 Sept.-15 Oct.

minutes. The numbers of passing chaffinches given in the paper concern individuals noticed during 15 minutes' observation periods (in the case of 5 and 10 minutes' observation periods the numbers of chaffinches noticed were adjusted to the standard 15 minutes' basis). Days with no observation have been marked in Figs. 2-4.

When calculating the total numbers of chaffinches observed during all season the numbers of individuals adopted for no-observation days were equal to the average percentage of chaffinches passing on those days in years in which observation had been carried out on those days. In the summarized curves of the daily passage dynamics, the values for 14 and 15 hrs. of the years in which observation had not been carried out at this time of the day have been adopted as equal to the average values for the remaining years.

Table 3. Number of chaffinches ringed during Operation Baltic in the years 1960-1969 of which recoveries were obtained before 1975.

Ringing season	Number of chaffinches ringed	Number of chaffinches of which recoveries have been obtained			
		Non-local	Local long-term*		Total
			Caught during Operation Baltic (retraps)	Found by third persons	
Spring	4 588 100 %	12 0.26 %	14 0.31 %	—	26 0.57%
Autumn	5 218 100%	24 0.46%	61 1.17%	1 0.02%	86 1.65%
Total	9 806 100%	36 0.37%	76 0.78%		112 1.14%

* A local recovery — a recovery from a locality 10 km, at the most, far from the ringing site (the recoveries presented in the table, except one, have been obtained by capturing the birds in nests, the distances between the ringing site and the site of recapture not exceeding 1 km). A long-term recovery — a recovery of birds recorded again at least 91 days after the ringing.

Chaffinches were caught with mist-nets, and at MW* also with a Helgoland trap (Busse 1965). The individuals caught were mainly those halting on their passage, and less frequently birds flying in smaller numbers at a low altitude.

Information on the number of nets and bird catching period can be found in the papers Busse and Kania (1969a,b, 1970a,b, 1972, 1973), Busse, Kania and Petryna (1974).

When considering the staying of chaffinches at the site of their ringing, retrappings on the day of ringing were left out, and so were multiple retrappings on the same day.

* For explanations of bird stations name abbreviations see Figure 1.

The significance of differences was determined by STUDENT'S t test, the similarity of the dates of occurrence of the passage peaks was checked with the chi-square test, and consistency of the dynamics of passage across different bird stations was determined by SPEARMAN'S sequence correlation coefficient (ϱ).

Discussion of methods

The omission of high passages, at an altitude above 150-250 m, at which chaffinches are no longer discernible to the naked eye (DOLNIK 1968) probably does not significantly affect the conclusions that I thought possible to draw on the basis of the data collected. High passage occurs primarily during winds in the direction of migration, or during a calm when the sky is cloudless (DEELDER 1949, GRUYS-CASIMIR 1965). However, such weather conditions are not frequent on the Polish coast in autumn (TARANOWSKA 1968, RAFAŁOWSKI 1971). Apart from this, it is thought (RABØL 1967, ALERSTAM and ULFSTRAND 1972) that the passage at low altitudes accounts for a considerable proportion of the total passage.

Table 4. Percentage of bramblings *Fringilla montifringilla* among *Fringilla* sp. passing across MW in 1973 (observers: P. BUSSE, W. KANIA).

Period	September			October			Total
	16-20	21-25	26-30	1-5	6-10	11-15	
Number of *Fringilla* sp. observed	33	73	194	433	488	21	1 242
% *Fringilla montifringilla*	—	—	3.6	6.5	11.7	9.5	7.6

Chaffinches migrating at low altitudes were in general difficult to overlook. Sometimes, however, e.g. with strong side winds, they concentrated into narrow streams and passed behind a wood or dunes. Flying chaffinches sometimes form such streams even during a calm weather (OKULEWICZ and TOMIAŁOJĆ 1964). At sites not located on narrow spits (NP, MW, Ś, Ż, W), a passing stream may sometimes have been invisible to the observer. Even on the narrow Hel Peninsula it was possible to overlook birds flying low over the meadows situated on the Bay of Puck. However, a failure to notice, for these reason, a relatively small number of birds should not be of any greater significance for the considerations presented in the paper.

During a high-rate migration it was not always possible to tell chaffinches from bramblings, but all the passing waves observed contained a large proportion of chaffinches (Table 4). Only on one day was the number of bramblings greater than 10 %, coming up to 36 %, but this was a day with a low-rate passage (69 *Fringilla* sp.). Also at Falsterbo, chaffinches were found to represent a very considerable percentage of the passing birds of the *Fringilla* genus, while the proportion of bramblings was only greater on low-rate passage days (ULFSTRAND *et al.* 1974). Similarly, HAARTMAN *et al.* (1972) report that only a small number of bramblings join flocks of chaffinches. Because of this, I decided to use data concerning chaffinches with and admixture of bramblings as if they only concerned chaffinches.

The data from MK used for comparisons concern chaffinches caught by means of large traps (ERIK 1967, MEZHENNY 1967) in which mainly passing birds are trapped. According to PAYEVSKY and DONIK (pers. comm.), under the conditions of MK a description of the passage dynamics on the basis of the number of captured chaffinches usually agreed with a visual observation.

RESULTS

Results from passage observation

Directions and rate of passage. Passing chaffinches flew chiefly in the directions from north-west to south-west, along the shoreline. An exception was a passage across some bird stations situated at some distance from the sea-shore (Ż,W: Fig. 1, Table 1). At MW, passage concentrated along the southern shore of the spit.

A reverse passage (i.e., in a direction opposite to the prevailing one), of a noteworthy magnitude, occurred at H, Ł and in some years at B and in areas with much diversified passage directions: Ż and W (Table 1).

In the period 11 Sept.-15 Oct., adopted here as a comparable period (BUSSE and KANIA 1970a), and delimited by the beginning of the regular passage and the most frequent end of observation periods, at MW an average* of 51 303 chaffinches were recorded each year. According to the data for the years in which observation at this station was carried out from 17 Aug. to 15 Nov., the chaffinches observed in the comparable period represented over 90 % of all the chaffinches that passed over the stations during the autumn. At H, an average of 1450 chaffinches were observed, representing 2.8 % (in the individual years 1-3 %) of the passage across MW. The chaffinches that passed across B represented onan average 40 % of those recorded at MW. The average number of chaffinches observed in the comparable period at B was in fact only 14 573, that is, 28 % (4-64 % in the individual years) of those passing across MW, but a high-rate passage across B still continued after 15 Oct. (see page Fig. 7). In those years in which observation at B was continued for a longer time, the chaffinches observed in the comparable period constituted 68 % of those observed between 17 Aug. and 25 Oct. For the years 1967-1969 when it was possible to compare the numbers of chaffinches observed at MW and at B in the period 11 Sept.–24 Oct.,

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*** Average values for the years in which during the period 11 Sept.–15 Oct. there were not more than 7 no-observation days on which not more than 15 % chaffinches passed.**

the chaffinches censused at B represented 81, 15 and 22 % of those recorded at MW.

Passage rate differences between successive years. The result from the observation, those worked out by me (Fig. 5) and those by, in a slightly different way, ABRASZEWSKA-KOWALCZYK (1974), as well as the results of catching (BUSSE 1973) show a decrease in numbers of passing chaffinches in the years 1961-1970, with a transient increase in 1966*, caused by the passage of

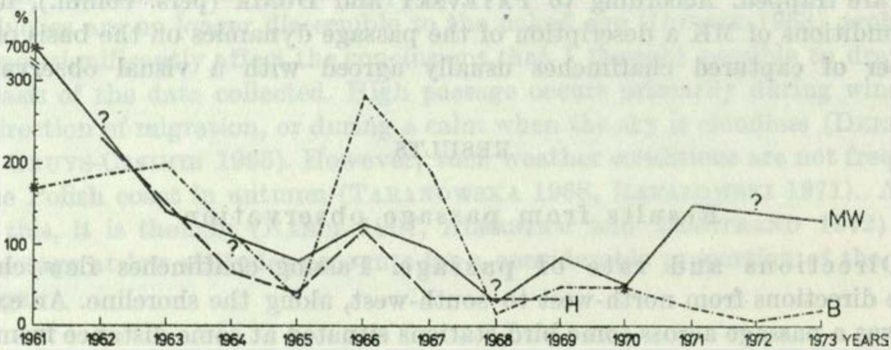


Fig. 5. Rate of passage, observed 11 Sept.–15 Oct., of chaffinches expressed as % of a many years' average (calculated for the years 1963-1971 and 1973, in the case of B with the exception of 1970); * — approximate values; ? — no data.

the fourth wave, particularly numerous in that year (Fig. 6). In 1961, the record year, OKULEWICZ and TOMIAŁOJĆ (1964) observed at 11-12 hrs. on 23 and 25 Sept. the passage of 2000 individuals/minute.

Since bird station MW I, used in the years 1961-1966, was located at some distance from the main stream of passing chaffinches, this being in contrast to bird station MW II (observation started in 1967) situated right on the shore of the Vistula Coastal Lagoon, the differences in the numbers of chaffinches between the first and the last observation years were greater than it would appear from Figure 5 (ABRASZEWSKA-KOWALCZYK 1974, has taken this into account in the method for data interpretation).

In the years 1971 and 1973 more than an average number of chaffinches passed across MW, and only a very small number of them across B. The cause of the differences in 1971 may have been the small numbers of birds in the fourth wave at MW (Fig. 6) that passed also across B, with numerous passages in the second and third waves, not usually observed at B.

Passage dynamics. At MW, mass migration begins between 15 and 25 September, on the average on 20 September (Figs. 2, 7). However, a distinct passage of small flocks to the west can be observed many days before, sometimes at the turn of August. The earliest passage recorded occurred on 28 Aug. 1973

* The indication by ABRASZEWSKA-KOWALCZYK (1974) of a lack of passage across MW in that year is a mistake.

(5, 11, 3, 9, 1, 1 individuals recorded at successive observation 15-minute periods). The latest passage of several thousand chaffinches during a day was recorded on 26 Oct. 1966 (2 360 individuals), but the most intensive passage usually ended in the first 10 days' period of October. The passage peaks* that occurred during the next two weeks were usually formed by smaller numbers of chaffinches and occurred at longer time intervals. In the years 1970, 1972, 1973, when the observation was continued until mid-November, the daily totals of chaffinches observed in the period 26 Oct.–15 Nov. only in four cases slightly exceeded 200, amounting on an average to 26.

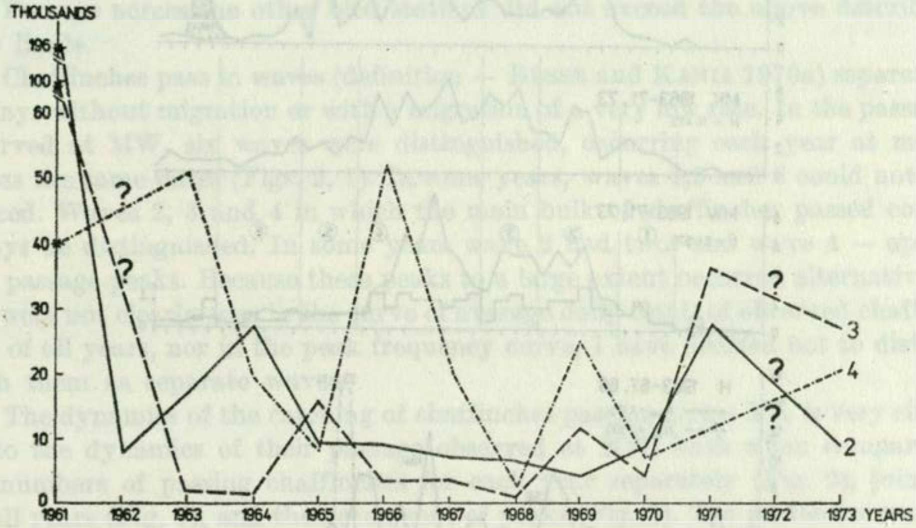


Fig. 6. Rate of passage of chaffinches in waves 2, 3 and 4 at MW. * – approximate data; ? – no data.

At H, a passage could be observed as early as the beginning of the observation period (1 or 6 Sept., Figs. 3, 7) but the rate was very low. The end of the passage across H could not be established, because at that bird station the observation was terminated on 15 Oct. In 1962, when the observation was

* The „passage peak" concept has been defined by Busse and Kania (1970a), but in the statistical calculation a more precise definition was needed. I, therefore, have adopted as days of passage peak 1–3 consecutive days closer to each other in respect of the number of chaffinches than to any other neighbouring days, and satisfying the following conditions: (a) at least one of the extreme days of the peak was characterized by a number of observed migrants at least twice as large as that of the next non-peak day; (b) the number of chaffinches observed on a peak day was not smaller than 500 for MW, 150 for B, and 50 for H, and the number of chaffinches caught on MK not smaller than 50. For MK, as peak days I have considered also all those days on which at least 1000 chaffinches were caught.

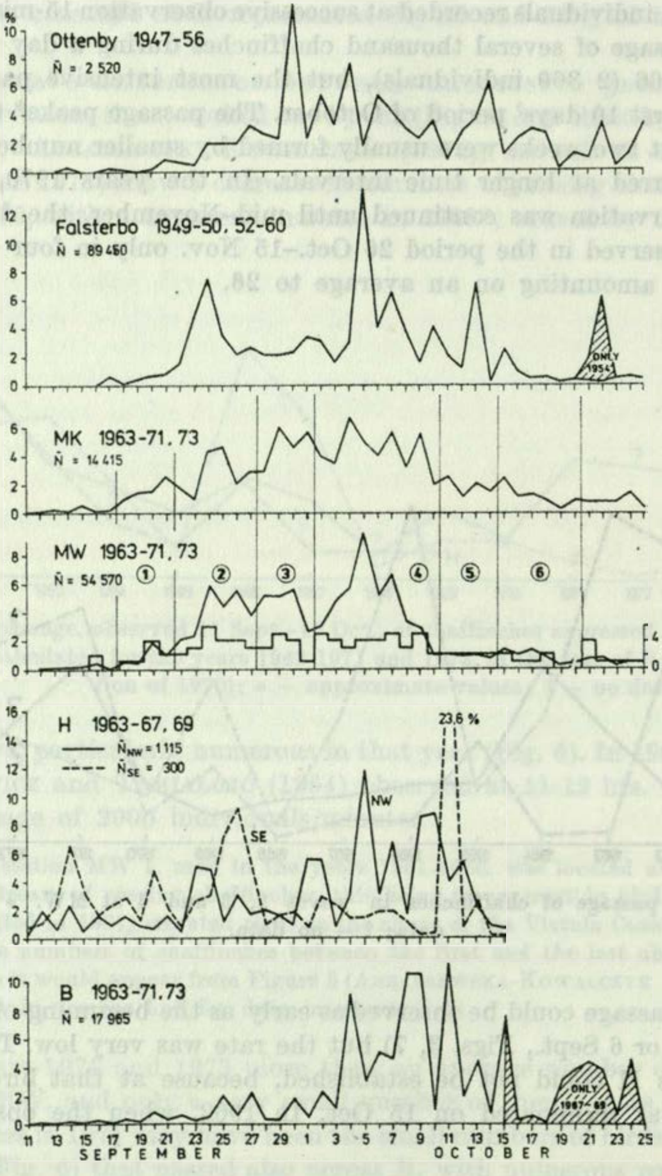


Fig. 7. Average dynamics of passage of chaffinches across different bird stations on the Baltic coast, and the total of peaks found on particular days at MW (the histogram, scale on the right). Vertical lines — wave boundaries; figures in circles — wave numbers; $\bar{N}$ — average number of chaffinches observed or captured (MK) yearly in the periods marked in the graph. The values obtained on the basis of full hours' observations at Ottenby and Falsterbo have been divided by 4.

exceptionally continued until 25 Oct., the passage of chaffinches occurred throughout this time.

The beginning of a fairly intensive migration across B (Figs. 4, 7) often occurred in about the same time as across MW, but it showed a doubled dispersion in the particular years (16 Sept.-9 Oct.). The earliest distinct passage, though of very low intensity, was recorded on 23 Aug. 1969 (3, 4, 6, 7 birds in successive observation periods). In the remaining years (1967, 1968, 1971-1973) the first passage-like flights were recorded in the first or second 10 days' period of September. As there was no observation after 25 Oct., the end of passage of the chaffinches at this site could not be determined.

Passage across the other bird stations did not exceed the above described time limits.

Chaffinches pass in **waves** (definition – BUSSE and KANIA 1970a) separated by days without migration or with a migration of a very low rate. In the passage observed at MW, six waves were distinguished, occurring each year at more or less the same dates (Figs. 2, 7). In some years, waves 1,5 and 6 could not be noticed. Waves 2, 3 and 4 in which the main bulk of chaffinches passed could always be distinguished. In some years wave 2 had two, and wave 4 – up to four passage peaks. Because these peaks to a large extent occurred alternatively and were not clearly seen in the curve of average daily totals of observed chaffinches of all years, nor in the peak frequency curve, I have decided not to distinguish them as separate waves.

The dynamics of the catching of chaffinches passing across MK is very similar to the dynamics of their passage observed at MW, both when comparing the numbers of passing chaffinches for each year separately (Fig. 2), jointly for all years (Fig. 7), and the occurrence of peaks (Fig. 2). The particular waves occur at both these sites most often on the same days. The correlation of the seasonal average values (presented in Figure 7) of the dynamics of the passage of chaffinches across these two bird stations is high (SPEARMAN'S $\varrho = 0.87$). When the dynamics of passage across MW is correlated with the dynamics of passage across MK, shifted back by one or more days, the value of the coefficient decreases. The probability that the occurrence of peaks at MK and MW on the same days is fortuitous, taken into account all the peaks found in the comparable periods in the years 1961-1973, is lower than 0.001. When comparing the dates of the peaks on MW with their occurrence on MK, one or more (up to eight) days earlier, I found that there was no consistency of occurrence ($P>0.7$), except the comparisons where the time difference was 3 days ($P = 0.01$).

BLUMENTAL *et al.* (1967) also distinguished six waves in the passage of the chaffinches across MK. However, the dates of occurence of these waves given by them differ from those given in Figure 7. This is no doubt due to a different approach of the above authors to the problem (they considered as a wave only days with the highest rate passage, leaving out days with a slower rate passage; they divided the wave which corresponded to the fourth wave, as distinguished by me, into two waves) and taking into account by them a smaller number of years (1956-1962).

The passage across H and B can be divided into waves in the same way as the passage across MW, although not all the waves found at MW can be identified here. At B, 54 % of the peaks recorded at MW were found, and at Hel — 37 %. The peaks most often occurred on the same days at all the stations (for MW and H $P = 0.08$, for MW and B $P<0.001$). When the dates of peaks at B are compared with the dates of their occurrence at MW 1-8 days earlier, no consistency of occurrence can be seen ($P = 0.10$ when the difference was 6 days, $P>0.7$ in all other cases).

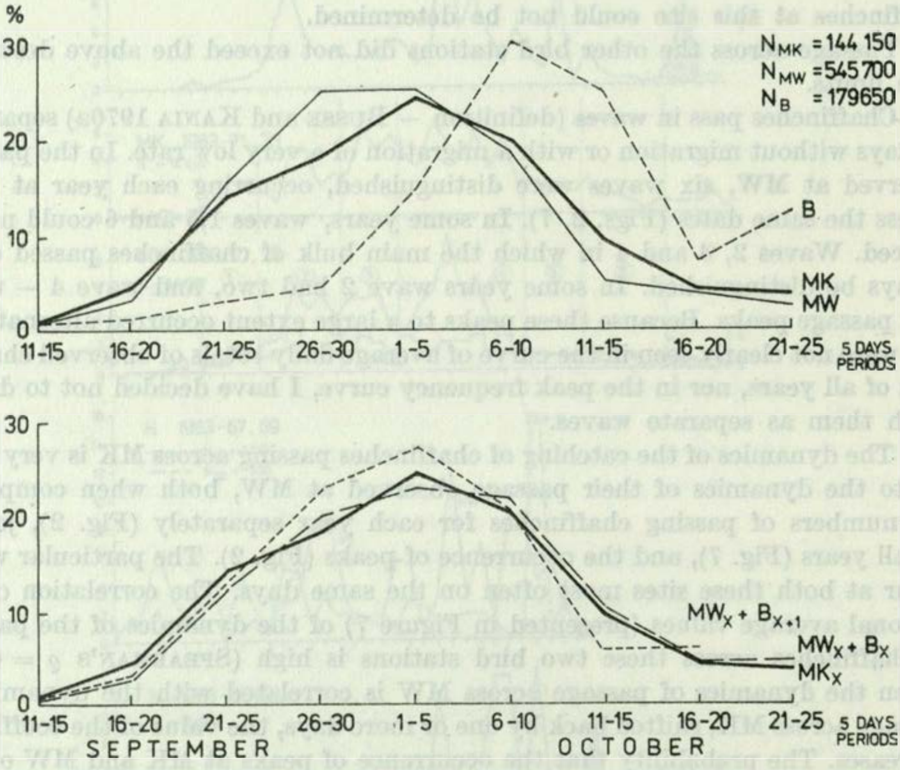


Fig. 8. Top — dynamics of passage of chaffinches across MK, MW and B in the years 1963-1971, 1973. Bottom — a comparison of the passage of chaffinches across MK with totalled passage across MW and B, when the same 5-day periods were totalled ($MW_x + B_x$),)and when 5-day periods at MW were totalled with 5-day periods following them at B ($MW_x + B_{x+1}$).

In September, relatively few chaffinches pass across B, as compared with MW (Figs. 7, 8). There is no greater similarity either between the total dynamics of passage across B and that across MW, shifted backwards by one or more days (when the shift is by 6 days, SPEARMAN'S $\varrho = 0.62$; in other cases it takes values below 0.58). Attention is drawn by the similarity of the joint passage dynamics of chaffinches observed at MW and at B to the dynamics of passage across MK. This similarity occurs when the numbers of chaffinches at MW and at B are totalled for the same 5 days' periods, and when the number of chaffinches observed at MW is added to the number of individuals observed at B one 5 days' period later (Fig. 8).

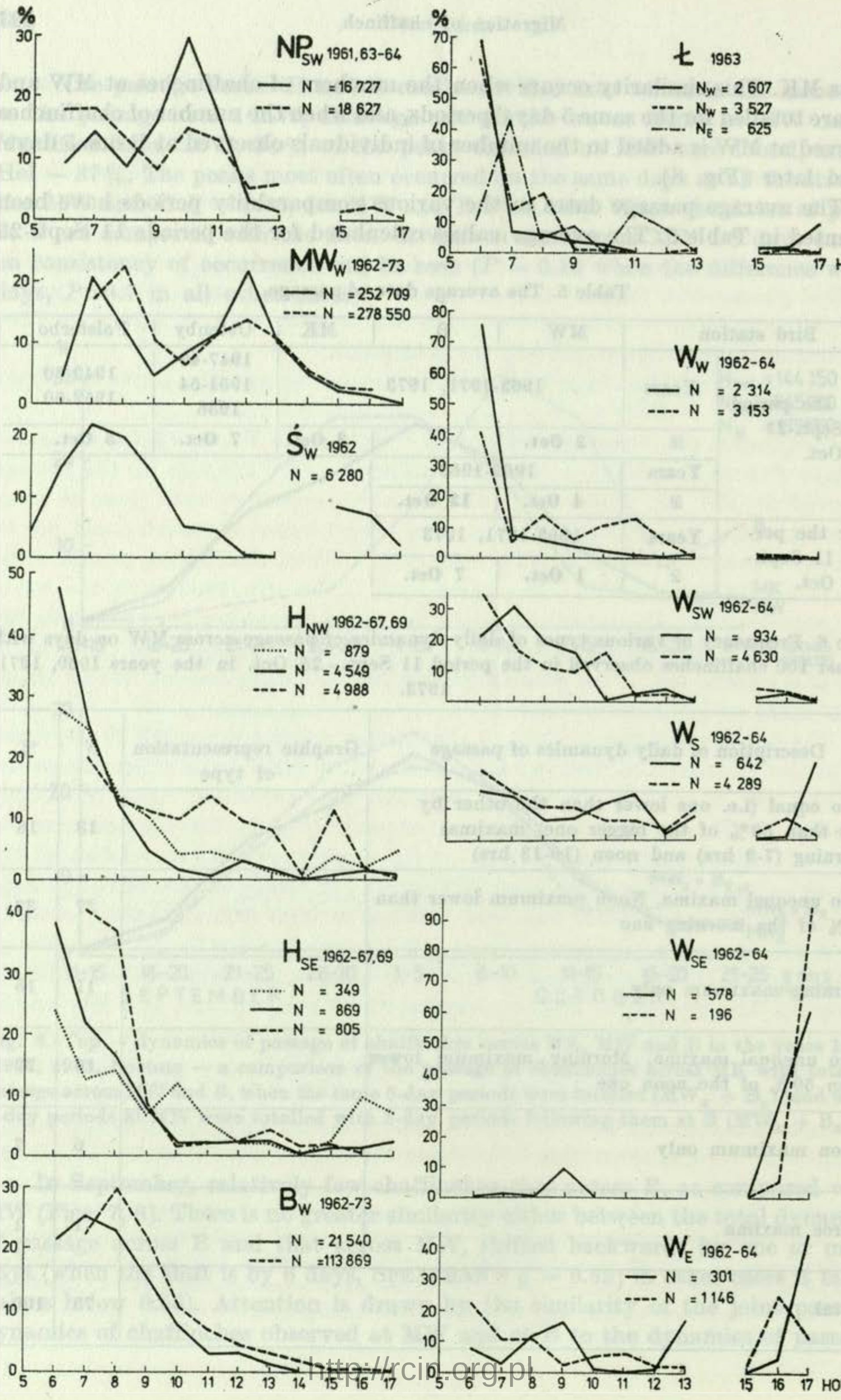
The average passage dates in the various comparablity periods have been presented in Table 5. The average values calculated for the periods 11 Sept.-25

Table 5. The average date of passage.

Bird station		MW	B	MK	Ottenby	Falsterbo
For the period 11 Sept.-25 Oct.	Years	1963-1971, 1973			1947-49 1951-54 1956	1949-50 1952-60
	$\bar{x}$	2 Oct.		3 Oct.	7 Oct.	5 Oct.
	Years	1967-1969				
	$\bar{x}$	4 Oct.	12 Oct.			
For the period 11 Sept.-15 Oct.	Years	1963-1971, 1973				
	$\bar{x}$	1 Oct.	7 Oct.			

Table 6. Frequency of various types of daily dynamics of passage across MW on days with at least 100 chaffinches observed in the period 11 Sept. - 25 Oct. in the years 1969, 1971, 1973.

Description of daily dynamics of passage	Graphic representation of type	N	%
Two equal (i.e. one lower than the other by less than 50 % of the bigger one) maxima: morning (7-9 hrs) and noon (10-13 hrs)		13	18
Two unequel maxima. Noon maximum lower than 50 % of the morning one		27	37
Morning maximum only		11	15
Two unequal maxima. Morning maximum lower than 50 % of the noon one		16	22
Noon maximum only		6	7
Three maxima		1	1
Total		73	100


%
NP SW 1961, 63-64
N = 16 727
N = 18 627
MW W 1962-73
N = 252 709
N = 278 550
Ś W 1962
N = 6 280
H NW 1962-67, 69
N = 879
N = 4 549
N = 4 988
H SE 1962-67, 69
N = 349
N = 869
N = 805
B W 1962-73
N = 21 540
N = 113 869
Ł 1963
N W = 2 607
N W = 3 527
N E = 625
W W 1962-64
N = 2 314
N = 3 153
W SW 1962-64
N = 934
N = 4 630
W S 1962-64
N = 642
N = 4 289
W SE 1962-64
N = 578
N = 196
W E 1962-64
N = 301
N = 1 146
HOURS

Oct. for MW and MK are similar to the real ones. The average values for other stations are too low, because the passage there lasted a longer time and the comparability period did not include all passing chaffinches.

The course of passage during a day. The course of passage within a wave, or during a day varied considerably with respect to both the number of maxima* per day (Table 6) and the time of their occurrence. However, for

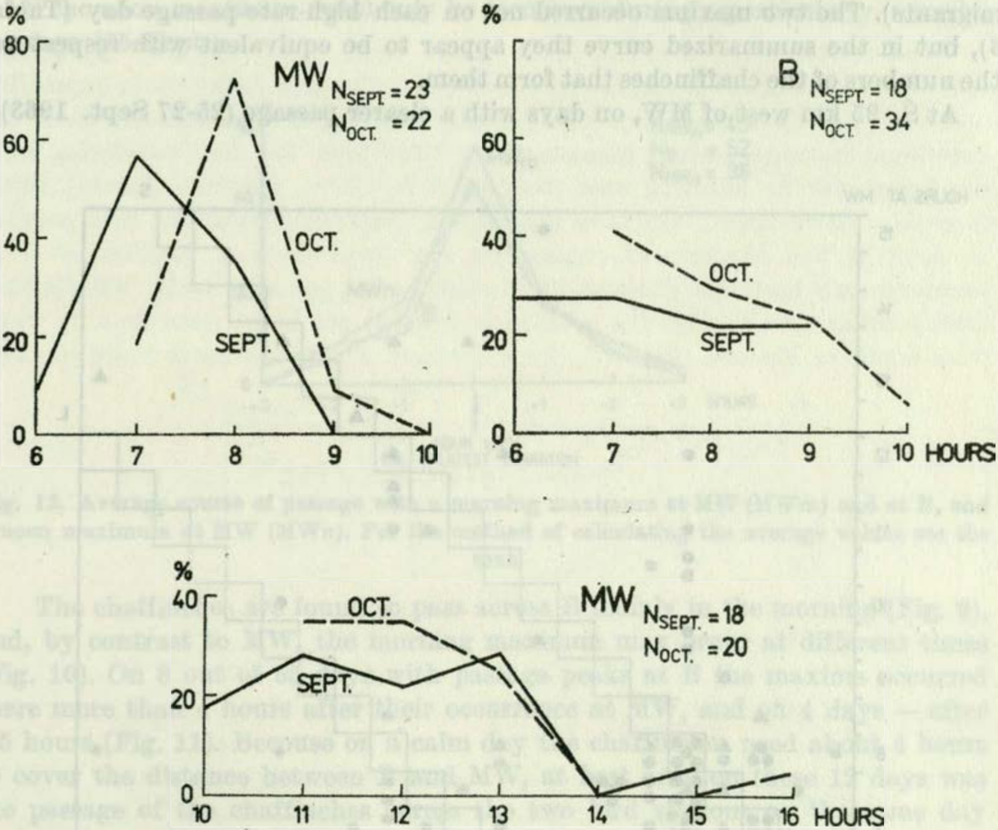


Fig. 10. Morning (MW and B) and noon (MW) passage maxima in September and October. Data for MW of the years 1965, 1969, 1973; for B — of the years 1962-1973. For more detailed explanations see the text.

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* The term "**maximum**" is used to designate a high passage rate in one or several adjacent observation 15-minute periods in an intraday analysis, whereas the term "peak" is reserved for one or several whole days with high passage rate.

Fig. 9. Course of passage of chaffinches during a day. ..... — 1-15 Sept.; ——— — 16-30 Sept.; — — — — —1-20 Oct. (MW, B), or 1-15 Oct. (other bird stations); —·—·— —16-30 Sept., passage on E. Indices given after bird station name abbreviations — direction of passage.

each bird station one most frequent curve type could be distinguished for a particular passage direction. This made it possible to draw a mean curves (Fig. 9). At MW and at NP generally two maxima – a morning maximum and a noon one – occurred. Days with three, or even four maxima were relatively rare, and could usually be regarded to be days with a deformed bimodal passage dynamics, with one of the maxima protracted in time and split up into two parts (e.g. due to the effect of local weather conditions, or chance deviations in the number of recorded migrants). The two maxima occurred not on each high-rate-passage day (Table 6), but in the summarized curve they appear to be equivalent with respect to the numbers of the chaffinches that form them.

At Ś, 25 km west of MW, on days with a clearer passage (25-27 Sept. 1963),

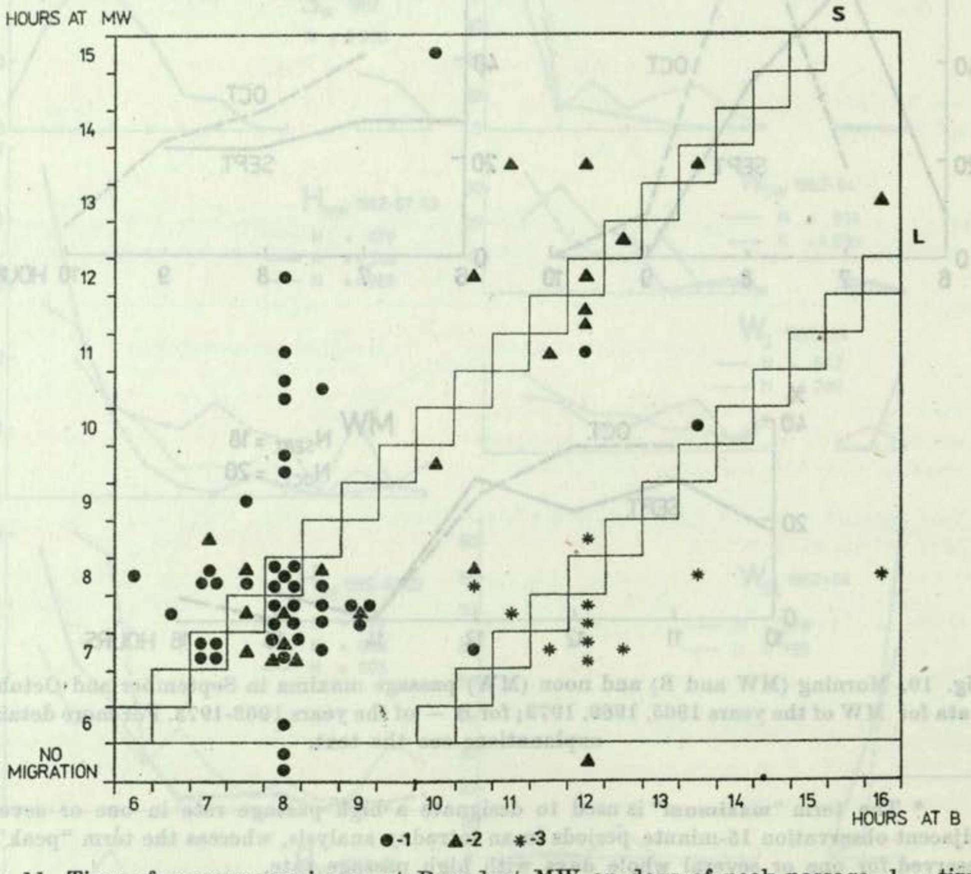

Fig. 11. Time of passage maximum at B and at MW on days of peak passage. 1 – time of occurrence of the maximum on days with one maximum at B; 2 and 3 – time of occurrence of maximum on days with two or three maxima at B; 2 – time of occurrence at MW and at B of maxima of the same sequence, 3 – time of occurrence of the earliest maximum at MW and the latest one at B; S – time of simultaneous occurrence of maximum at MW and at B; L – time of occurrence of maximum at B 4 hours later then at MW.

when over 800 chaffinches were observed daily, all the maxima were found at the same time, or one hour later than at MW. On other days, on which the number of chaffinches observed at Ś was never more than 250, the time difference between the occurrence of maxima at MW and Ś was in most cases more than 1 hour, or the maxima occurred at Ś at an earlier time than at MW. Of 14 compared days, on which over 60 passing chaffinches were observed at Ś each day, 12 were characterized by a morning and by a noon maximum ocurrence at MW. At Ś the noon maximum could only be seen once during a particularly intensive passage (25 Sept.).

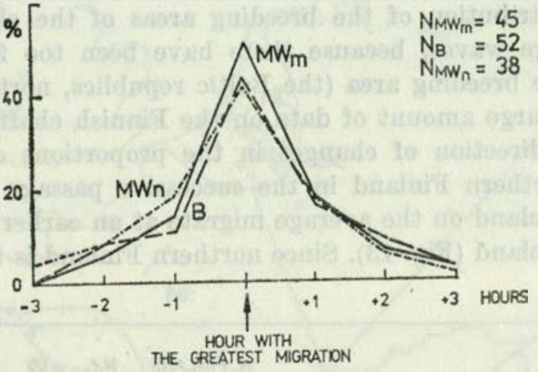

Fig. 12. Average course of passage with a morning maximum at MW (MWm) and at B, and a noon maximum at MW (MWn). For the method of calculating the average values see the text.

The chaffinches are found to pass across B mainly in the morning (Fig. 9), and, by contrast to MW, the morning maximun may occur at different times (Fig. 10). On 8 out of 55 days with passage peaks at B the maxima occurred there more than 4 hours after their occurrence at MW, and on 4 days – after 3.5 hours (Fig. 11). Becouse on a calm day the chaffinches need about 4 hours to cover the distance between B and MW, at best only on these 12 days was the passage of the chaffinches across the two bird stations on the same day possible.

The average course of passage before and after a maximum does not depend on the time of occurrence of it and is the same for MW and B (Fig. 12).

It has been calculated from the results of the first four morning observation periods (6-9 hours in September, 7-10 hours in October), or four observation periods with the largest number of individuals out of six afternoon observation periods (10-15 hours in September, 11-16 in October). The number of birds recorded at the particular times of the four hours' time-period has been presented in per cent and subsequently the largest numbers of birds observed at one observation time on each analysed day were totalled, and so were the numbers of birds observed one, two or three hours earlier or later. Each total was then divided by the number of addends. The quotients have been presented in the form of percentages, adopting their sum total as 100%.

Results of ringing

For the analysis of the relative number of recoveries (Table 3) I adopted a 5 years' period of waiting for a recovery (acc. to PAYEVSKY 1971, for 99% of the 1267 chaffinches ringed at MK the time period between the ringing and the recovery did not exceed 5 years). As the number of foreign recoveries of the chaffinches ringed during the Operation Baltic (Table 3) is not large and over the Polish Baltic coast the same chaffinches pass as over the nearby MK (see page 32), the analysis of the wintering grounds and breeding areas of migrating chaffinches has been made on the basis of the data from there.

Percentage of chaffinches from near and distant breeding areas in successive passage waves. For the time being, it is impossible to assess the distribution of the breeding areas of the chaffinches from the individual passage waves, because there have been too few recoveries from some parts of the breeding area (the Baltic republics, northern Russia). Since there is a fairly large amount of data on the Finnish chaffinches it is possible to describe the direction of changes in the proportions of chaffinches from southern and northern Finland in the successive passage waves. Chaffinches from southern Finland on the average migrate at an earlier time than do those from northern Finland (Fig. 13). Since northern Finland is much more sparsely

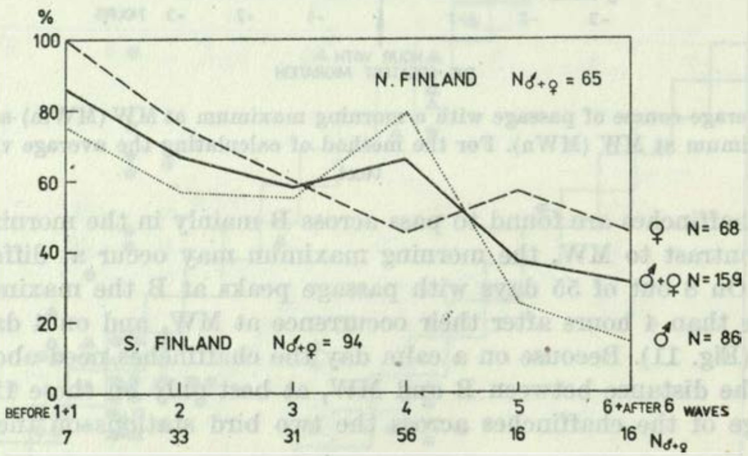

Fig. 13. Percentage of chaffinches from northern and southern Finland (boundary — loxodrome 63°00′N, 20°00′E — 62°00′N, 28°00′E) in the waves of autumn passage, among individuals caught at MK and on the coast of the Gulf of Gdańsk.

inhabitet by people than is the southern part of that country (WALCZAK 1973), rate of recovery in the former is no doubt lower than in areas farther to the south, thus the real proportion of northern-Finnish birds in the particular waves is greater than that found.

Taken into account in the curve presented in Figure 13 are chaffinches found in Finland in the period 16 May-31 Aug., that is, in most cases those after the spring migration and before the autumn migration (HAARTMAN *et al.* 1972). They usually were individuals ringed at MK in the autumn and found in Finland in a later breeding season, after having wintered in SW Europe. For I have thought one can correlate the date of arrival and the place of origin of an individual also when between its recording in the breeding area and during the migration more than one season elapses, because the chaffinches return to the places of their hatching and previous nesting (HAJEK, and BAŠOVA 1963), and they pass across the particular places located on their migration route in successive years, on the whole on the same days (PAYEVSKY 1972).

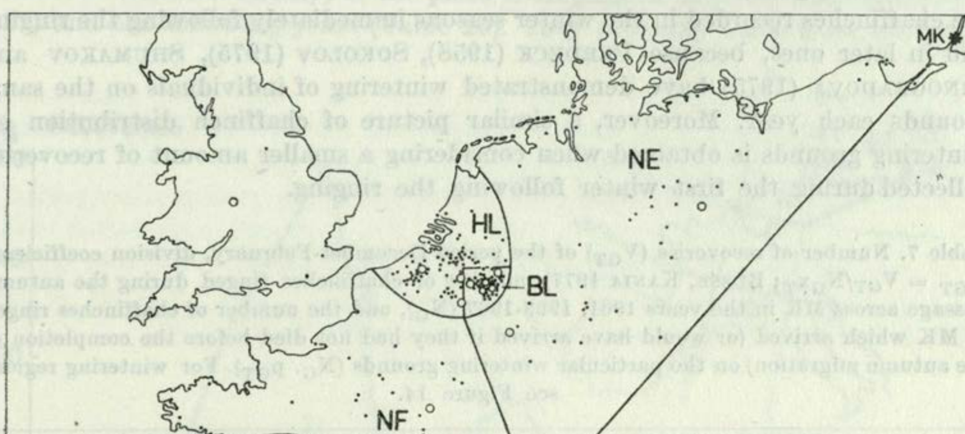

Fig. 14. Localities where chaffinches caught at MK were found (●) and those caught during Operation Baltic (○), and a division of Europe into wintering grounds.

Distribution on wintering grounds and the migration directions of the chaffinches of successive passage waves. Chaffinches of the first waves migrate mainly to the farthest wintering grounds, chaffinches of the middle waves winter in similar numbers on all wintering grounds. They constitute the most numerous group on medium-distant wintering grounds, and together with the former group also on the most distant ones, while chaffinches of the last waves winter mainly on the closest wintering grounds (Fig. 14, Table 7).

In the assessment of the distribution on the wintering grounds of migrant chaffinches from individual passage waves I took into account the number of ringed birds of each wave and the indications coefficient which varied from one wintering ground to another (Busse and Kania 1977). Presented in Table 7 are chaffinches recorded in the winter seasons immediately following the ringing and in later ones, because Perdeck (1958), Sokolov (1975), Shumakov and Vinogradova (1975) have demonstrated wintering of individuals on the same grounds each year. Moreover, a similar picture of chaffinch distribution on wintering grounds is obtained when considering a smaller amount of recoveries collected during the first winter following the ringing.

Table 7. Number of recoveries (V_{GT}) of the period December-February, division coefficients ($p_{GT} = V_{GT}/N_G x_T$; Busse, Kania 1977), number of chaffinches ringed during the autumn passage across MK in the years 1961, 1963-1967 (N_G), and the number of chaffinches ringed at MK which arrived (or would have arrived if they had not died before the completion of the autumn migration) on the particular wintering grounds ($N_G \cdot p_{GT}$). For wintering regions see Figure 14.

Wave	Wintering regions	PP	SF + NF	HL + NE	Total
	Number of ringed chaffinches per 1 recovery (x_T)	1 109	571	1 522	
1-2	V_{GT}	14	6	1	21
	p_{GT}	**0.76**	**0.17**	**0.07**	**1.00**
	$N_G \cdot p_{GT}$	15 556	3 480	1 433	20 469
3-4	V_{GT}	13	37	10	60
	p_{GT}	**0.28**	**0.42**	**0.30**	**1.00**
	$N_G \cdot p_{GT}$	14 213	21 319	15 228	50 759
5-6 and later, up to 31 Oct.	V_{GT}	7	6	7	20
	p_{GT}	**0.35**	**0.16**	**0.49**	**1.00**
	$N_G \cdot p_{GT}$	7 644	3 495	10 702	21 841
Total	V_T	34	49	18	101
	$N_G \cdot p_{GT}$	37 413	28 294	27 363	93 069

Chaffinches migrating at an earlier date migrate in a more southerly direction than do those that migrate later on (Fig. 15). The average date of ringing at MK of the chaffinches recovered at S, as presented in Figure 15 (2.5 Oct.), was earlier ($P = 0.001$) than the average date of ringing of the chaffinches recovered at N (9.2 Oct.).

Origin and duration of stay of the chaffinches caught before migration. Chaffinches caught again at the place of ringing have been divided into two groups: short-staying – retrapped on the fourth day at the latest, and long-staying – retrapped five or more days after the ringing.

The choice of this criterion of divison was suggested by the fact that on the fifth day following the ringing the number of recaptures of chaffinches ringed before migration (Fig. 16) appeared to have decreased noticeably.

Long-staying chaffinches are captured mainly before the onset of an intensive migration (Tables 8, 9). They differ from chaffinches captured for the first time during the migration period also by the higher trappability (connected with the duration of stay) at the place of ringing, in both the same season (Fig. 17) and the following years (Table 10). They probably come from the nearest

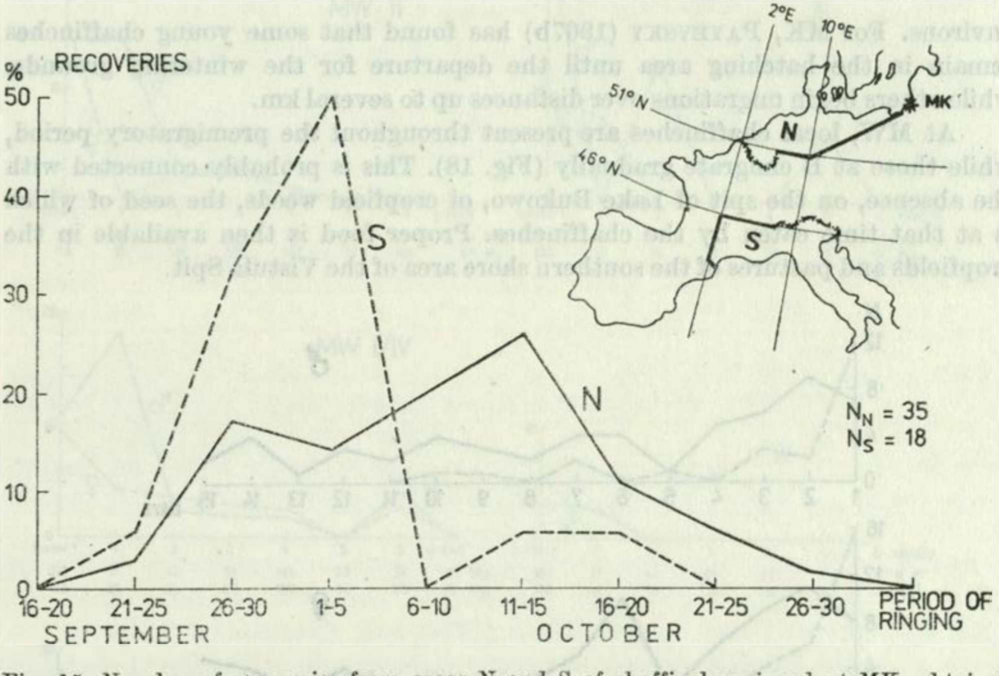

Fig. 15. Number of recoveries from areas N and S of chaffinches ringed at MK, obtained during the first autumn or winter following the ringing.

Table 8. Relative number of long-staying chaffinches (%), depending on the ringing period. Taken into account are only those chaffinches which were retrapped again 15 days, at the most, after ringing, and those ringed at least 15 days before the end of catching at the given station. In brackets — the number of long-and short-staying chaffinches jointly.

	Bird station	MW II + MW I/IV		H		B		Total	
	Sex	♂	♀	♂	♀	♂	♀	♂	♀
Period	Before migration	48 (29)	58 (36)	54 (28)	54 (39)	60 (10)	59 (22)	52 (67)	57 (97)
	Wave 1	50 (4)	— —	50 (2)	— —	— —	— (1)	50 (6)	— (1)
	After wave 1	8 (12)	18 (17)	25 (4)	19 (16)	— (1)	— —	12 (17)	18 (33)

Table 9. Average time interval between the ringing and the last, before the elapse of 15 days, retrapping (days). In brackets — number of individuals.

Period of ringing	Site of ringing / Sex	MW II + I/IV ♂	MW II + I/IV ♀	H ♂	H ♀	Total
	Before the beginning of wave 1	5.9 (29)	6.3 (36)	6.5 (28)	6.1 (39)	6.2 (132)
	During wave 2 and during later waves	1.8 (12)	2.2 (17)	1.5 (4)	3.8 (16)	2.5 (50)

environs. For MK, PAYEVSKY (1967b) has found that some young chaffinches remain in the hatching area until the departure for the wintering grounds, while others begin migrations over distances up to several km.

At MW, local chaffinches are present throughout the premigratory period, while those at B emigrate gradually (Fig. 18). This is probably connected with the absence, on the spit of Lake Bukowo, of cropfield weeds, the seed of which is at that time eaten by the chaffinches. Proper food is then available in the cropfields and pastures of the southern shore area of the Vistula Spit.

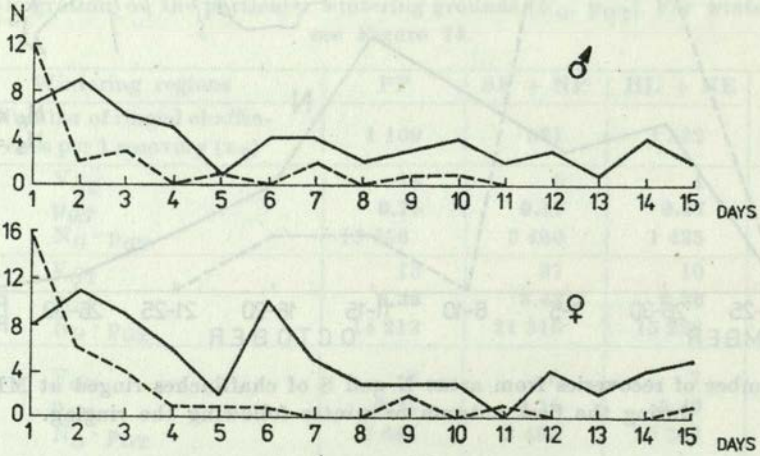

Fig. 16. Time between ringing and the last retrapping at MW and H. ——— — birds ringed in the premigration period; — — — —birds ringed in the migration period. Into account taken only chaffinches retrapped 15 days, at the most, after ringing, and those ringed at least 15 days before the end of work at the given bird station.

At MW the main bulk of local females leave the study area before the onset of the transit migration, while local males still remain during passage wave 1 (Fig. 17, Table 8). This indicates that males show a tendency to start the autumn migration at a later date, this being in agreement with the findings reported by PAYEVSKY and VINOGRADOVA (1974).

Birds retrapped on the site of ringing during one of the following autums were almost exclusively those that had been ringed in the premigration period.

Their recording for the second time, too, derived mainly from that period, but took place more often in the migration period than did the ringing (Table 10). Since both young and old (i.e., over one year of age) birds are ringed, and at the time of being recorded for the second time all the individuals retrapped were

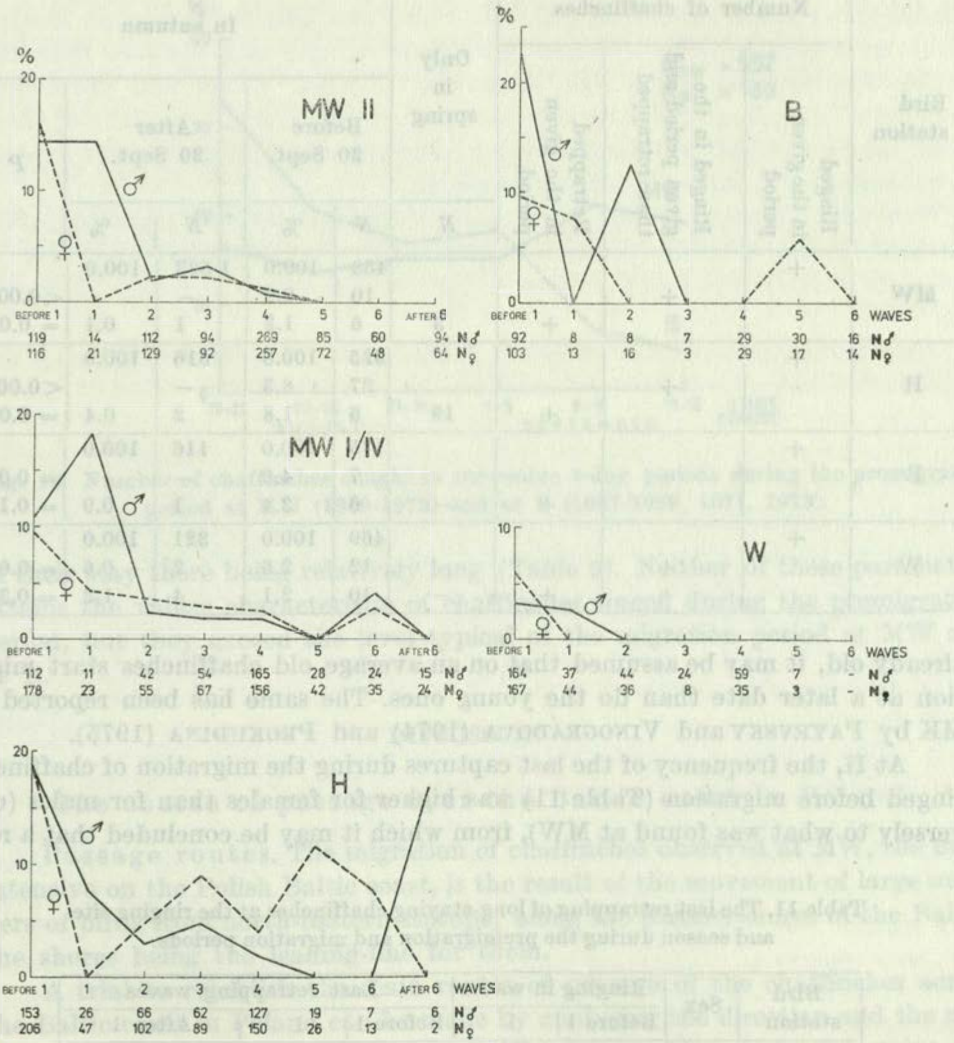

Fig. 17. Percentage of male nad female chaffinches ringed during the passage of various waves and retrapped at the place of ringing after 15 days at the most. N — number of chaffinches of the given sex, ringed in the given wave. Data of the years 1961-1973 (MW, H, B) and 1962-1964 (W). The values for the periods: after wave 6 at MW II and from wave 4 at MW I/IV, H and B may be too low, because in some years these periods ended less than 15 days before the end of catching at the bird station H, ♀: the difference between the premigration period and waves 1-4 is significant ($P \leqslant 0.02$). Waves 5 and 6 do not differ significantly from the premigration period, or from wave 1 ($P \geqslant 0.08$).

Table 10. Number of chaffinches ringed in the autumn of 1961-1969, of which local long-term recoveries were obtained in the years 1962-1974. In the case of birds retrapped more than once taken into account is the earliest retrapping. Data from different bird stations are not comparable, because of different catching periods.

Bird station	Number of chaffinches: Ringed in the given period	Number of chaffinches: Ringed in the given period and than retrapped	Number of chaffinches: Retrapped in the given period	Only in spring	In autumn: Before 20 Sept.		In autumn: After 20 Sept.		P
				N	N	%	N	%	
MW	+				458	100.0	1 523	100.0	
		+			10	2.2	—		<0.001
			+	3	6	1.3	1	0.1	= 0.02
H	+				325	100.0	516	100.0	
		+			27	8.3	—		<0.001
			+	19	6	1.8	2	0.4	= 0.07
B	+				175	100.0	116	100.0	
		+			7	4.0	—		= 0.01
			+	—	6	3.4	1	0.9	= 0.13
W	+				469	100.0	321	100.0	
		+			12	2.6	2	0.6	= 0.05
			+	—	10	2.1	4	1.2	= 0.33

already old, it may be assumed that on an average old chaffinches start migration at a later date than do the young ones. The same has been reported for MK by Payevsky and Vinogradova (1974) and Prokudina (1975).

At H, the frequency of the last captures during the migration of chaffinches ringed before migration (Table 11) was higher for females than for males (conversely to what was found at MW), from which it may be concluded that a rela-

Table 11. The last retrapping of long-staying chaffinches at the ringing site and season during the premigration and migration periods.

Bird station	Sex	Ringing in waves: Before 1	Ringing in waves: 1	Last retrapping waves: Before 1	Last retrapping waves: 1	Last retrapping waves: After 1	
MW II + I/IV	♂	40 100%		30 75%		10 25%	P = 0.04
	♀	38 100%		35 92%		3 8%	
H	♂	33 100%		30 91%		3 9%	P = 0.05
	♀	41 100%		25 61%		16 39%	

tively large proportion of local females remain there also during high-rate passages. By contrast to the males and also to chaffinches of either sex from other bird stations, passing females trapped on the Hel Peninsula are also comparatively often retrapped at the site of ringing (Fig. 17), the duration

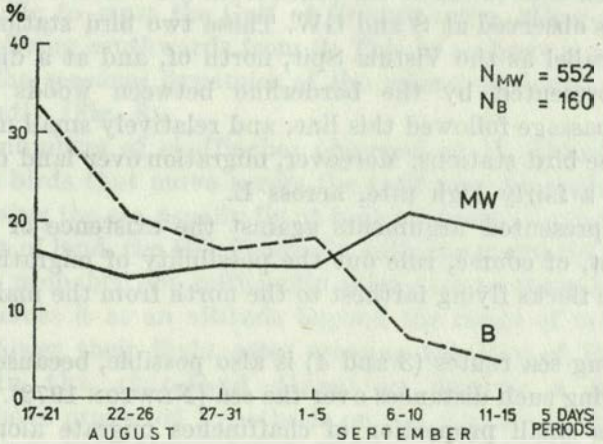

Fig. 18. Number of chaffinches caught in successive 5-day periods during the premigration period at MW (1969-1973) and at B (1967-1969, 1971, 1973).

of their stay there being relatively long (Table 9). Neither of these parameters attains the values characteristic of chaffinches ringed during the premigration period, but they exceed the level typical of the migration period at MW and at B.

DISCUSSION

The course of passage over the Baltic coast in Poland

Passage routes. The migration of chaffinches observed at MW, the most intensive on the Polish Baltic coast, is the result of the movement of large numbers of birds from north-eastern Europe, along the eastern shores of the Baltic, the shores being the leading-line for them.

A trial to establish the main routes of passage of the chaffinches across the Baltic coast in Poland can be made by analysing the direction and the rate of the passage over each bird station. The key problem is to determine the route followed by the chaffinches observed in large numbers on the spit of Lake Bukowo. Four routes may be considered: (1) a land route, across the Courland Spit and the Vistula Spit; (2) a gulf route, across the Courland Spit, Sambia and the Gulf of Gdańsk; (3) a sea route, over the Baltic from Latvian coasts to the coast west of the Gulf of Gdańsk; (4) a sea route from Sweden (Fig. 1).

To migrate over land, the chaffinches leaving the Vistula Spit would have to fly west, or even in a direction slightly deviated to the north but the observations described on page 13 indicate that chaffinches migrating over the east-west segment of the Vistula Spit congregate at its southern bank, so their standard direction is deviated to the south from the western direction. A similar phenomenon was observed at Ś and GW. These two bird stations were located on the same parallel as the Vistula Spit, north of, and at a distance from the leading-line represented by the borderline between woods and cropfields. Chaffinches on passage followed this line, and relatively small numbers of them passed across the bird stations. Moreover, migration over land does not explain the passage, of a fairly high rate, across Ł.

The above-presented arguments against the existence of mass-migration over land do not, of course, rule out the possibility of migrating from MW to B of parts of the flocks flying farthest to the north from the main axis of migration.

Passage along sea routes (3 and 4) is also possible, because chaffinches are capable of covering such distances over the sea (Newton 1972). It seems, however, that only a small proportion of chaffinches migrate along these routes. It may be assumed that since the route along the coasts of Latvia, Lituania and the Courland Spit is more convenient than passage over the sea (there is no danger of drift, Alerstam and Pettersson 1977, with only a slightly longer distance to cover), natural selection eliminates those chaffinches which too firmly stick to the standard direction and try to migrate from Latvia across the sea. Radar observations carried out by Alerstam and Ulfstrand (1972) in the period 21 Sept.–10 Oct. 1971 speak against the possibility of high rate migration of chaffinches from Scania (4). According to these authors, some chaffinches leave the coasts of Scania and move in directions from SE to SSE (23 % echoes). If they continue to follow the same direction until they arrive on Polish coasts, it is near Bukowo that individuals which have flown farthest in the E direction will reach land. They cannot, therefore, represent the majority of the streams observed there. Moreover, there have been no recoveries from the Polish coast of birds ringed on Öland, while there have been such recoveries from regions west of the frontiers of Poland (Perdeck 1970). There have, in fact, been reports on chaffinches migrating from Bornholm southwards, towards the Polish coast, but they only concerned a small number of individuals (Biering and Sillehoved 1964).

The land (1) and sea (3 and 4) routes having been eliminated, the most probable migration route followed by the chaffinches observed at B is the gulf route (2).

Thus the passage of chaffinches over the southern coast of the Baltic may be imagined as follows. Chaffinches migrating across the Courland Spit and following the standard migration direction, more west-deviated than the line connecting the southern tip of this spit to the Vistula Spit, reach the western coast of Sambia. As this coast and the standard direction form a large angle, with favourable weather conditions a large proportion of these birds set out on migration across the Gulf of Gdańsk (about 100 km, i.e., a 2 hours' flight). After covering this distance, they pass over northern Pomerania and concentrate along a leading-line formed by the coast segment north-east of B. Chaffinches that do not decide to cross the Gulf of Gdańsk move along the Vistula Spit and pass by B, flying southwards from it. This hypothesis is supported by the consistency of the seasonal dynamics of the migration across MK, and across MW and B jointly (Fig. 8).

The small numbers of chaffinches observed at H, situated on the route followed by the birds that move across the Gulf may be explained as follows. Chaffinches crossing the sea usually fly at high altitudes (GRUYS-CASIMIR 1965). As a narrow strip of land, the Hel Peninsula with the mainland visible immediately behind it is probably not sufficiently attractive to these birds, so in most cases they fly across it at an altitude beyond the range of usual observation, and they only lower their flight after crossing the Bay of Puck.

Changes in the standard direction during a passage. To be complete, the above-presented hypothesis on the migration across the Gulf of Gdańsk requires an explanation why chaffinches appear at B in large numbers at a date much later then could be calculated by adding the time needed by them to cover that distance to the dates of their mass appearance in the region of the Gulf of Gdańsk. For the average date of their movement across B is later by at least eight days than the date of crossing the MW (Table 5). The restoration of energy reserves, which may be expected to take place in an area located between these stations, requires on an average only a 3 days' interval in the migration (BLUMENTHAL *et al.* 1967), and the flight over that distance — one day.

The retarded average passage across B, relative to the passage across MW, can be explained if the assumption is made that chaffinches migrate across the Gulf of Gdańsk mainly in the later period of their movement, and there is no migration across the Gulf in the initial period, whereas all chaffinches migrate across the Vistula Spit. It would follow, therefore, that at the beginning, the standard direction followed by the chaffinches flying across Sambia is more south–deviated than it is in the later period.

A different standard direction at various localities along the migration route has been known for Scandinavian chaffinches (Perdeck 1970). In the case of the Finnish–Russian chaffinches we would be dealing with different standard directions at the same locality, but in different time periods. The existence of a similar situation on the north–eastern coast of Lake Ladoga is indicated by the variation in numbers of the chaffinches moving in the NW and SE directions in the successive periods of migration in 1962: 20-30 Sept. about 35% of chaffinches flew to NW, and 6-20 Oct. — over 97% (SIMIN 1969).

The coast–shape–forced direction of the real migration of chaffinches across MK and MW does not in fact change, but individuals moving at a later time in a more west-deviated standard direction reach the western coasts of Sambia at a greater angle and they more often decide to cross the Gulf of Gdańsk than do those birds which migrate at an earlier time.

The cause of a change in the standard direction of chaffinches crossing the southern coast of the Baltic may be:

a) a migration of birds mixed together during the migration, but representing two populations, the standard directions of which are different. The observed changes in this direction would result from changes in the proportions of birds from the two populations, in the successive migration waves;

b) a gradual change in the standard direction of individuals, progressing with their individual time of migration;

c) a simultaneous change of the standard direction of all chaffinches, regardless of the locality at which they are at the given point of time.

The changed standard direction concept explains the later passage across MK of the chaffinches recorded in Belgium, Holland and northern Federal Republic of Germany, relative to that of the chaffinches recorded in south-eastern France and in Italy (Fig. 15).

The later average date of passage at MK relative to that at MW which is more distant from the breeding sites (Table 5), and the later date of passage end at the former bird station (in the period 9-25 Oct. 25 % of chaffinches pass across MK and 15 % across MW) become clear if the fact is taken into account that not all the chaffinches recorded at MK in the second part of the migration pass across MW, because some of them choose the route across the Gulf of Gdańsk.

A similar explanation may be given in the case of the longer (Fig. 7) and on an average later, than at MK and MW (Table 5), migration across Ottenby on Öland which is crossed also by Finnish chaffinches (Perdeck 1970). Because of the change of the standard direction, at a later stage of migration, to a more west-deviated one, a greater proportion of the Finnish chaffinches then move over the sea to the Swedish coast.

Halting places of chaffinches on passage. According to Gruys-Casimir (1965) and Dolnik (1974), chaffinches migrate mainly in the morning, this being confirmed by the data analysed in the present paper. The additional noon maximum, recorded at MW and at NP (Fig. 9), may have been caused by specific terrain conditions. Chaffinches moving along the eastern coast of the Baltic for an afternoon feeding connected with a night rest, may have stopped only on the Sambian Peninsula and in areas north of the Courland Spit. Because of their small area and the woods covering a large proportion of it, the Courland Spit and the Vistula Spit certainly do not provide suitable feeding sites for such large numbers of birds of this species. If we take into account the fact that at the time of the most intensive migration the sun rises between 5^{20} and 6^{00} hrs, that the average speed of flight of the chaffinches is 52 km/hour (Sokołowski 1950), and that the distance between MW and Sambia is 60 km, and from the northern edge of the Courland Spit – 200 km, and assuming that the main bulk of birds sets out on migration an hour after sunrise, we may presume that the chaffinches passing across MW and NP in the morning maximum have begun that day's migration from Sambia, and the chaffinches passing in the noon maximum from areas north of the Courland Spit.

The occurrence of the maxima at B, most often at about the same time as at MW (Fig. 11), indicates that chaffinches starting on their daily migration from Sambia and crossing the Vistula Spit, or the Gulf of Gdańsk, usually do not reach B on the same day. The absence of the noon maximum at Ś, with the morning one present, indicates that chaffinches moving from Sambia continue their migration after crossing the Vistula Spit, while individuals which have crossed the Courland Spit and Sambia stop immediately after leaving the Vistuula Spit. This finding agrees with the view held by BLUMENTHAL *et al.* (1967) that during an intensive migration chaffinches cover an average distance of 250 km during a day.

By contrast to MW, the morning maximum at B occurs at a different time each day (Fig. 10). This probably results from the fact that the chaffinches moving across this station may have started on their daily migration from localities situated at different distances from it, because east of B there are large areas providing suitable feeding grounds for these birds.

The occurrence at H of the highest migration rate in the morning (Fig. 9) indicates that most of the chaffinches that had stopped on the peninsula after crossing the Gulf of Gdańsk restarted their migration only after passing the night there.

Origin of passing chaffinches. The chaffinches migrating across the Baltic coast in Poland come from the Lithuanian SSR, Latvian SSR, Estonian SSR, from Finland, from the Karelian ASSR, and from the north-European part of the Russian, FSSR (BUSSE and GROMADZKI 1966, 1967a, 1967b, 1969, 1970, PAYEVSKY 1971, GROMADZKI 1973). From the latter territory, only three recoveries have been reported by PAYEVSKY (1971): from the Novgorod region, western part of the Arkhangelsk region and from the Komi ASSR. However, since chaffinches are not ringed in this part of the Russian FSSR, and the recovery rate is low there, it is not certain whether these recoveries really mark the north-eastern range of the chaffinches migrating across the Polish coast, or whether the range continues further north, or ends in regions less distant – while the findings mentioned here concern birds that had found themselves beyond this range exceptionally. The latter possibility seems to be particularly probable in the case of the recovery from the Kozvinsk region in the Komi ASSR, slightly north of the range of the species, as reported by DEMENTIEV and GLADKOV (1954) and FLINT et all. (1968).

The view held by PAYEVSKY (1967a) that the limit of the north range of the chaffinches migrating across the Courland Spit runs along parallel 64° N cannot be considered as documented. PAYEVSKY's opinion is based on a small number of recoveries from regions north of this parallel. The cause of this may be, however, not the migration of chaffinches from areas north of 64° N by a route not running across the Courland Spit, but a low rate of recovery due to a factor mentioned on page 24, and a small number of chaffinches breeding there (MERIKALLIO 1958).

As it foollows from the considerations on page 32, Swedish-Norwegian chaffinches represent at the most a small admixture among the chaffinches migrating across the western part of the Polish Baltic coast.

At least from a part of the origine area of the chaffinches passing across the Polish coast some individuals move along a different route. This has been proved for Finland, from where part of the chaffinches migrate across Sweden (PAYEVSKY 1967a, PERDECK 1970).

Passage sequence of chaffinches from different areas. Chaffinches from different breeding areas situated along the southern and eastern Baltic coasts begin their autumn migration at dates depending on the distance to the wintering grounds of the species. The shorter is the distance, the later they start, and on the average the earlier cross each bird station on the passage route (Fig. 19). This is indicated by the later dates of crossing by chaffinches localities nearer to the wintering grounds (PAYEVSKY 1967a), the departure of most of the local chaffinches before the beginning of the transit passage, as recorded at MW, H (page 28) and MK (PAYEVSKY 1967a, 1971, PAYEVSKY and VINOGRADOVA 1974, PROKUDINA 1975), and an earlier, on an average, date of passage across MK of southern-Finnish chaffinches, relative to those from northern Finland (Fig. 13). Simultaneously, the presence of Finnish chaffinches already in the first wave indicates that there is no time isolation among the passing chaffinches from different breeding areas, which also follows from PAYEVSKY's (1971) considerations.

Earlier PAYEVSKY's hypothesis (1967a) that the transit passage across MK is started by one wave of non-Finnish chaffinches followed by waves containing birds from Finland, is contradicted by the data collected later on (Fig. 13, PAYEVSKY 1971).

The first wave distinguished by PAYEVSKY (1967a), ocurring 15–16 Sept., consisted of a very small number of birds (Figs 2 and 7): from the material at my disposal I have not identified them as a separate wave. The absence from it of chaffinches found later on in Finland resulted from the low probability of finding even one of them among the few individuals caught.

It may seem that the departure of local chaffinches from localities on the migration route before the appearance there of the transmigrants is in contradiction with the lack of time isolation among the transmigrants from different areas and the earlier passage of chaffinches across areas located farther NE than across areas closer to the wintering ground (PAYEVSKY 1967a), as well. These discrepancies disappear, however, if we accept the migration pattern as presented in Figure 19.

Payevsky (1967a) supposes that the departure of local chaffinches before onset of passage of transmigrants may only be characteristic of narrow spits, along which birds will migrate at a high rate at a later time, and that it is caused by the migration of local birds into the mainland. It is possible, however, that this time separation at the start of migration is true of the whole area here discussed. If so, the migration in the first phase would have to be slow, and consequently chaffinches moving faster from areas farther to NE would soon join to individuals beginning their migration (Fig. 19).

In view of the above considerations, my unpublished concept, quoted

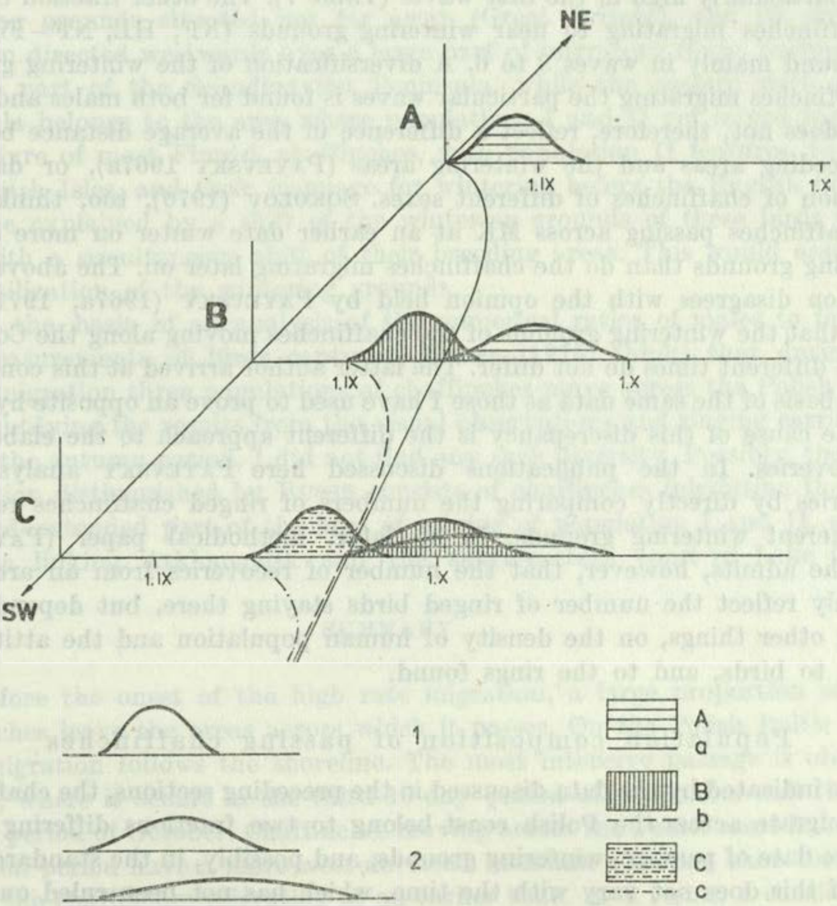

Fig. 19. Dates of departure and passage of chaffinches from populations A, B and C across hypothetical bird stations located in the breeding areas of these populations, along the NE-SW axis of the autumn migration. 1 – departure of the local population; 2 – passage of the population from more NE-extended areas; A-C – departure/passage of individual populations. a-c – passage of the first individuals from the particular population across the areas located between bird stations.

by Busse (1972, 1976), of a time-isolated passage of chaffinches from separate breeding areas, which I have suggested on the basis of the data collected during the autumns of the years 1961-1964, and which Busse adopted for the spring migration, must be rejected in the case of the autumn migration.

Wintering grounds of passing chaffinches

The chaffinches migrating across the Polish coast can be divided into two fractions. One of them consists of individuals migrating to distant wintering grounds (PP, SF – Fig. 14). It is represented in all the waves, its proportion being particularly high in the first waves (Table 7). The other fraction consists of chaffinches migrating to near wintering grounds (NF, HL, NF – Fig. 14). It is found mainly in waves 3 to 6. A diversification of the wintering grounds of chaffinches migrating the particular waves is found for both males and females, it does not, therefore, reflect a difference in the average distance between the breeding areas and the wintering areas (Payevsky 1967a), or dates of migration of chaffinches of different sexes. Sokolov (1976), too, thinks that the chaffinches passing across MK at an earlier date winter on more distant wintering grounds than do the chaffinches migrating later on. The above interpretation disagrees with the opinion held by Payevsky (1967a, 1971) who states that the wintering grounds of the chaffinches moving along the Courland Spit at different times do not differ. The latter author arrived at this conclusion on the basis of the same data as those I have used to prove an opposite hypothesis. The cause of this discrepancy is the different approach to the elaboration of recoveries. In the publications discussed here Payevsky analyses the recoveries by directly comparing the numbers of ringed chaffinches recorded on different wintering grounds. In his later, methodical paper (Payevsky 1973) he admits, however, that the number of recoveries from an area does not only reflect the number of ringed birds staying there, but depends also, among other things, on the density of human population and the attitude of people to birds, and to the rings found.

Population composition of passing chaffinches

As indicated by the data discussed in the preceding sections, the chaffinches that migrate across the Polish coast belong to two fractions differing in the average date of passage, wintering grounds, and possibly, in the standard direction (if this does not vary with the time, which has not been ruled out). The first two migration waves consist mainly of chaffinches of only one fraction, migrating to distant wintering grounds, and probably in a more south-deviated standard direction (see the above reservation). Later on, the migration of chaffinches of both fractions follows, the number of birds of the first fraction in the last waves decreasing considerably.

The following hypothesis is to explain the nature of the fractions and the origin of the above-described relationship between them. Waves 1 and 2 consist mainly of population I, originating from areas nearer to the Polish coast, while later migration involves chaffinches from areas farther to the north where this population gets mixed with population II, whose wintering grounds are less distant, and standard direction is more west-deviated.

As in the case of the crow (BUSSE 1969), a mixing may have occurred of two populations which, after the retreat of the glacier, colonized areas adjacent to the Baltic, moving south–west on both its sides.

The winter distribution of the recoveries of chaffinches ringed in Scandinavia (PERDECK 1970) seems to indicate that a pure population II, with its wintering grounds situated not far away (Great Britain), and its standard direction directed westwards over a large part of migratory route, occupies the western part of the Scandinavian Peninsula, while the eastern part of this peninsula belongs to the area where populations I and II get mixed together. The failure of most Finnish chaffinches, with population II features, to reach the British Isles, and their stoppage for wintering before the English Channel could be explained by a shift of the wintering grounds of these birds to the east, with a simultaneous shift of their breeding areas. This would assure an even utilization of the wintering grounds.

On the basis of an analysis of the numerical ratios of males to females, and measurements of birds captured, BUSSE (1976) thinks that during the spring migration three populations of chaffinches move across the Polish coast. When sutdying the results from the visual observations and ringing carried out during the autumn period, I did not find any such diversity. Possibly, the third population distinguished by BUSSE consists of chaffinches inhabiting the most eastward–extended part of the area of mixing of population I and II, east of the line linking Arkhangelsk and the south-eastern coast of Lake Onega.

SUMMARY

Before the onset of the high rate migration, a large proportion of local chaffinches leave the areas across which it passes. On the Polish Baltic coast, mass migration follows the shoreline. The most intensive passage is observed at MW, where it occurs in the third 10-day period of September and the first 10–day period of October. Chaffinches moving across the Polish coast late in the migration period have a more west-deviated standard direction than the direction of the chaffinches migrating at an earlier time. As a result, a considerable proportion of them move from Sambia across the Gulf of Gdańsk and can be observed at B, while the chaffinches moving at an earlier time pass almost exclusively across MW and are represented at B by small numbers.

Passage across MW and MK, in six waves, occurs every year at about the same dates. The most intensive migration is observed in morning hours. Only at MW and at NP does a second, noon maximum daily passage dynamics occur.

Chaffinches crossing these bird stations in the morning probably spend the preceding night on the Sambian Peninsula, while those passing at noon probably spend the night in an area north of MK. Chaffinches crossing B on different days start their migration at different distances from that station. The average course of passage during a day does not depend on the time at which the maximum occurs, and is the same for MW as for B.

The chaffinches that move across the Polish Baltic coast originate from the Soviet Baltic republics, Finland and the north-western part of the Russian FSSR. Although chaffinches from all these areas are found throughout the migration period, individuals nesting in areas nearer to the Polish coast cross at an earlier date than do chaffinches from more distant breeding grounds. The wintering grounds of these chaffinches begin already in Poland and extend in the south-western direction as far as the Pyrenean Peninsula, but they do not include Great Britain and Italy. Chaffinches migrating at earlier dates winter mainly on more distant wintering grounds, whereas chaffinches moving at a later time tend to winter on less distant wintering grounds.

The facts summarized above permit the following hypothesis. Chaffinches migrating across the Polish Baltic coast possess migratory habits typical of two geographic populations. One of these (with a passage time on an average earlier, more distant wintering grounds, and, probably, a more south-deviated standard direction) consists of individuals nesting in areas along the south-eastern coast of the Baltic. The characteristic features of the other population, found in its pure form in the western part of the Scandinavian Peninsula (with a passage time on an average later, not distant wintering grounds, and, probably, a more west-deviated standard direction), can be seen in some individuals nesting in an area where the two populations are mixed together. The area in question is situated on the Gulf of Bothnia north-west of the areas of occurrence of the former population.

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STRESZCZENIE

[Jesienna wędrówka zięby *Fringilla coelebs* przez polskie wybrzeże Bałtyku]

Opis i analizę jesiennej wędrówki zięb oparto na wynikach obrączkowania i wizualnych obserwacji przelotu dokonanych podczas Akcji Bałtyckiej w latach 1961-1973 (ryc. 1-5, tab. 1-3), a także na Mierzei Kurońskiej, w Ottenby i Falsterbo.

Przed rozpoczęciem się intensywnej wędrówki znaczna część zięb miejscowych opuszcza tereny, przez które wędrówka ta będzie przebiegać. Samice i ptaki młode odlatują średnio wcześniej, niż samce i ptaki stare. Przelot koncentruje się wzdłuż linii brzegowej. Najintensywniejszy przelot obserwuje się

w MW (skróty nazw punktów badawczych podano na ryc. 1) i w trzeciej dekadzie września i pierwszej października. Zięby, wędrujące przez nasze wybrzeże w późniejszej części okresu wędrówkowego, mają bardziej zachodni kierunek standardowy, niż zięby wędrujące wcześniej. Skutkiem tego znaczna ich część leci z Sambii nad Zatoką Gdańską i jest obserwowana w B, podczas gdy zięby wędrujące wcześniej lecą prawie wyłącznie prze MW i w B są reprezentowane nielicznie.

Wędrówka przez MW i MK odbywa się w sześciu falach występujących corocznie w mniej więcej tych samych terminach (ryc. 7). Najintensywniejszy przelot ma miejsce w godzinach rannych. Drugie, południowe maksimum dziennej dynamiki przelotu występuje jedynie w MW i NP (ryc. 9). Zięby, wędrujące przez te punkty rano, poprzednią noc prawdopodobnie spędzają na Półwyspie Sambijskim, następną zaś na zachód od Wisły, podczas gdy zięby wędrujące w południe, przypuszczalnie nocują na północ od Mierzei Kurońskiej, a następnie między Mierzeją Wiślaną a Wisłą. Zięby przylatujące przez B mogą nocować w rozmaitych odległościach od tego punktu. Średni przebieg przelotu w godzinach poprzedzających i następujących po maksimum dynamiki dziennej nie zależy od godziny wystąpienia maksimum i jest jednakowy na MW i B (ryc. 12).

Zięby wędrujące przez polskie wybrzeże Bałtyku pochodzą z radzieckich republik nadbałtyckich, Finlandii i północno-zachodniej części Rosyjskiej FSRR. Mimo że zięby ze wszystkich tych obszarów są stwierdzane w czasie całego okresu wędrówkowego, osobniki gnieżdżące się bliżej naszego wybrzeża przelatują przez nie średnio wcześniej, niż zięby z lęgowisk dalej położonych. Zimowiska badanych zięb zaczynają się już na terenie Polski i rozciągają się na południowy-zachód aż po Półwysep Pirenejski, nie obejmując Wielkiej Brytanii i Włoch (ryc. 14). Zięby wędrujące wcześniej zimują głównie na zimowiskach dalszych, podczas gdy zięby wędrujące później mają tendencję do zimowania na zimowiskach położonych bliżej.

Na podstawie podsumowanych wyżej faktów można przyjąć następującą hipotezę. Przez polskie wybrzeże Bałtyku przelatują zięby o zwyczajach wędrówkowych charakterystycznych dla dwóch populacji geograficznych. Jedna z nich (o średnio wcześniejszym przelocie, dalszych zimowiskach i prawdopodobnie bardziej południowym kierunku standardowym) gniazduje na terenach położonych wzdłuż południowo-wschodniego wybrzeża Bałtyku. Cechy charakterystyczne dla drugiej populacji, występującej w stanie czystym w zachodniej części Półwyspu Skandynawskiego (średnio późniejszy okres przelotu, bliskie zimowiska i przypuszczalnie bardziej zachodni kierunek standardowy), wykazuje część osobników, gniazdujących na obszarze zmieszania obu tych populacji, rozciągającym się nad Zatoką Botnicką na północny-zachód od terenów występowania populacji pierwszej.

Redaktor pracy — doc. dr hab. Maciej Gromadzki

Contents

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Uspenski, S.M. 1970. Waterfowl of the Soviet arctic and subarctic regions (in Russian with English summary). Finnish Game Res. 30: 97-100.

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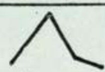
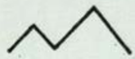
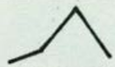
Errata

Table 6 on p. 393 should be of the following form:

Description of daily dynamics of passage	Graphic representation of type	*N*	%
Two equal (i.e. one lower than the other by less than 50% of the bigger one) maxima: morning (7-9 hrs) and noon (10-13 hrs)		13	18
Two unequal maxima. Noon maximum lower than 50% of the morning one		27	37
Morning maximum only		11	15
Two unequal maxima. Morning maximum lower than 50% of the noon one		16	22
Noon maximum only		6	7
Three maxima		1	1
Total		73	100

On p. 400, line 15 from above, it should be read $V_{GT} \cdot x_T/N_G$ instead of $V_{GT}/N_G x_T$.